Energy Masterplan for Vauxhall Nine Elms Battersea Opportunity Area

Wandsworth Borough Council

November 2012

PARSONS BRINCKERHOFF

Energy Masterplan for Vauxhall Nine Elms Battersea Opportunity Area

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Glossary

AAP	Area Action Plan
AMR	Annual Monitoring Report
CCGT	Combined cycle gas turbine
CCL	Climate Change Levy
CEM	Contract Energy Management
CHP	Combined Heat and Power
CIBSE	Chartered Institute of Building Services Engineers
CIL	Community Infrastructure Levy
CRBO	Community Right to Build Order
DCLG	Department for Communities and Local Government
DEN	Decentralised Energy Network
DG	Distributed generation
DH	District Heating
DNO	Distribution network operator
DPCR	Distribution Price Control Review
DPD	Development Plan Documents
DUoS	Distribution use of system
EfW	Energy from Waste
EPN	Eastern Power Networks
ESCo	Energy Services Company
ETC	Environmental Technologies Complex
FTE	Full Time Equivalent
GCV	Gross calorific value
GFA	Gross Floor Area
GLA	Greater London Authority
HTHW	High temperature hot water
HV	High voltage
IWMF	Integrated Waste Management Facility
ktpa	Kilo tonnes per annum
LBC	Lambeth Borough Council
LDA	London Development Agency

LDDs	Local Development Documents
LDO	Local Development Order
LPN	London Power Networks
MSW	Municipal Solid Waste
MUSCo	Multi-utility Services Company
MW(e)(th)	Mega-watt (electrical) (thermal)
NDO	Neighbourhood Development Order
NDP	Neighbourhood Development Plan
NPV	Net present value
OAPF	Opportunity Area Planning Framework
PB	Parsons Brinckerhoff
PPA	Power Purchase Agreement
PPA	Planning Performance Agreement
PPS	Planning Policy Statement
RDF	Refuse Derived Fuel
RHI	Renewable Heat Incentive
ROC	Renewable Obligation Certificate
RRP	Resource Recovery Plant
SIGE	Spark ignition gas engine
SPD	Supplementary Planning Document
SPG	Supplementary Planning Guidance
SPV	Special purpose vehicle
SRF	Solid Recovered Fuel
TfL	Transport for London
TWUL	Thames Water Utilities Limited
UKPN	United Kingdom Power Networks
WBC	Wandsworth Borough Concil
WDHS	Whitehall District Heating System
WID	Waste incineration directive

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1 EXECUTIVE SUMMARY

1.1 Opportunity

1.1.1 The Vauxhall Nine Elms Battersea Opportunity Area (VNEB OA) includes some of the highest density, large-scale development anywhere in London. As such, it offers huge potential for the development of a coherent, low carbon energy supply system. The VNEB OA could host the integration of an efficient, low-carbon energy hub and avoid the emergence of piecemeal, stand-alone solutions in individual development sites.

1.2 Benefits

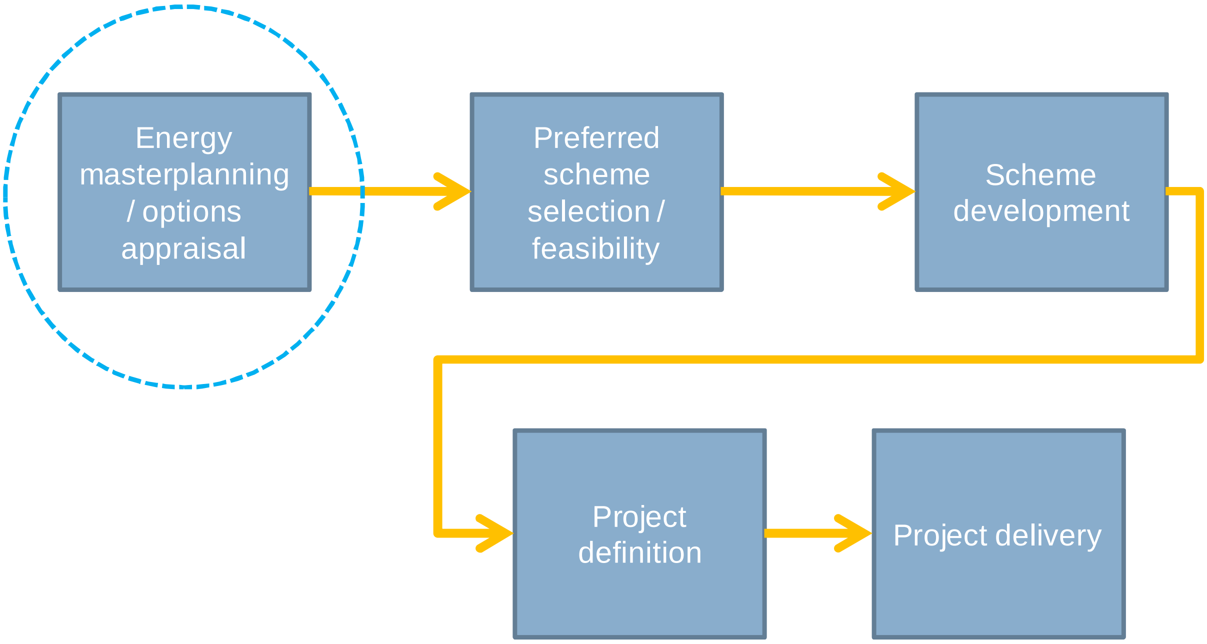
1.2.1 The development of a rationalised energy supply strategy offers the potential to provide cost-competitive low carbon heat and will also allow the area to benefit from future technological advances. Replacement of a single item of central plant can be carried out with considerably more ease than the replacement of multiple individual installations. This aspect of centralised supply represents a future-proofing of energy supply.

1.2.2 Centralising heat generation plant to one or two locations within the OA will allow significant opportunities to benefit from economies of scale. These economies could be seen in utility procurement, deployable plant types, and efficiencies. Despite the high capital cost of installation, these economies and efficiencies allow low carbon energy to be delivered in a cost-competitive manner.

1.3 Development

1.3.1 This masterplan is the first stage in the development of a low carbon energy solution for the area and this report contains a number of proposed solutions. These are presented as a 'proof of concept' rather than a concrete proposal that must be adhered to. A number of variants of the solution proposed here would perform comparably. Further stages of feasibility and design development are required to lead to a defined scheme to take forward to procurement and implementation. A notional diagram of the process is shown here:

Figure 1-1 Overall project development process



1.4 Methodology and results

1.4.1 This report is based on energy demand data gathered from energy statement submissions and development phasing information provided by Wandsworth and Lambeth. These energy demand data have been processed to show how demand changes over time. The data illustrate a high demand density and swift emergence of key clusters of demand, particularly around the junction of the boroughs of Wandsworth and Lambeth close to Vauxhall station.

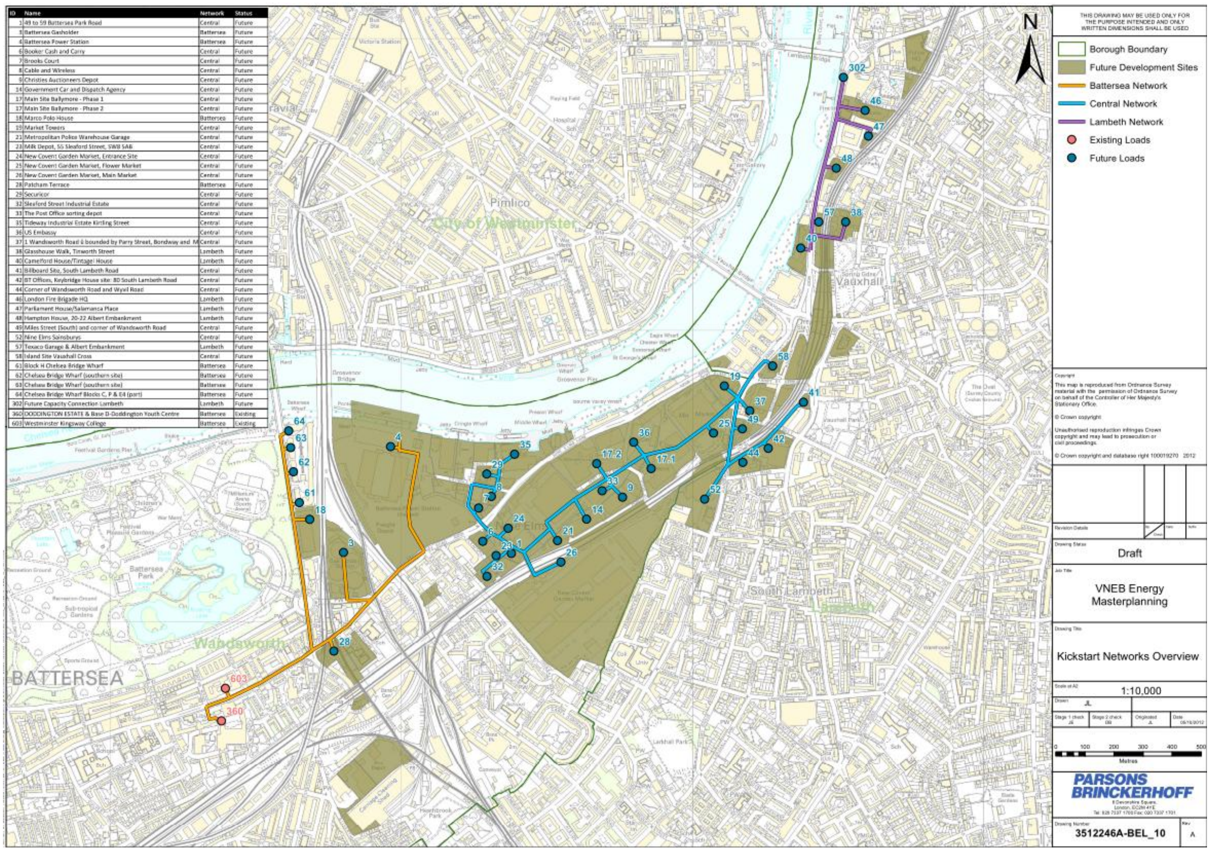
1.4.2 The projection of phased heat demands has in turn lead to the conceptual development of heat distribution networks to link demand nodes. A number of network permutations have been considered. The configurations presented here represent a good balance between the aspiration to develop strategic wide-area coverage, and the requirement to deliver a commercial scheme. The configuration proposed has been modelled in terms of its changing technical performance over time (i.e. how primary plant would operate against the growing demands of both network expansion and additional loads connecting to sections of network), and in terms of its financial performance.

1.4.3 A number of assumptions have been made in relation to both operating and capital cost inputs. We would emphasise that at this high level of study, there is clearly a substantial margin of variation that must be expected. However, the figures used are considered sensible and appropriate within the parameters of the level of analysis undertaken. The results of the study are considered to show the likely trends of performance that could be expected from strategic infrastructure implementation. The analysis undertaken has divided the OA into three separate 'kick-start' networks. These groupings have been developed from analysis of the quanta of development emerging at different times and in different parts of the OA. The kick-start networks aim to minimise pipework infrastructure requirements for the linking of key loads, thereby maximising annual incomes from heat sales with a capital outlay that is kept as low as feasible for the deployment of a future-proofed system.

1.4.4 The three networks developed are termed:

- Lambeth
- Central[1]
- Battersea

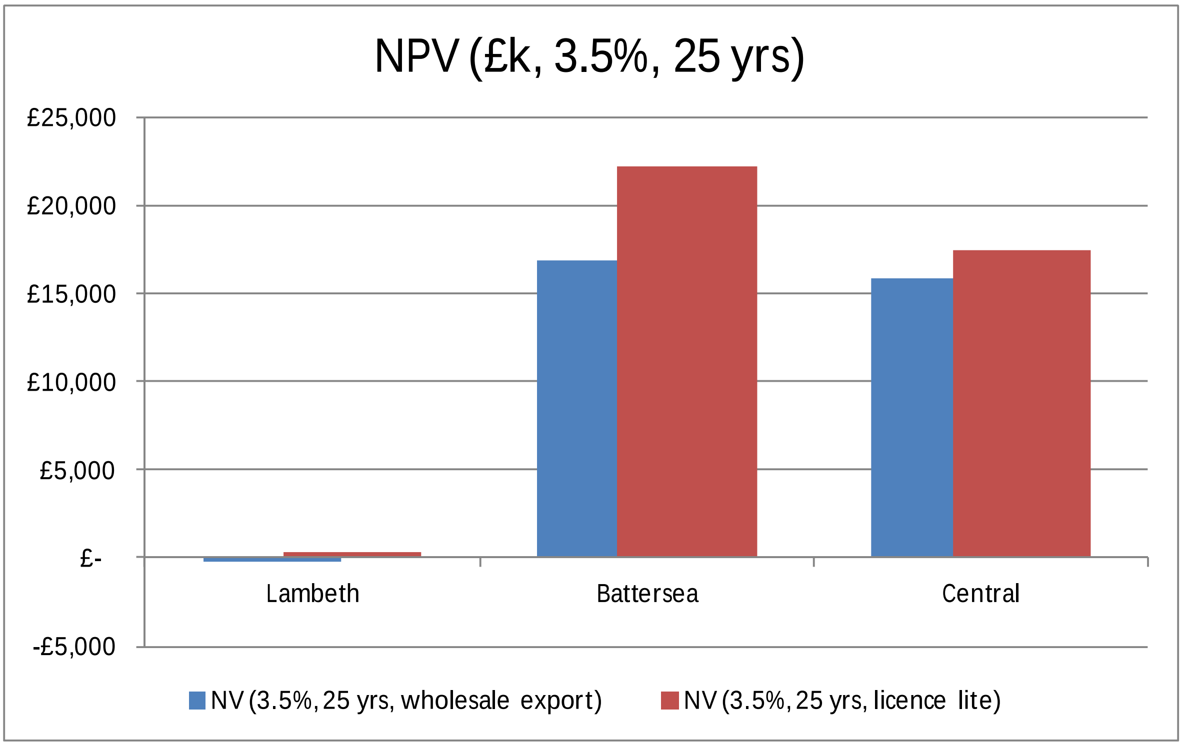
1.4.5 These three networks are shown in the figure below (greater resolution of the proposed connected loads is shown in the main body of the report):



1.4.6 Analysis of the performance of these networks (as stand-alone entities with gas-CHP as prime movers) shows the following overall results;

[11] NB there are also loads within Lambeth that form part of this scheme.

Figure 1-2 Financial results (NPV)



1.4.7 These results illustrate that, with proven prime mover technology (that would otherwise be installed on a fragmented basis on individual sites), good financial performance can be delivered particularly by the Battersea and Central networks.

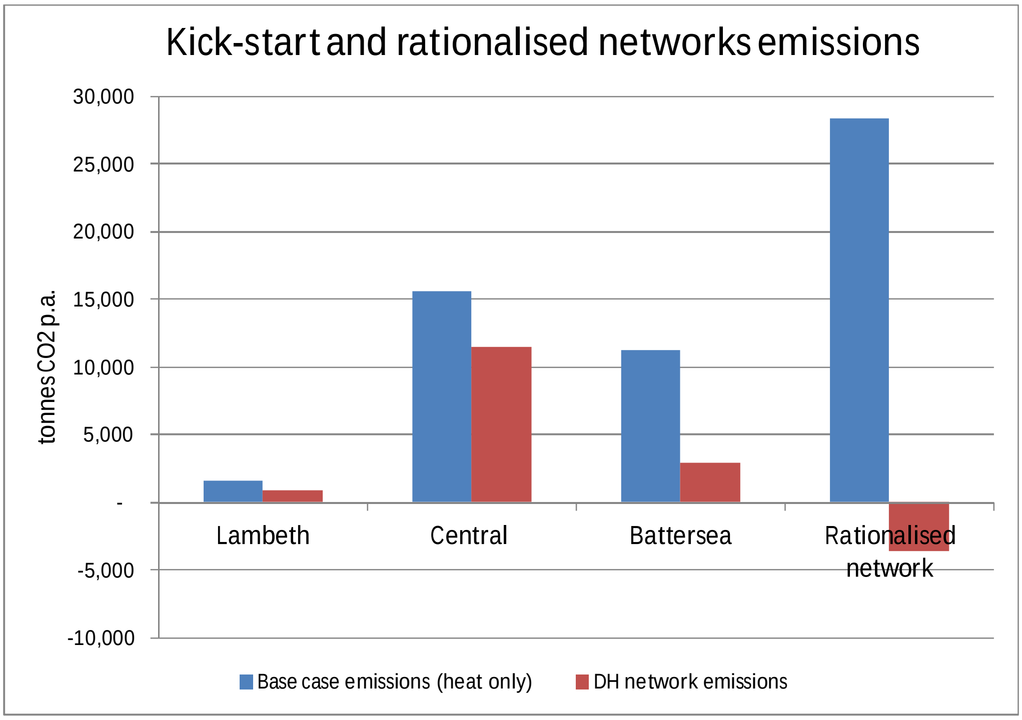
1.4.8 Further analysis has also been undertaken for interconnection and build-out of the kick-start networks. We have assumed this would be undertaken by a single entity with the networks rationalised to a single energy centre supply from the Battersea site. This site has been selected on the basis that it provides a location close the river, to enable efficient delivery of renewable fuels in later years, and has existing large flues of a suitable height. It also forms part of the largest site being developed within the OAPF and so the marginal size increase for the capacity to serve the whole network is lower than in any other site within the area. The result of this analysis is shown below:

Table 1-1 Rationalised Scheme Results

	Fully rationalised
CHP size (kWe)	US Embassy supply (3.5MWe) + 8MWe biofuel CHP
Network length (m trench)	9,206
Total heat demand (inc losses) (MWhth p.a.)	130,616
Peak heat demand (MWth)	100
NPV (3.5%, 25 yrs, (£k)) / IRR (wholesale electricity export scenario) (£k)	£11,021 / 7.2%
NPV (3.5%, 25 yrs, (£k)) / IRR (licence lite scenario)	£19,020 / 9.4%

1.4.9 An alternative rationalised case has also been considered – with the linking of the Central and Battersea schemes only, and the continued use of gas-CHP throughout the whole life cost evaluation period. This significantly improves the economic performance of the scheme, at the cost of some reduction in scope of coverage of the network and emissions savings. The alternative rationalised scheme delivers an IRR of around 10% (electricity wholesale export scenario). Whether a scheme of this design can be implemented will depend upon the prevailing Building Regulations and planning frameworks in place.

Figure 1-3 Emissions summary



1.4.10 The indicative space requirements for the kick-start and rationalised energy centres to serve the networks are shown within this report (13.7). The exact locations of these energy centres has not been determined at this stage, and the dimensions developed for these facilities should help the process of negotiation to determine where these energy centres could be sited.

1.5 Recommendations

1.5.1 The key recommendations of this masterplan include:

- To implement kick-start networks based around early loads in three locations. These should be taken forward as quickly as possible in order to capture as many developments as possible before individual solutions are installed.
- To identify and secure energy centres for these kick-start networks.
- To open discussions to reinstate the hydraulic link to the Pimlico District Heating Undertaking Energy Centre.
- To preserve a district heating network route through the linear park
- To continue dialogue with the US Embassy to show that a district energy network could be developed with benefits for the area and the Embassy.
- To put planning policy in place to oblige developments to connect to a DH network
- To put planning policy in place to oblige development to adopt secondary heating system designs that are fully compatible and complementary with efficient DH operation. A key focus of this should be the temperatures at which water is returned to the distribution system and thence to a central energy centre. This policy should be supported by reference to a design guide and/or adoption of specific standards such as those outlined within the OAPF[2].
- Ensure that in utility planning discussions with UKPN that consideration is given to co-locating a new primary substation in proximity to the proposed rationalised energy centre.

[2] OAPF, Technical Appendix 5, Section 9 – Technical Standards.

2 INTRODUCTION

2.1 Aims and scope

2.1.1 Parsons Brinckerhoff (PB) has been appointment by Wandsworth Borough Council to establish an Energy Master Plan (EMP) based on decentralised energy (DE) for the Vauxhall Nine Elms Battersea (VNEB) Opportunity Area and, where appropriate, adjacent areas.

2.1.2 PB understands that the output of this work should be a well-defined project (or series projects) to take forward, with a delivery plan for implementation and an outline technical / financial model that demonstrates viability both in terms of a 'kick-start' phase and also in the longer term. The study investigates whether there is an overarching benefit to the area from the inter-connection of loads via a district energy solution. This study addresses whether a notional proposed solution is technically and commercially deliverable, in order to be credible for both Local Authority planners and the private developer community.

2.1.3 This report illustrates the process and analysis that has led to a technical solution that meets the requirements of national, regional and local policy and regulation. The outputs of the study form an evidence base from which planning policy can be developed, and against which planning applications can be assessed with confidence in the robustness of the analysis.

2.1.4 The project brief for this commission included the following items:

- *Identify energy loads and determine the current and future energy demand and supply balance*
- *Determine an overarching district heating (DH) network connecting to and utilising existing and future low to zero carbon energy sources supplying the identified energy loads*
- *Determine the environmental benefits in terms of carbon dioxide savings compared with 'business as usual'*
- *Identify major barriers, issues and constraints (such as crossing major rivers, rail lines, roads; public realm works, etc) and make recommendations*
- *Spatially map the DE vision by using the VNEB OAPF and collecting other information*
- *Establish an incremental DE delivery plan based on consecutive construction phases, clearly identifying where the scheme should be 'kick-started', whether temporary Energy Centres should be considered and taking into account the energy loads development etc*
- *Identify indicative costs and revenues for the various phases and appraise financial viability of the proposed DE scheme over its whole life cycle*

The EMP should develop a discrete and well defined project with a delivery plan and a technical / financial model.

The project delivery plan shall be mapped onto a timeline for the OAPF over the next 40 years (to coincide with the Government's 2050 carbon reduction targets) to ensure the timely delivery of a low carbon DE system for the VNEB as well as the best value match of energy supply and demand at any point in time.

The EMP should be undertaken in the context of relevant national, regional and local policy advice and regulation; and should allow for amendments according to changes in the regulatory framework as well as the use of new technologies as they become available.

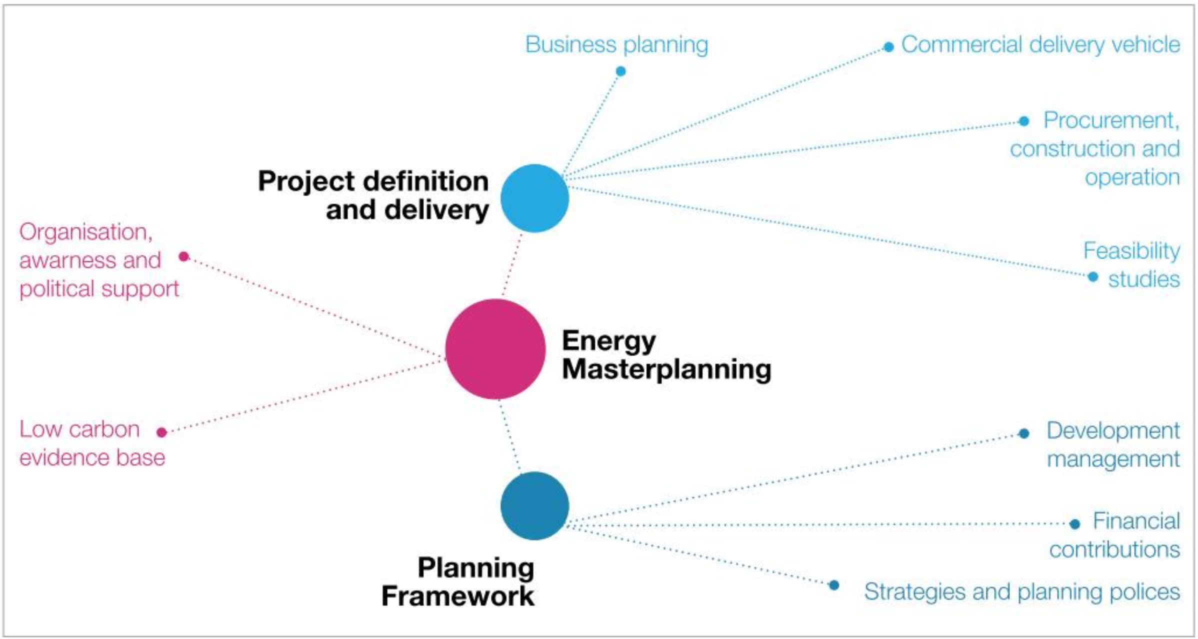
The EMP should make recommendations for actions regarding potential future and wider demand that support borough policies and strategies for increasing decentralised and low carbon energy. Furthermore, the EMP should develop the implementation plan for the VNEB OAPF by considering realistic actions for achieving the recommended strategic policy options.

The project should be considered according to the following breakdown: energy production, energy demand, energy sale, energy distribution, carbon calculation, financial appraisal and project plan & risks.

2.2 Framework Conditions

2.2.1 The energy masterplanning process is one element in the wider backdrop of the trajectory towards a low-carbon economy. The energy masterplanning process takes place within the context illustrated below[3]:

Figure 2-1 Energy Masterplanning Framework



[3] Decentralised Energy Masterplanning – A manual for local authorities, Department for Energy and Climate Change, ARUP, Haringey, 2011, Figure 2

2.2.2 This illustration shows a part of the wider context of energy planning. PB would stress the key interlinkage between the planning policy framework and the ability and effectiveness of the energy masterplanning process. It is important that the policy framework supports DE's expansion, and is implemented in the assessment of planning applications as they are submitted. From this point of view, capacity building and awareness are important elements of DE masterplanning within local authorities.

3 ENERGY DEMANDS

3.1 Energy demand mapping principles

3.1.1 PB has collated data for heating, electricity and cooling demands using the following priority hierarchy of data sources:

- Actual consumption records (existing buildings)
- Planning energy statements / other energy modelling results available
- Benchmarked loads

3.1.2 As the proposed scheme will form part of the energy infrastructure for an Opportunity Area, the majority of load being assessed for connection is, as yet, undeveloped. The availability of actual consumption records that could be used in this analysis was therefore somewhat limited.

3.1.3 However, there was a cluster of existing buildings to the west of the VNEB area that were considered for connection and modelled in our analysis. Load data for these buildings was sourced from the London Heat Map and, as such, is based on actual consumption records.

3.1.4 For proposed development, where available, Parsons Brinckerhoff consulted planning materials – specifically energy strategies and sustainability statements – in which energy demand had already been assessed. The level of detail available in these documents ranged considerably – in some cases requiring us to extrapolate energy demand from building floor areas and the emissions factors used in the calculation of CO_2. In other cases a full, building specific inventory of all energy demands was available, from which the data could be copied directly over.

3.1.5 As well as annual consumption data, Parsons Brinckerhoff also developed a set of benchmarks from energy strategies where sufficient data was available to do so. It was not always possible to extrapolate energy benchmarks from the data presented; however, where there was enough granularity, we did so. The benchmarks were then used in the calculation of demands for developments where only building floor areas were available.

3.1.6 A summary of loads calculated or sourced from energy strategies is presented below:

Table 3-1 Data derived from energy application documents

Site Description	Application Number	Space heat demand MWh p.a.	DHW demand MWh p.a.	Cooling demand (thermal) MWh p.a.	Regulated electricity demand MWh p.a.	Unregulated electricity demand MWh p.a.
Battersea Power Station and Goods Yard, Kirtling Street, SW8	2009/3575 etc	11,588	15,564	11,517	16,665	18,380
Battersea Studios	2006/0416	890	-	616	998	-
Ingate Place	2001/4592	88	-	61	99	-
Main Site, Ballymore	2011/1815	13,300	-	1,640	12,800	-
Marco Polo House, 346 Queenstown Road, SW8	2011/2089 (& conservation area consent 2011/2090)	236	868	209	595	1,790
Market Towers	2012/038	4,277	-	787	2,921	-
NCGMA - Entrance site	2011/4664	546	1,034	39	501	1,146
NCGMA - Northern site	2011/4665	3,118	5,905	2,751	4,133	6,684
NCGMA - Market site	2011/4666	1,089	2,063	3,241	3,209	5,852
Royal Mail Group Site, Ponton Road, SW8	2011/2462	6,370	-	353	1,972	2,865
Tideway Industrial Estate, Nine Elms, SW8	2011/3748	1,614	2,183	-	621	-
US Embassy, Nine Elms Lane	2009/1506 & 1507	3,460	-	2,708	3,016	3,912
Vauxhall Square Cap Gemini Site	11/04428/FUL	2,481	7,007	780	2,431	3,656
2 -14 Tinworth Street and 108 -110 Vauxhall Walk (Spring Mews)	11/04510/FUL	273	1,358	196	336	651
Billboard site	11/04181/FUL	357	1,893	119	293	707
Sky Gardens	09/04322/FUL	441	382	91	1,748	-
London Fire Brigade HQ, 8 Albert Embankment	10/04473/FUL	1,062	-	159	1,131	-
81 Black Prince Road (Parliament House)	08/04454/FUL	186	210	-	114	261
Hampton House 20-22 Albert Embankment	07/04264/FUL	2,316	-	322	1,426	-
Parry Street East (Bondway South)	09/01520/FUL	772	-	224	224	-
Nine Elms Sainsbury's, Wandsworth Road	11/02326/OUT	1,651	1,559	318	2,822	4,418
1-9 Bondway & 4-6 South Lambeth Place	10/03151/FUL	94	353	292	349	-
Texaco Garage, 38-46 Albert Embankment	08/02765/FUL	544	-	69	541	-
Island Site Vauxhall Cross	10/02060/FUL	1,031	1,602	698	585	1,152
10 Albert Embankment (Wah Kwong House)	08/01136/FUL	1,304	-	-	239	-
Eastbury House 30 - 34 Albert Embankment	12/01768/FUL 09/01954/INFO R 10/04163/FUL	118	126	39	62	178

3.2 Stakeholder discussions

3.2.1 In addition to assessing energy demands, PB has also engaged with various stakeholders in order to understand the drivers of key organisations with influence over general anticipated trends of energy use across the study period.

3.2.2 Transport for London

3.2.3 PB held a discussion with Transport for London and their consultants in the early phase of the project in order to evaluate to what degree, and in what context, the development of the Northern Line Extension should be considered in the development of the Energy Masterplan for the Area. The TfL representative was Matthew Webb, Climate Change Strategy Manager.

3.2.4 The few key actions and outputs of this meeting were:

- That TfL is working to generally decrease the level of heat gain generated in its new stations, via a combination of improved train design, platform design (e.g. with ramped station approaches to avoid braking requirements), and other measures. However, projected residual heat gains mean that the active heating of platform spaces is not anticipated to be required, even in the future. The emphasis is on natural ventilation where possible, and the increase in power efficiency overall.

- TfL is, and will remain, one of the largest consumers of power in the UK, and it is interested in procuring its electrical energy from decentralised sources. It is willing to enter into long-term agreements, and has a predictable large base-load power requirement on its pan-London power network that can absorb significant distributed generation. Sale of power generation to TfL is therefore is key potential route for power from VNEB energy centres, assuming that the location of assets can be designed for mutual benefit.

3.2.5 CEMEX

3.2.6 PB discussed the operation of the Cringle Dock site with CEMEX. CEMEX currently operate on the Cringle Street site at Cringle Wharf, and are expanding their operations in order to have capacity in production to meet demand anticipated in the development of the Opportunity Area. The long-term production levels for the site are difficult to predict, and will be subject to the vagaries of the property markets, developments in concrete technology, etc. The expansion of operations may be restricted to the progress of the Thames Tunnel works, as the CEMEX site is 'squeezed' by the requirements of the Thames Tunnel operation.

3.2.6.1 The current plan is to install a second batching plant in summer 2012, and then to look to further increase capacity in around 2020, when it is thought that the Thames Tunnel construction will be complete, and the site will revert to CEMEX and allow them to expand their operations.

3.2.6.2 Current energy demands are predominantly for power (for aggregate / materials handling and the concrete mixing process), with seasonal requirements to heat water (currently by gas-oil boilers, in order to ensure that the concrete production is not impaired through low temperature water), and to heat aggregates ((via steam lance or quartz-ray) to allow them to flow and to ensure that their temperature does not harm the concrete production process).

3.2.7 Approximate power requirements are anticipated in late 2012 to be around 360kVA for concrete batching and a further approx 600kVA for materials handling. At the time of increased production capacity in around 2020, this is expected to rise to around 700kVA for concrete production, and with a related increase in materials handling requirements.

3.3 Heat demand mapping

3.3.1 The first stage of demand mapping involved a desk-based review of heat demand information; this was based around the data available from Planning Application Energy Statements, the London Heat Map, previous energy studies of the area, and other data provided by Lambeth and Wandsworth Councils. These data were mapped on GIS, and used as the basis for scoping additional potential demand points.

3.3.2 These additional demands points and 'demand gaps' were identified through comparison of the buildings identified within the study brief, and those developed from the desktop-information load map (GIS). It should be noted that a significant element of the energy demands for the area are related to new development. However, for existing buildings, wherever possible, Parsons Brinckerhoff has sought to use actual consumption data.

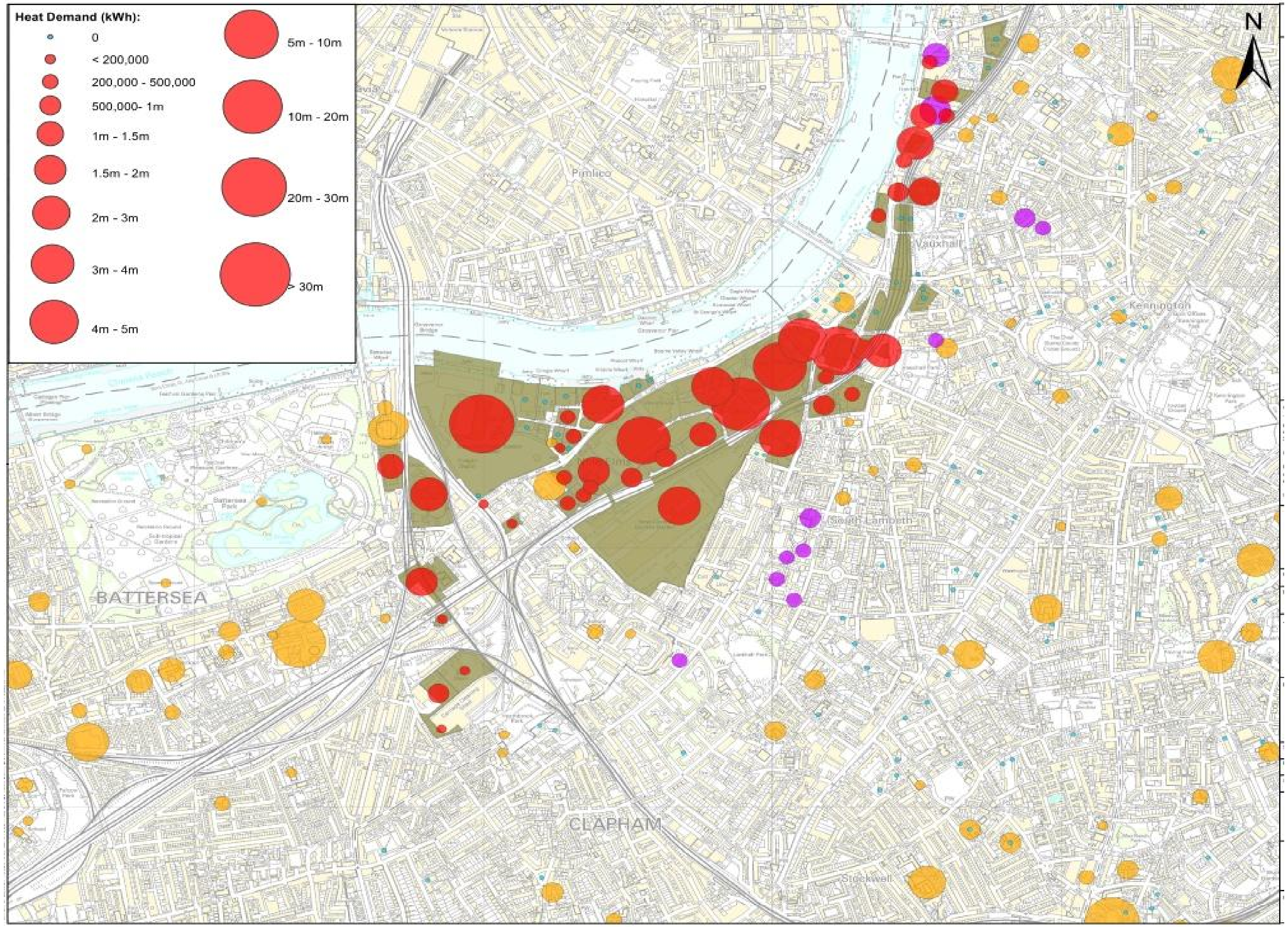
3.3.3 PB has considered:

- Housing developments
- Mixed-use developments
- Commercial developments
- Social housing estates
- Retail sites
- Public buildings
- Leisure centres
- Industry

3.3.4 Where demand information was not available, Parsons Brinckerhoff used published benchmarks from CIBSE publications (e.g. Guide F, TM46). Appropriate percentage reductions were applied to the benchmarks to account for improvements in fabric energy efficiency standards as future iterations of Building Regulations are introduced. These benchmarks were applied to floor area figures provided by LB Wandsworth and LB Lambeth or sourced from Planning Application Energy Statements.

3.3.5 A map showing the heat mapping produced as a result of the above is shown in Figure 3-1.

Figure 3-1: Area heat mapping at full build-out – (red = new development, yellow = existing loads, and purple = estimated existing loads from multi-residential dwellings



3.3.6 The mapping shows the spatial distribution and scale of load at full build-out. However, the way in which this load grows over time is important in determining how, and when, a district heating network serving VNEB should develop. The network should be designed to focus on early-phase development around which a core 'kick-start network' is built. As development progresses, so the network expands to meet new demands.

3.3.7 Parsons Brinckerhoff developed a load build-up over time for each of the development areas in the VNEB Opportunity Area. Where available, this information was taken from phasing schedules provided in energy statements. Where an energy strategy was not available, we were provided with estimated development schedules by the planning teams at LB Wandsworth and LB Lambeth. This allowed us to reproduce the same heat mapping shown above, but in time lapse video format, wherein the load growth progresses through time.

3.3.8 Analysis of the load progression video described above highlighted a cluster of early-phase demand around the American Embassy / Market Towers sites. A selection of years of load build-out are included in the appendices to this document. This area is also fairly central relative to the rest of the Opportunity Area, providing an excellent starting point from which the network can grow. This is particularly pertinent as, in discussion with the GLA and planners from the two Boroughs, it was noted that the American Embassy is expected to be a net heat exporter. As such, assuming the available heat is sufficient to supply early phase demand, there is a potentially viable heat source for the kick-start network.

3.3.9 Further description of analysis undertaken and the recommended development of kick-start networks is provided in Section 7.

4 ENERGY DISTRIBUTION

4.1 Heat

4.1.1 The optimisation of phased growth of heat distribution infrastructure is central to this project. PB's proposed approach has been to develop a wide-area network growth plan that joins key loads within an appropriate timescale, and which minimises the need for interim, piecemeal energy supply plant. However, PB recognises that there are many developments proceeding in the short-term, and that it may be unavoidable to operate temporary energy centres to meet developers' immediate requirements.

4.1.2 The maps shown above in Section 3.3 illustrate the geographies of heat requirements at full build-out. These maps highlight both where there are isolated early schemes that are unlikely to be able to form part of a networked solution, and also areas of more closely aligned heat-on dates that could be clustered into a networked scheme.

4.1.3 A further factor in devising a strategy for the site is an understanding of the degree to which already consented (or soon to be consented) development can be required to connect. The project steering group has decided that this report should assume that all loads will connect to the system for the purposes of energy masterplan development.

4.1.4 The development of a masterplan for the OAPF is described in Section 7 – this section highlights some of the key principles of heat distribution that have been adopted in development of this plan.

- Network assets installed at the inception of the project must be of sufficient capacity to serve the anticipated final expansion loads of the scheme
- Network assets must be 'maintainable' – i.e. in areas to which the scheme operator will have access
- Network specification should fit the aspiration for this infrastructure to be a long-term (i.e. 40+ years) asset that will benefit future energy supply system methodologies.
- Avoiding major road routes where possible to minimise cost and disruption in installation

4.2 Network constraints

4.2.1 The key constraint to district heating network installation is the railway trunk leading from Waterloo towards Vauxhall, Clapham Junction and beyond. Equally the river forms an even more significant barrier to the north of the site (although crossed with the existing link to PDHU).

4.2.2 Recommendations for network enabling

4.2.3 Application discussions between Wandsworth and developers are understood to have led to agreement in principle on an allowance for a utility corridor. This corridor will run along the 'linear park' that runs parallel to the Thames and the railway viaduct, approximately half-way between the two. This location is excellent, providing a route of connection to the individual development plots on either side of the park with great efficiency. It is recommended that the following requirements for the DH element of this infrastructure corridor are incorporated in developer agreements:

- Access for the network operator to be able to maintain the pipework
- Sufficient width for expansion loops
- Sufficient space to be able to add new connections at strategic intervals. The easements / wayleaves / other arrangement agreed for the utility corridor should ensure that the DH network operator has access to this buried asset.

4.3 Network sizing

4.3.1 The calculation of the size of network connections has been carried out on the basis of assumptions regarding temperature differentials between flow and return pipework, and pipework characteristics as shown below.

- Flow temperature – 110 deg C (as per the OAPF[4])
- Return temperature – 65 deg C (accounting for a mix of existing and new connections)

Table 4-1 Network design characteristics

		SPINE		Branches (final connections)	
mm nominal diameter	Actual ID (Seamless Steel) (mm)	Max allowable pressure drop (pa/m)	Max velocity (m/s)	Max allowable pressure drop (pa/m)	Max velocity (m/s)
32	36.1	150	1	150	0.5
40	42	150	1.2	150	1
50	53.1	150	1.5	150	1
65	68.8	150	1.5	150	1.2
80	80.8	150	1.5	150	1.2
100	105.1	150	1.5	150	1.5
125	129.7	150	1.5	150	1.5
150	155.2	150	1.5	150	1.5
200	211.9	150	2	150	1.75
250	265.8	150	2	150	2
300	315.9	150	2	150	2
350	347.6	150	2.5	150	2
400	398.4	150	2.5	150	2
450	448	200	2.5	200	2
500	499	200	3	200	2
600	601	200	3	200	2

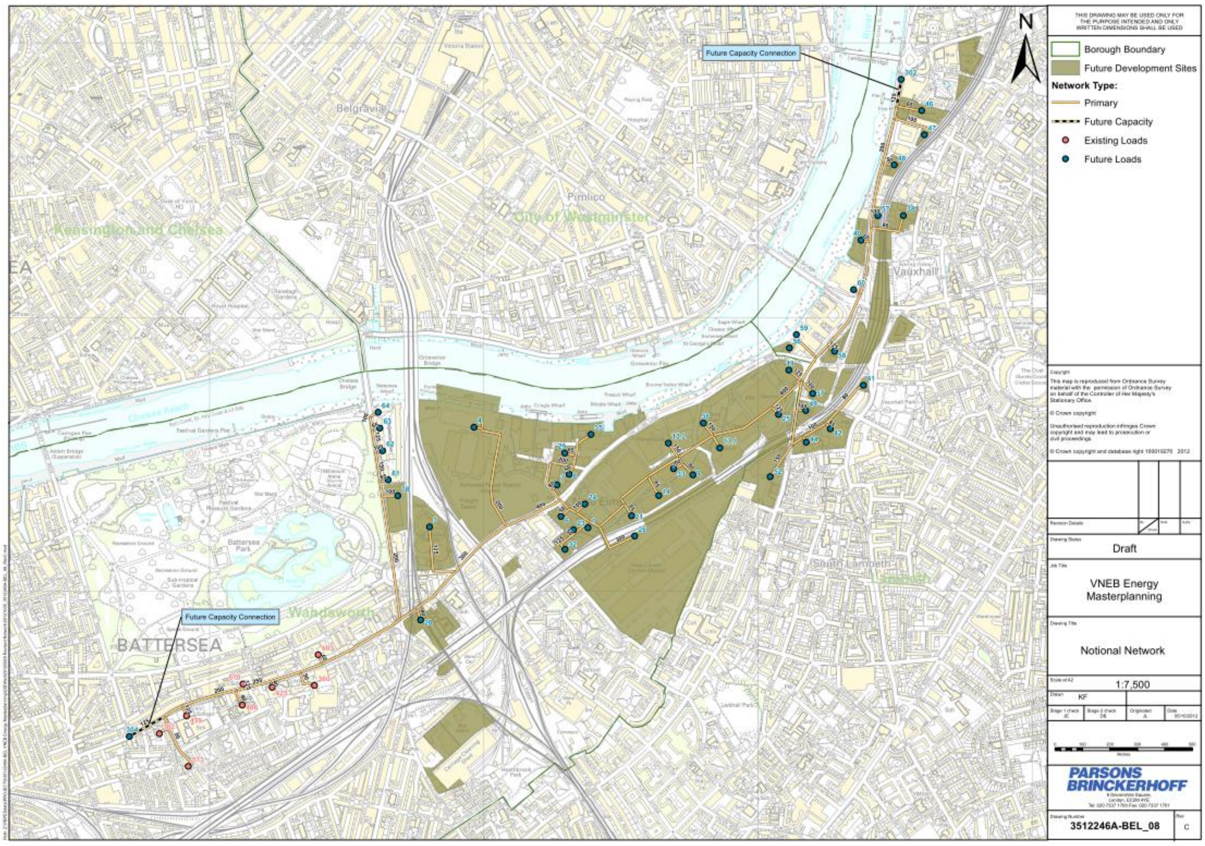
[4] OAPF, TA5, Section 9.1.

4.3.2 An allowance of 15% above frictional pressure losses has been included to account for bends and fittings.

4.3.3 Network sizing has been carried out on the basis that the network installed for the OA (i.e. Battersea Power Station area, Central Scheme area around the US Embassy and Market Towers, and the area south of Lambeth Bridge along the Embankment) should allow a single energy supply system to deliver heat to all loads. Therefore network dimensioning has been carried out on the basis of the connection of all of the key identified loads. A degree of allowance for additional connections beyond those identified within the study area has been assumed. A 2MWth allowance figure at two network points has been modelled. This is a notional figure, but is roughly equivalent to the demands of 400 new dwellings – a quantum of development that seemed appropriate for the areas.

4.3.4 The size of connections and hence costs of network development is driven by the temperature differential that can be achieved across consumer connections. A 10 deg C reduction in return temperature would increase the capacity of connection by 20% for no increase in network capital or operating cost. This level of return temperature reduction is easily achievable but it requires an enlightened, different approach by building system designers. This approach will have a minimal impact on building costs at construction but will cost considerably more as a retro fit. Ensuring that this change is implemented as widely as possible will require a combination of incentives, lower connection charges, guidance and requirements through planning conditions or similar. The added potential future benefit of such changes is discussed in section 4.5.

Figure 4-1 Future capacity points illustration



4.4 Network design / materials

4.4.1 For the network installation within the OAPF, PB recommends the use of steel pre-insulated pipework. The key alternative technology on the market currently is plastic pre-insulated pipework. This alternative system can have significant benefits in terms of reducing the labour-intensity of installation (by reducing the need for welded joints) and can help reduce overall installation costs. However, particularly at higher temperatures (i.e. 90 deg C and above), the longevity of the plastic systems is considerably reduced. Equally, larger diameters of plastic pipework are not available, and hence the primary recommended area for its application is in lower temperature, local networks.

4.5 Opportunity to use waste heat

4.5.1 Parsons Brinckerhoff has considered the use of waste heat sources in the vicinity of VNEB to supply the network with low carbon energy. There are two potential waste heat sources in the area: the underground, where heat is emitted through ventilation shafts or from new stations; and electrical substations, where heat is emitted from large transformer equipment. A plan illustrating the anticipated location of the northern line extension underground shafts is included in Appendix 13.2.

4.5.2 The benefits of using waste heat to supply a district network are considerable. Firstly, there is the potential for significant carbon reductions, as waste heat itself is normally considered to be carbon neutral (or very low carbon). Secondly, it reduces reliance on volatile and increasingly expensive fossil fuel markets to supply the network with heat. Thirdly, and without pre-empting any commercial arrangements with potential waste heat suppliers, it is not commoditised and is therefore likely to be available at low cost. There are, however, some key considerations in supplying a DH network with waste heat.

4.5.3 Waste heat by definition is likely to be low grade and therefore not suitable for district heating in its primary state. In this instance, it is necessary to ‘step up’ the grade of the heat so it is at a suitable operating temperature for district heating. This is done using a heat pump, which uses electricity as part of the process. The efficiency of this process (i.e. the amount of electricity required) is a product of the grade of the waste heat and the required ‘step up’.[5] Typically, under current market prices, a DH network supplied with waste heat via heat pump must operate at low temperatures in order for the cost of heat generation to be lower than a gas boiler alternative method of heat generation.

4.5.4 For efficient operation of a low temperature network, secondary systems should be designed to maximise heat transfer and thereby minimise return temperatures. This can be achieved using large radiators and/or under-floor heating. Note that this is considered best practice for district heating networks, regardless of the network flow temperature, as it makes for a more efficient delivery of heat and, ultimately, reduced costs. As such, **Parsons Brinckerhoff strongly recommends that planning approval for development within the VNEB OA is subject to secondary system designs that are compatible with delivering low return temperatures to a district heating network**.

4.5.5 The use of secondary designs delivering lower temperature returns will also enable the future integration of lower flow temperatures. This could in turn lead to the

[5] Parsons Brinckerhoff have recently completed a study looking at the viability of heat pumps in district heating networks, which concluded that cost and carbon savings are achievable under the right conditions.

sourcing of heat from a more diverse set of 'waste heat' sources – including ventilation shafts, transformers at substations, etc.

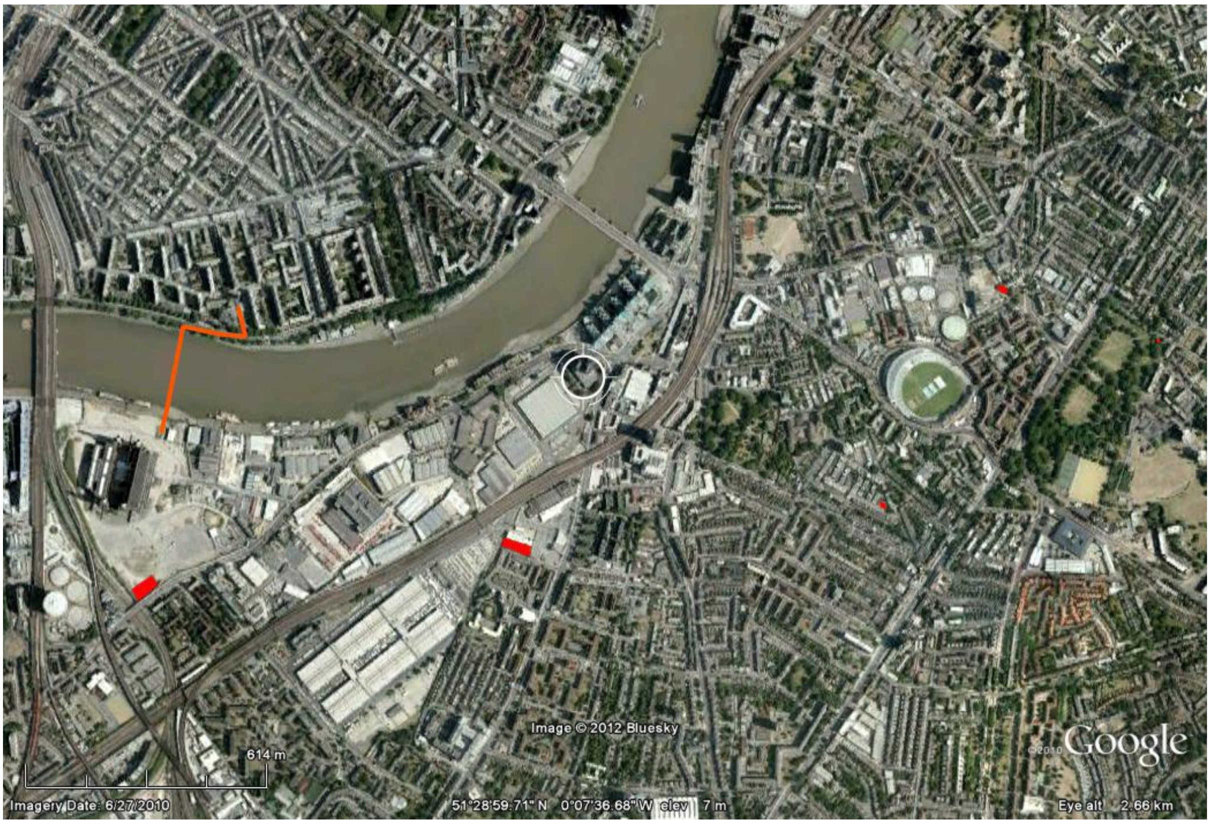
4.5.6 In addition to the proposed development within the VNEB OA, this study assesses the potential for connecting suitable existing loads in the vicinity of the proposed network. The secondary systems in these buildings will not be able to deliver sufficient heat energy from low temperature supply at times of high or peak load. However, there is still the possibility of supplying these buildings with lower grade heat outside of the heating season.

4.5.7 In reality, connecting existing buildings to the network buildings would to some extent limit the potential for using waste heat; however it is noted that LB Wandsworth and LB Lambeth can influence compatibility over time by ensuring that any heating system overhauls requiring planning permission are specified appropriately. Furthermore, if a suitably attractive heat price is offered, building owners could be sufficiently incentivised to adapt their systems.

4.5.8 It is proposed that one aim of the strategic design of energy supply systems must be to increase overall efficiency in energy delivery. One means of achieving this is through the re-use of 'waste heat' when appropriate efficiencies can be achieved.

4.5.9 Key identified sources of waste heat energy that could be utilised within the OAPF area are underground vent shafts, UKPN transformers, and the Northern Line extension stations. Co-locating an energy centre close to both a new primary substation and the Northern Line extension stations could facilitate the use of waste heat so that the heat source and heat pump equipment effectively becomes an adjunct to the primary energy centre. The feasibility of this will depend upon discussions with UKPN and the availability of land for a new primary substation. The following illustration shows the key known locations of sources of waste heat (and the PDHU link).

Figure 4-2 Illustration of TfL locations where waste heat might be available (red areas)



4.5.10 This plan shows that there is no significant concentration of known waste heat sources in any single location. However, one key 'unknown' in this landscape is the potential location of a new primary UKPN substation to serve the area. The location of this substation appears to be as yet undecided. It is suggested that the location of the rationalised energy centre for a site-wide network and the UKPN substation site should be considered together. There could be mutual benefit in locating the substation close to the proposed main network energy centre for a number of reasons including costs of electrical connections and potential energy recovery options.

4.6 Electricity

4.6.1 One element of the development of an EMP for the VNEB OA is that electricity network infrastructure must be capable of supporting the integration of decentralised generation. Work in this area is also being taken forward by others, and will be a focus of the Utilities Masterplan that is being commissioned (Nov 2012) for the OA.

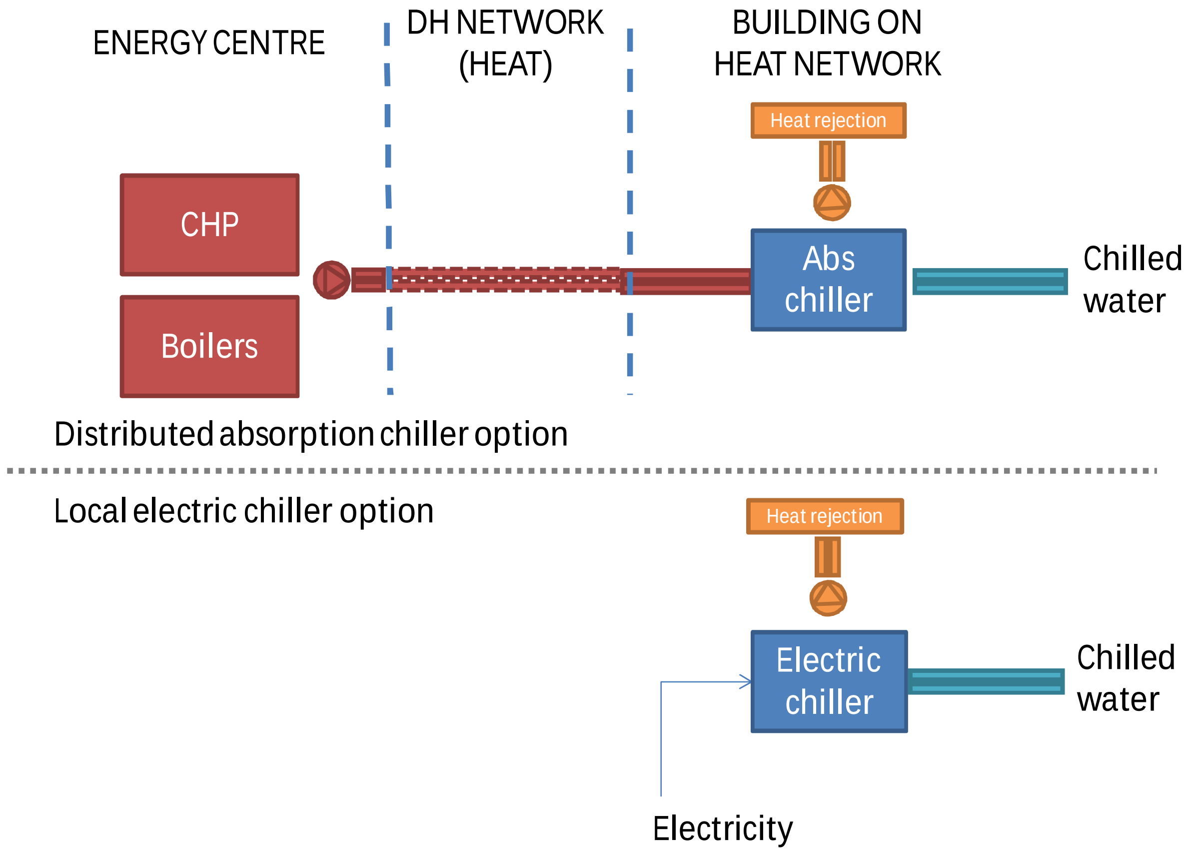
4.6.2 This EMP will be able to inform the Utilities study of likely levels of embedded generation and fuel requirements. This information is listed in Section 10.5.2.

4.7 Chilled water

4.7.1 The figures in Appendix C show the projected growth of chilled water demands in the OA.

4.7.2 One option that is sometimes considered for the provision of chilled water is the use of distributed absorption chilling. This means running an absorption chiller supplied with heat from a district heating network. An illustration of a comparison of this approach with a 'traditional' high-efficiency electric chiller is shown below:

Figure 4-3 Schematic comparison of chilled water provision



4.7.3 The calculation shown in Appendix 13.5 illustrates the benefit that the use of absorption chilling can deliver. The calculation, which has used typical current efficient values for the various plant items and typical values for energy prices, shows that for the delivery of 1GWh of chilled water, a distributed absorption chiller system could deliver a cost saving of £8k and a carbon saving of 40tCO_2/ year. In terms of cost, this saving is not considered sufficient to payback either the cost of the capital installation of the plant, nor even the annual maintenance costs. The carbon savings, and indeed the cost savings figures are also very sensitive to the competing electric chiller system, which in the example calculation shown in the appendix has a seasonal COP of 3. This does not reflect best available technology. If a higher COP for the competing system is used, then the distributed absorption chiller system does not make any savings, it in fact delivers both a financial disbenefit and an increase in overall carbon emissions. **On this basis the use of distributed absorption chilling is not recommended for the VNEB OA area**.

4.7.4 The balance of this system will also further worsen (in terms of carbon savings) as the grid progressively decarbonises. With an assumed electric chiller COP of 3, the grid only has to decarbonise to a level of 0.49kgCO_2/kWh (from the current level of around 0.52kgCO_2/kWh), for there to be no carbon advantage in the use of distributed absorption chilling.

5 ENERGY SOURCES

5.1 Technology choices

5.1.1 PB has considered conventional, proven technologies and other more innovative plant options that are enabled through both the scale of the scheme, and the unique geography and character of the site.

5.1.2 The scale of the scheme at full build out is such that it is appropriate to consider the installation of a bio-fuel based CHP solution, for example (this technology is only commercially available at the multi-megawatt scale). The geography of the site means that deliveries by barge are feasible and large-volume fuel sources (e.g. biomass) could be supplied via this route (particularly to an energy centre located close to Battersea Power Station, for example). The area also hosts a waste handling facility and a source of bio-degradable matter, and hence the use of anaerobic digestion has also been considered.

5.1.3 The following technologies have been considered in the light of two potential time-frames for implementation; first, as a kick-start technology for the first phase of the scheme, and second, as a technology adopted at full scheme build-out:

- Gas-fired CHP
- Biofuel CHP
- Organic Rankine Cycle CHP
- Biomass gasification and CHP
- Biomass anaerobic digestion (AD)
- SRF or MSW-fuelled CHP
- Heat pumps (on-site heat rejection or Thames Water as sources)

5.1.4 The assessment of these technologies has been carried out on a scored qualitative analysis basis (described below) as a means of providing a transparent approach to technology selection.

5.1.5 The scale of the network and hence appropriate rated output of plant has an influence on this assessment, and hence the approach has been to identify what scale of network appears most appropriate for the geographic pattern (and phasing) of demands for the kick-start network, and for full build-out. The scale of plant considered for each phase of network is as shown in the table below:

Table 5-1 Technology assessment - scales considered for network phasing

Network	Prime mover total heat output considered (MWth)
Kick-start network (Central)	3
Kick-start network (Battersea)	3
Kick-start network (Lambeth)	0.6
Full build-out	12

5.1.6 The choice of heat production technologies for the schemes is central to delivering both a viable scheme, and to also delivering heat that is sufficiently decarbonised for network customers to achieve planning compliance.

5.1.7 Kick-start networks – the choice of technologies suitable to match the early phase loads will be considered in the context of de-risking delivery i.e. choosing well-proven technologies that have a demonstrable track-record. Depending on scale, key technologies for this early deployment might include gas-fired CHP, biomass boilers, gas-turbine technologies, etc.

5.1.8 Full build-out – in later phases, the choice of heat production source will be influenced by the desire to increase the self-sufficiency of the development area (i.e. using site-produced waste as a resource), and by the need to increase the proportion of renewable fuel used (in response to regulatory pressure).

5.1.9 The assessment of technologies has been carried out by rating each candidate technology against an agreed series of categories. These were:

- Carbon reduction potential
- Commercial viability (i.e. cost of heat generation)
- Proven track record
- Renewable fuel use
- Compactness of space requirement
- Lack of environmental impact from transport of fuels
- Fuel supply chain security

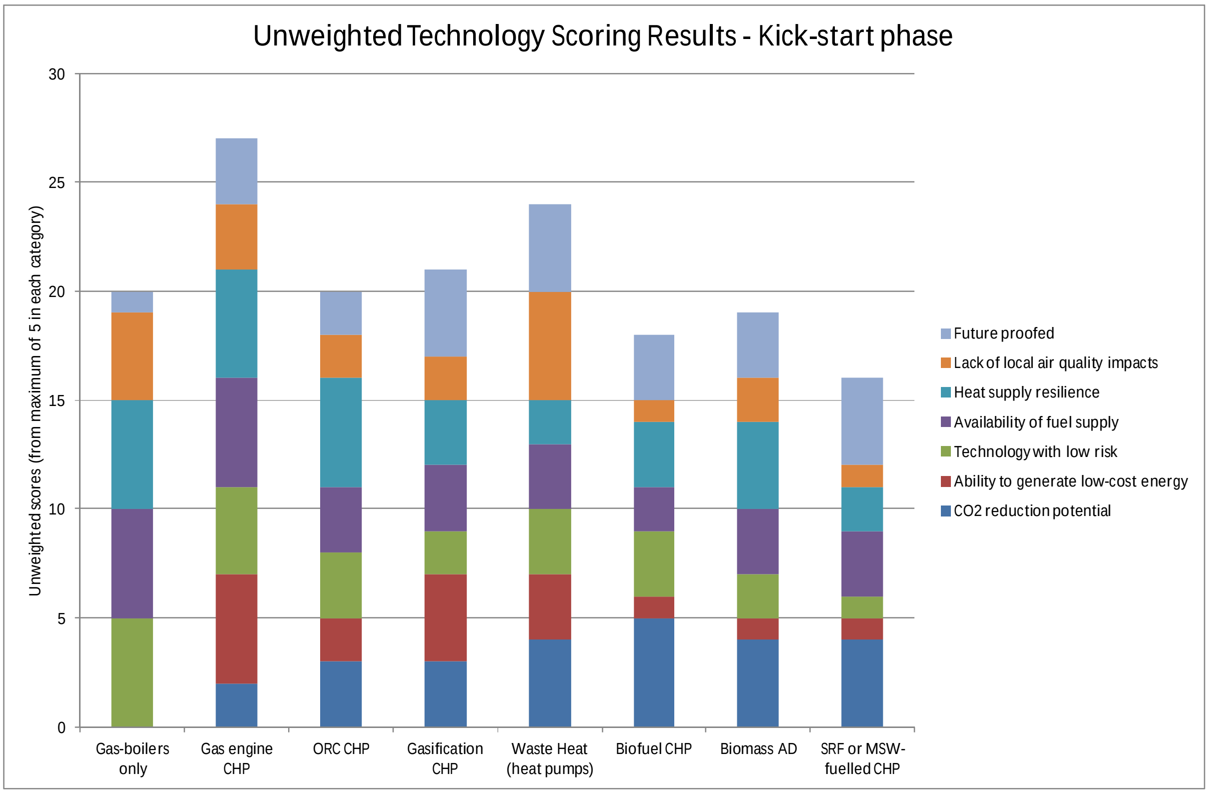
5.1.10 Each of these categories has been allocated a weighting suited to the phase of the scheme. The total weighted scores for each technology have then formed a ranked list of preferred options at each stage. The aim of this ranking is not to select a technology, but to illustrate which shortlist of technologies appear to offer the best match with the project criteria.

5.1.11 Over the next 40 years we can anticipate substantial changes to the landscape of technologies that are considered ‘proven’. Hence our recommendations focus primarily on the ‘kick-start’ phase of the project.

5.2 Kick-start phase

5.2.1 The unweighted inputs into the technology scoring tool are displayed below:

Figure 5-1 Unweighted technology scoring chart



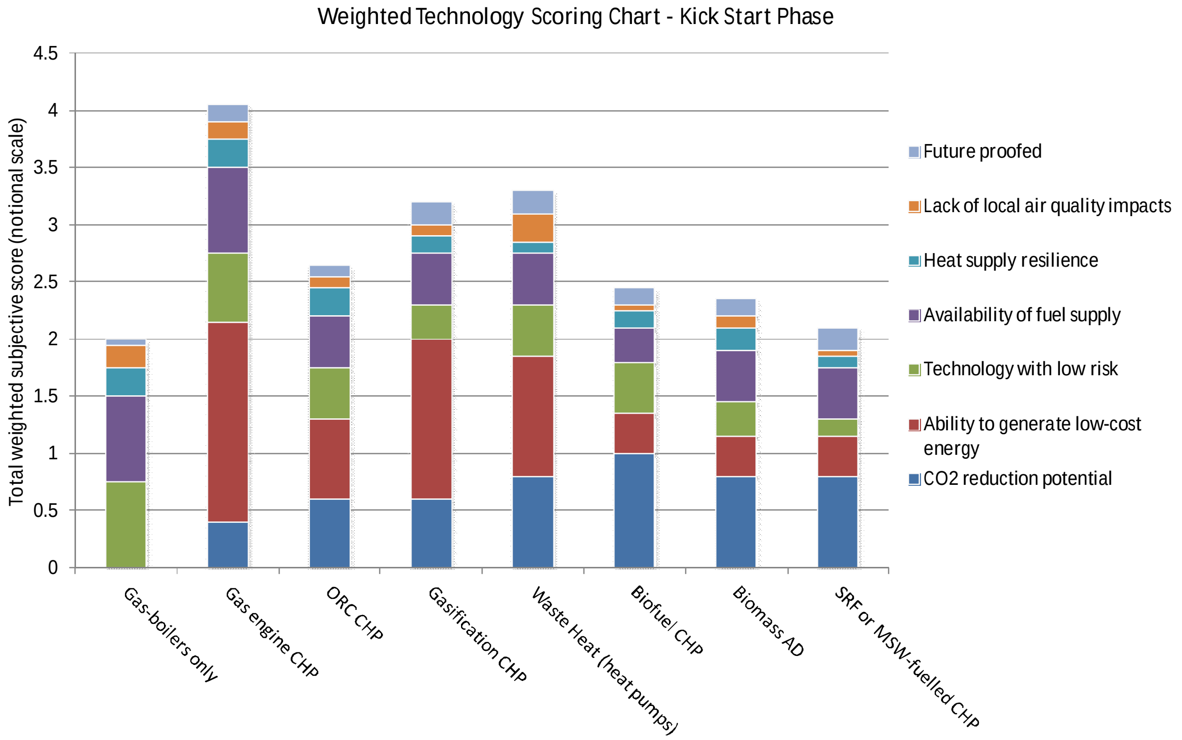
5.2.2 This chart illustrates the raw totals of the subjective scoring of technology that PB has carried out.

5.2.3 The following weightings where adopted for the kick-start network phase.

Figure 5-2 Kick-start phase technology scoring

	CO_2 reduction potential	Ability to generate low-cost energy	Technology with low risk	Availability of fuel supply	Heat supply resilience	Lack of local air quality impacts	Future proofed
Weighting	20%	35%	15%	15%	5%	5%	5%

Figure 5-3 Kick-start phase weighted technology scores



5.2.4 This chart suggests that the use of gas-CHP and possibly waste heat and gasification CHP are currently considered the most suitable technologies for the early phase network. This weighted scoring reflects primarily the proven nature of gas-fired CHP, and its ability to generate carbon savings at relatively low cost.

5.3 Later-phase heat supply (i.e. 2025 – 2030 onwards)

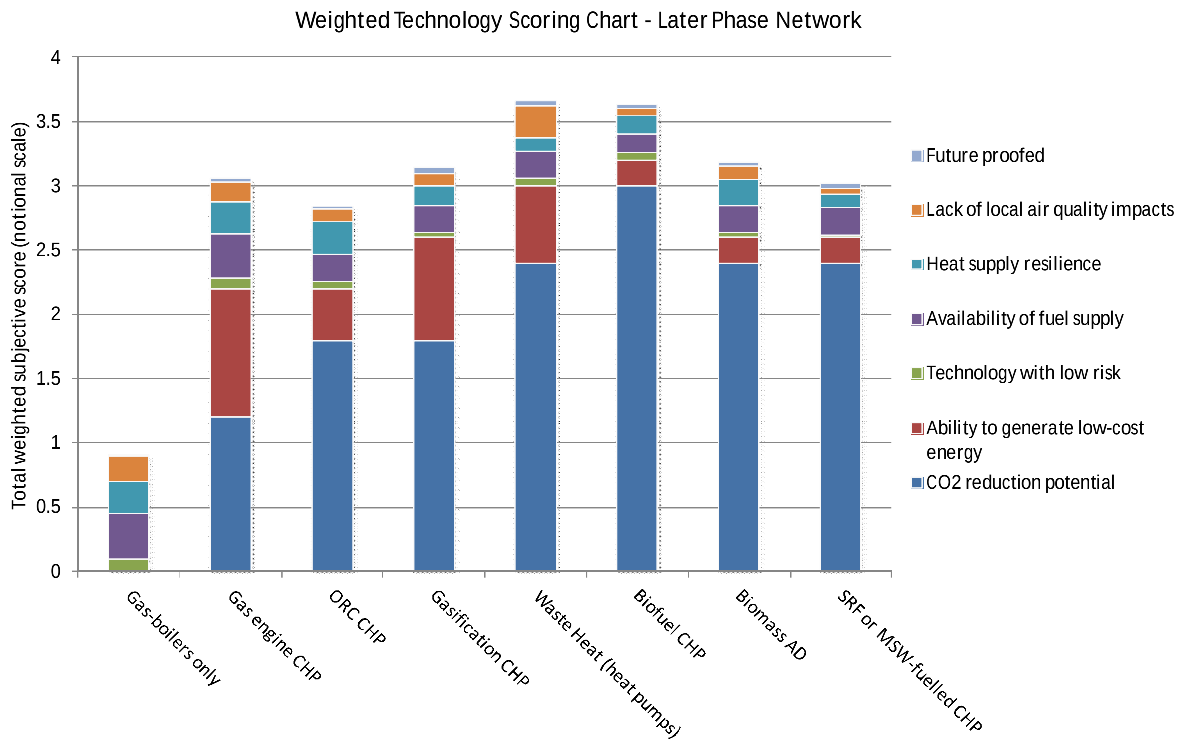
5.3.1 At this stage in energy masterplanning, the technology choice for later phases in the network growth is uncertain, and as it cannot be readily predicted which technologies will emerge to become 'proven' over the next 15 years or so, this category (technology with low risk) has been downgraded in its weighting. At the same time, the ability of technologies to deliver carbon savings against a decarbonised grid will increase in importance and hence this category has been given additional weight. The scores and weightings for the later phases are shown below:

Table 5-2 Later Phase Technology Weightings

	CO_2 reduction potential	Ability to generate low-cost energy	Technology with low risk	Availability of fuel supply	Heat supply resilience	Lack of local air quality impacts	Future proofed
Weighting	60%	20%	2%	7%	5%	5.0%	1.0%

5.3.2 Weighted scores for this are shown below:

Figure 5-4 Weighted Later Phase Technology Scoring



5.3.3 This chart illustrates that the front-runner technologies for the later phases of the network expansion would appear to include the use of waste-heat resources (and heat pumps) and biofuel CHP technology.

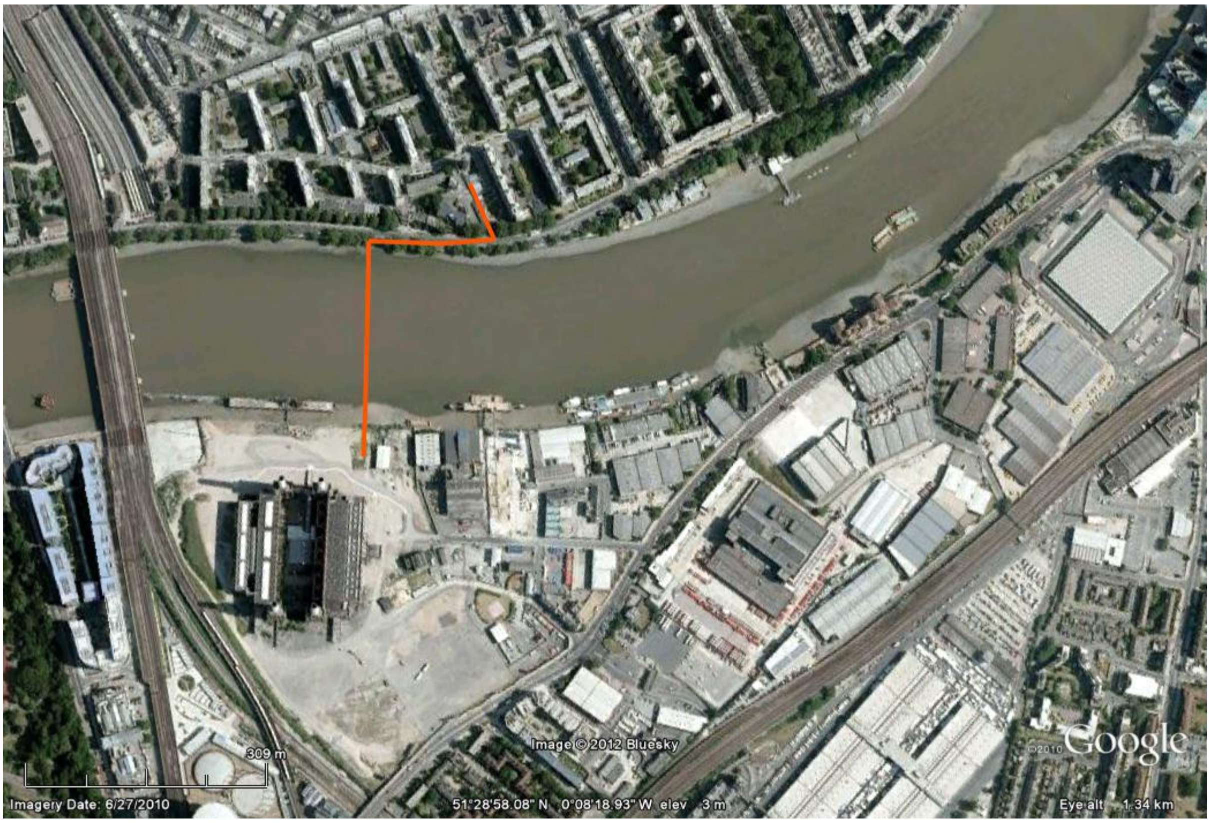
5.4 Heat supply to / from PDHU and SBEG

5.4.1 PB contacted Westminster City Council in order to discuss the potential future uses of the existing link between the Pimlico DH Undertaking (PDHU) and the Battersea site. There are no immediate plans for change to the current status quo, and a number of possibilities remain open for this link.

5.4.2 The current PDHU energy centre is located on the north side of the Thames and contains 2 no CHP units (approx 1.5MWe output each) and 3 no 8MWth gas-fired boilers, and all associated ancillary plant. The PDHU system also has one of the largest thermal storage vessels in the UK, an asset that is currently underutilised by the system, as the installed CHP capacity was limited by the physical dimensions of the existing energy centre site. The current connected loads on the system allow the CHPs to operate at full output during the winter season, and they modulate down slightly when meeting the summer baseload. There is available boiler capacity generally throughout the year.

5.4.3 The link to Battersea consists of 300mm flow and return pipework contained within a Metropolitan Water Board (as was) tunnel. The pipework is owned by PDHU, which pay wayleaves for continuing access to this link. An approximate sketch of the location of this link is shown below:

Figure 5-5 Sketch of link between Battersea and PDHU



5.4.4 There are a number of potentially complicating factors in terms of the overall balance of energy supply and demand through this link, not least the potential connection of the PDHU system to Whitehall District Heating System and the Victoria Circle development (Land Securities). In addition, PDHU have another site that has several aspects that render it an ostensibly ideal location for new CHP plant (proximity to large substation, existing MP gas supply nearby, lies on existing DH transmission link, basement location etc.). The potential to install CHP plant on this site could lead to a situation where there is the potential to export heat from PDHU towards Battersea.

5.4.5 Given the existing link under the Thames to the PDHU system, in hydraulic terms Battersea Power Station and the PDHU are close neighbours, and it would be an enormous waste of an opportunity not to utilise the existing PDHU assets and heat customer base. In particular, for early years operation of primary plant capacity in Battersea making use of the thermal store (and possibly the spare boiler capacity at PDHU) seems to be an opportunity that should be exploited. Equally, the ability to supply heat in early years of development to PDHU could allow for economic installation of larger, more efficient primary plant in Battersea. **PB therefore strongly recommends that any energy centre system developed on the Battersea Power Station site should link to PDHU via the existing network under the Thames**.

5.4.6 The 'rejuvenation' of the link would not require substantial additional infrastructure, and it would be anticipated that the two systems (PDHU and the new VNEB network) would be hydraulically separated. On this basis, the main elements of the installation would be ensuring that the pipes are in a suitable state for reuse, installation plate heat exchangers to create a hydraulic separation interface, and controls modifications at PDHU to ensure that the thermal storage capacity can be utilised by the remote VNEB energy centre plant.

5.4.7 The value of this link could also be enhanced by the connection of the PDHU system with the Whitehall District Heating System. This might further increase the potential availability of low carbon heat for export to Battersea. This potential benefit strengthens the recommendation to rejuvenate the connection between Battersea and PDHU.

5.4.8 PB is also designing a decentralised energy scheme for a major development (Victoria Circle (VC)) adjacent to Victoria Station on behalf of Land Securities, where there is also the possibility of including a heat link to the Pimlico District Heating Undertaking. The value of this link (between VC and PDHU) for the VNEB OA will depend on the balance between the supply plant capacity installed in the VC system, and the demands on the PDHU system not met by PDHU's own CHP plant. Similarly to the potential upside benefits from a WDHS link, in PB's view the potential availability of additional low-carbon heat from the north of the Thames as a result of developments beyond the control of the VNEB OA planning process is a strong reason to ensure that a connection is made between PDHU and Battersea, in order that the OA can benefit from these future developments.

5.4.9 Even if changes to the energy supply landscape north of the Thames do not transpire, the hydraulic connection of the two systems should allow Battersea-based primary plant to benefit from the use of the thermal storage asset that is located within PDHU, and possibly the existing customer base within Pimlico.

5.4.10 SBEG

5.4.11 PB has also considered the role that the South Bank Employers' Group DE project, might play in the foreseeable future for VNEB OA. PB is currently carrying out a study into the potential to implement a district heating network in the South Bank area. This study has evaluated the demands that could be connected to an area-wide system, and has examined potential energy centre / plant locations. The current status of this project indicates that substantial export of heat from SBEG to VNEB is unlikely, given constraints on plant locations.

However, export in the direction of VNEB to SBEG has been considered, and hence the safeguarding of capacity in the heat distribution network as described in Section 4.3.2.

6 ENERGY SALES

6.1.1 PB has compiled outline economic models of the operation of potential energy supply configurations for VNEB. One element of this model includes options on the means of energy sale.

6.2 Heat

6.2.1 Heat sales rates have been based upon current prices (as requested in the project tender documentation). Values adopted reflect PB's experience of recent project interaction with ESCos for new and existing domestic and non-domestic users. The following prices for heat sales have been modelled:

Table 6-1 Heat sales price assumptions

Heat sales customer group	Sales rate (p/kWh heat)
New residential	10
Existing residential	8
New commercial	6
Existing commercial	5.5

6.3 Electricity

6.3.1 PB has modelled a range of values for the income derived from electricity generation. This range reflects the following potential routes for electricity sale:

a) Wholesale export – this assumes that power exported to grid would be valued at wholesale electricity prices.

b) Retail sale ('netting off') - this assumes sale of a portion of generated electricity to a nominated large user. PB has assumed a value for power under this scenario based on a balance between published retail rates, minus an allowance for distribution costs, and wholesale values.

c) Supply licence – 'licence lite' arrangements not fully developed at this stage. The modelling assumptions that PB have adopted represent a fixed set-up cost, and a single unitised sales rate at a value above wholesale export. This simulates the notional sale of electricity via the licence lite route to a single large user (e.g. GLA / TfL).

d) Sale of electricity to a single large organisation via private wire.

6.3.2 The following values have been adopted to reflect these different routes:

Table 6-2 Electricity sales price assumptions

Electricity sales scenario	Sales rate (p/kWh electricity)	Source notes
Wholesale export	7.32	DECC central projections (wholesale, 2012)
Retail sale 'netting off'	8	Estimated
Supply 'licence lite'	8.5	Estimated
Private wire	9.72	DECC central projections (industrial, 2012, 80% of figure used, to represent energy only[6] element of total costs)

[6] Energy only element – meaning excluding elements such as maximum demand charges, triad costs, and other fixed elements of electricity costs

7 PROPOSED MASTERPLAN

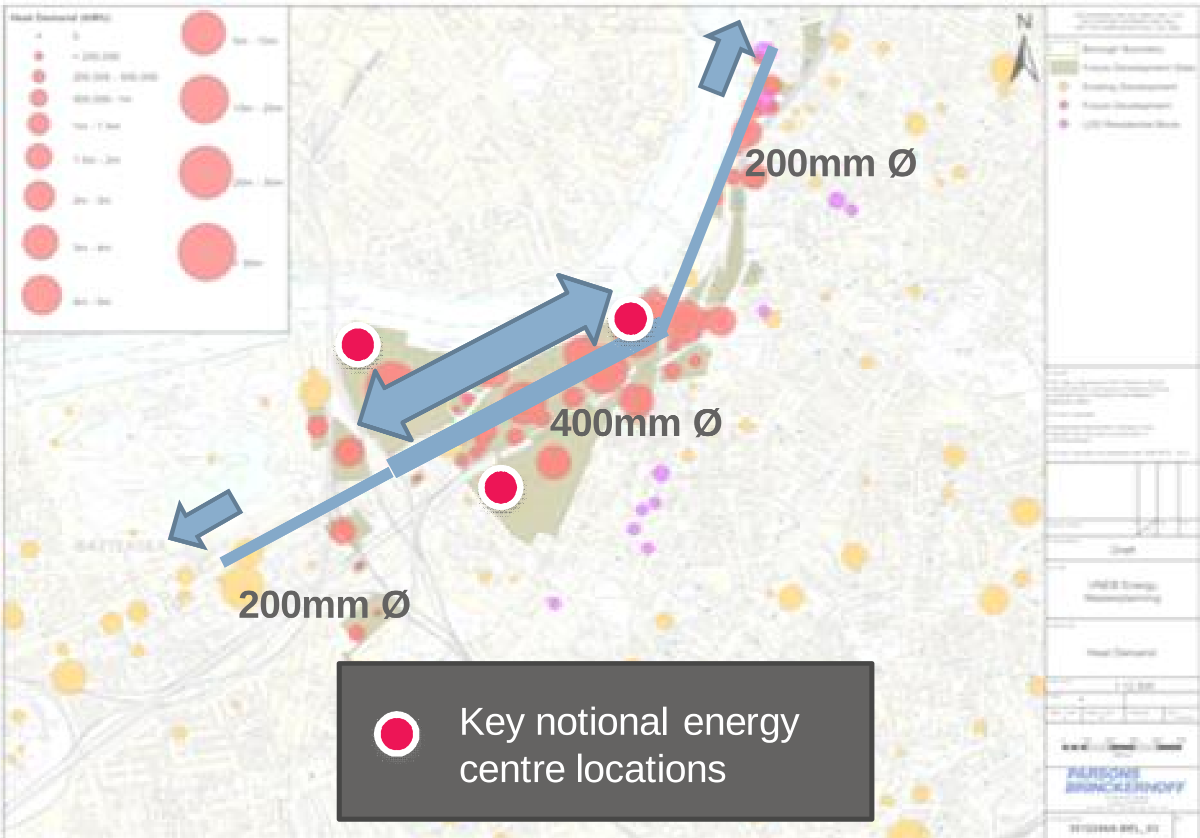
7.1 General Approach

7.1.1 This section addresses the strategic growth of a DH network in the VNEB area, with a view to creating an area-wide, rationalised heat supply system able to benefit from economies and efficiencies of scale. To this end, key spine elements of the individual kick-start networks must be designed to be capable of transporting the full flow-rates of the system as predicted at completion.

7.1.2 The pipe sizes for the heat distribution network have been set by hydraulically modelling the full network at completion, and then fixing the individual kick-start network pipe sizes on this basis. As indicated previously firm requirements to reduce the temperatures at which buildings return water to the DH network could allow these sizes to be reduced from the outset.

7.1.3 A further key principle adopted in network spine design has come from concept of maintaining flexibility at this stage in terms of location of energy centres. As discussed below, there are a number of possibilities for the location of a rationalised energy centre, and in order to safeguard these different options in terms of network design, a core spine network through Vauxhall to Battersea of a fixed diameter of 400mm flow and return pipework is recommended. This is illustrated below:

Figure 7-1 Main spine sizing illustration



7.1.4 The 200mm diameter sections at either end of this core network also take into account potential future loads as described in Section 4.3.2.

7.2 Central kick-start cluster

7.2.1 Figure 7-2 below illustrates for 2016 (the point in time at which it is considered realistic that a network could be installed[7]) the location and extent of loads around which a kick-start network could be built. It shows the area around the American Embassy where there is a well-established early phase heating demand. Note that this demand includes the American Embassy itself which is anticipated to be a net exporter of heat rather than a potential heat customer. The key loads in this central kick-start cluster are presented in Table 7-1 for 2016, and the loads to which this refers are highlighted for the following year in a box on the mapping (Figure 7-2: Area heat mapping in 2017) that follows.

Table 7-1: Loads in the proposed Central kick-start network core cluster

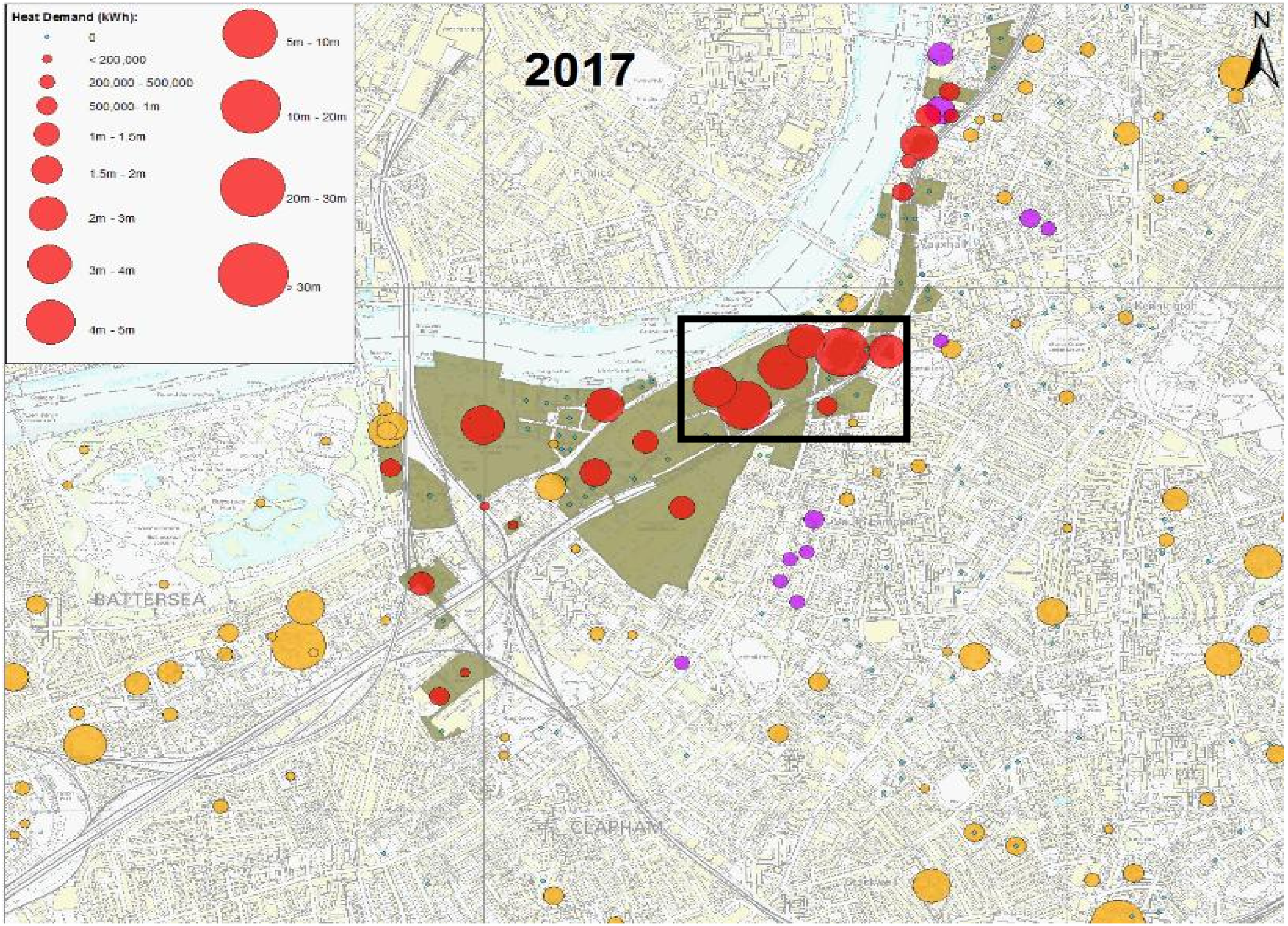
ID[8]	Name	Demand in 2016 (MWh heat)	Demand in 2035 (MWh heat)
36	US Embassy, Nine Elms Lane	Net heat exporter	Net heat exporter
25	NCGMA - Northern site	4,511	9,023
17	Main Site, Ballymore	6,650	13,300
19	Market Towers	2,406	4,277
44	Sky Gardens	716	823
37	Vauxhall Square Cap Gemini Site	-	9,489
41	Billboard site	2,251	2,251
Total demand (kWh heat)		**2,251**	**39,163**

7.2.2 The technology selection section of this report shows that for the early phase of network development, the most appropriate technology appears to be gas-fired CHP. This subjective analysis is certainly not designed to exclude the potential for other technologies to contribute to the heat supply mix, and has only been used to guide the economic analysis of kick-start network schemes for this study. This technology is also contained within many of the proposals put forward with energy statements for the sites within VNEB, and the centralisation of supply with gas-fired CHP is therefore likely to be seen as a non-contentious extension of these individual strategies.

[7] Please see timeline in appendices

[8] ID numbers refer to the OAPF map sites – as reproduced in Appendix D

Figure 7-2: Area heat mapping in 2017



7.2.3 PB has not yet received confirmation of the plant to be installed in the US Embassy, nor the phasing of this installation. Information included here is based on the planning application submitted to Wandsworth (dated May 2012). This document shows the following table on page 11:

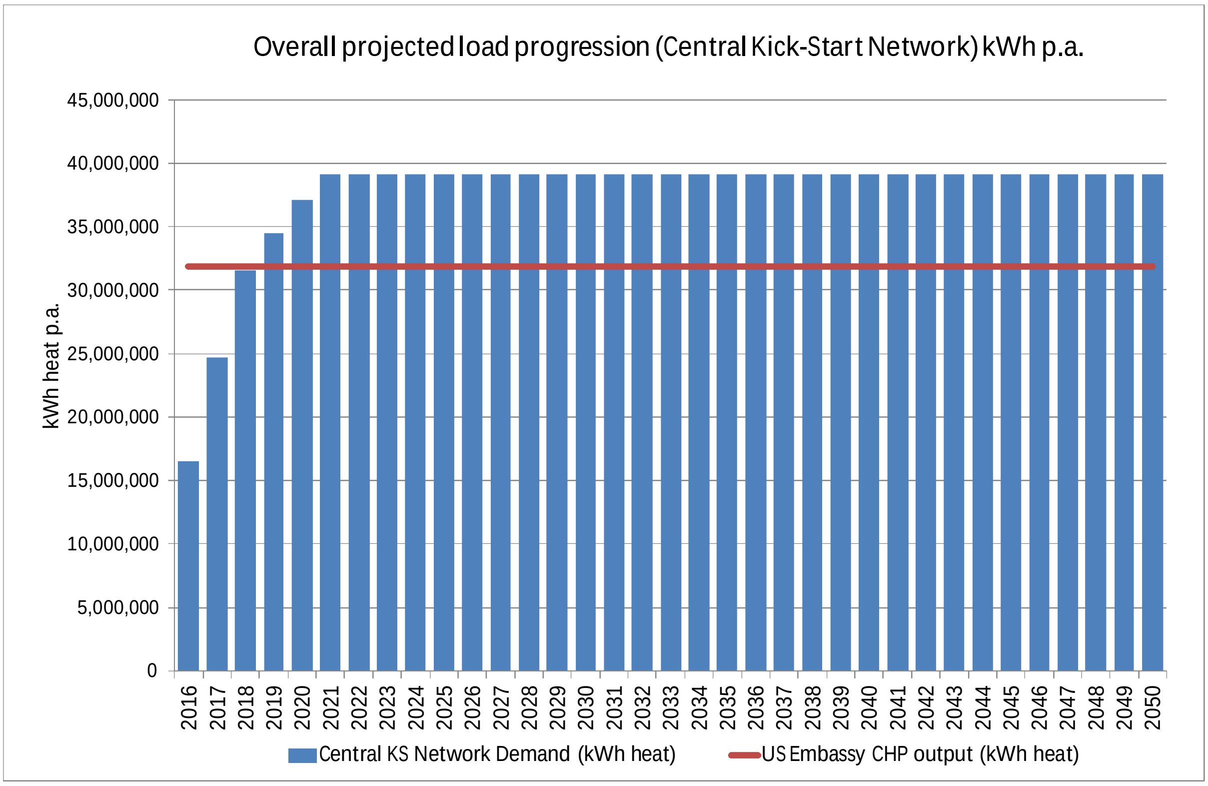
Figure 7-3 Excerpt from US Embassy Planning Submission

Emmisions Including CHP	Energy (kWh/year)	Carbon ($kgCO_2/yr$)
CHP Input Fuel	80,311,680	15,901,713
CHP Generated Electricity	(30,616,200)	(16,195,970)
CHP Heat Sold to District	(31,898,664)	(6,315,935)
With CHP: Total Carbon Emissions Excluding Misc Equipment	20,133,747	(5,406,667)
With CHP: Carbon Emissions Including Misc Equipment	26,090,065	(2,327,250)

7.2.4 This table suggests that 31.9GWh of CHP heat could be sold to the district heating network, based on the operation of a CHP unit with a useful heat output of 3.641MWth. This analysis does not (and could not) address the co-incidence between supply and demand, and hence it would be disingenuous to assume that all of this heat could be usefully used by the DHN at the kick-start scale. However, in broad terms, it can be seen that this figure represents a significant part of the kick-start network demands both in its early years and after significant growth.

7.2.5 The following chart compares the total heat demands predicted for the Central kick-start network with the forecast annual heat export figure of the US Embassy.

Figure 7-4 Comparison of Central Kick-start cluster of demands and US Embassy CHP heat export



7.2.6 This suggests that the CHP heat supply from the US Embassy could play a very significant role in at least the early years of the Central kick-start cluster scheme.

7.2.7 This leads to the key recommendation for the central network that **the kick-start scheme should be configured to include integration of the US Embassy exported heat into the heat supply make-up.** This in practice is likely to mean that the purchase of heat from the Embassy should be taken as the primary supply to the kick-start DHN, and that a dedicated energy centre (which could be located elsewhere), should provide top-up and standby heat for all customers on the network. This will also have implications on the thermal storage vessel design for the top-up and standby energy centre.

7.2.8 There two options for an energy centre location that have been considered here are:

- In the region close to the US Embassy and the high-density development of the Central Scheme (no specific location here has been identified).
- In the New Covent Garden Market development within the area identified for its site-wide energy centre.

7.2.9 This is not intended to be a definitive list of all available options for EC locations, but provides a starting point for analysis.

7.2.10 Advantages of the location close to the US Embassy (and possibly integrated with one of the high-rise developments of the area), would include:

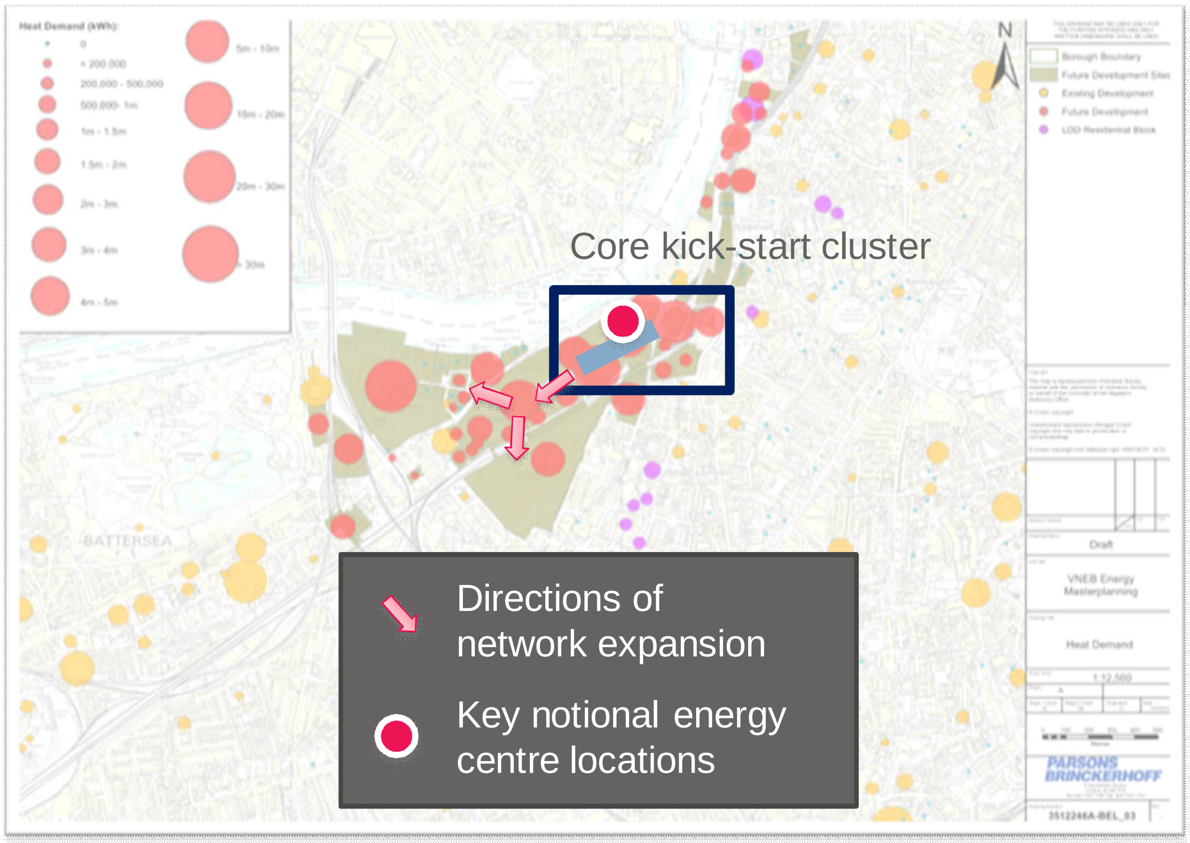
- Ease of integration of the US CHP heat supply with the other primary heat plant
- Potential to use the high-rise buildings as a conduit for flues to high level (albeit the presence of other high-rise buildings such as St George's Tower in the vicinity may also present difficulties in developing a flue-gas dispersion strategy).

7.2.11 Advantages of the NCGMA EC location would include:

- Lower value land directly adjacent to the railway
- No immediately adjacent high-rise development that could pose difficulty in flue gas dispersion strategies
- Some allowance for energy plant has already been made in this location
- If a DH distribution route can be arranged through the linear park north of the railway line, then this provides ready connections to further development.

7.2.12 The two potential energy centre locations lead to two different trajectories of scheme growth. In broad terms, the different approaches can be illustrated as shown below:

Figure 7-5 Central Network notional energy centre expansion diagram



7.2.13 This configuration allows the kick-start cluster to be served from a local energy centre, and creates a very high heat-density cluster (which corresponds to a high likelihood of being economically viable and deliverable). Growth from the kick-start cluster can happen in line with the development of the neighbouring plots.

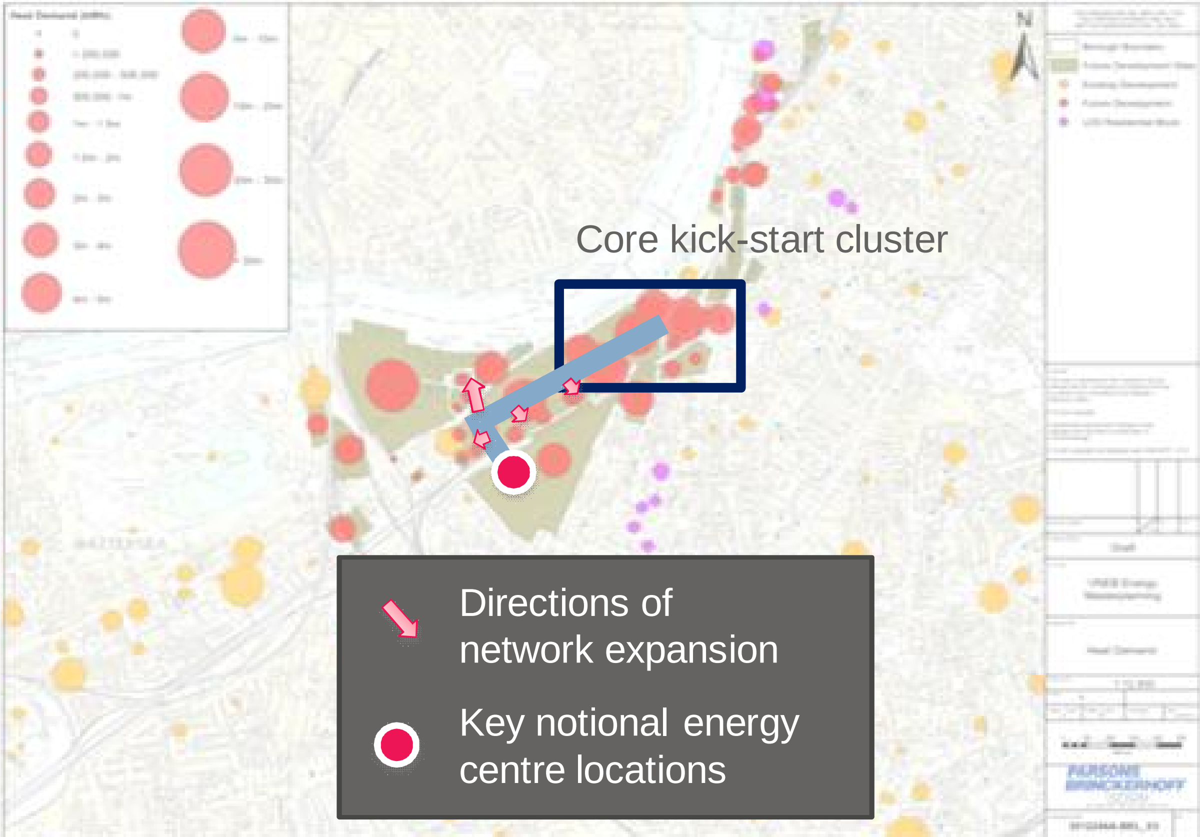
7.2.14 The following table illustrates the approximate dates at which heat is required by the different loads that could be connected to this central network under this scenario:

Table 7-2 Table with provisional heat-on and individual boiler-only dates

OAPF no	Description	Date heat required	Notional DH connection date	Period during which boiler-only provision required
36	US Embassy, Nine Elms Lane	2014	2016	2014-2016
25	NCGMA - Northern site	2014	2016	2014-2017
17	Main Site, Ballymore	2012	2016	2012-2016
19	Market Towers	2015	2016	2015-2016
44	Sky Gardens	2015	2016	2015-2016
37	Vauxhall Square Cap Gemini Site	2017	2016	n/a
41	Billboard site	2015	2016	2015-2016
6	Booker Cash and Carry, 41-49 Nine Elms Lane, SW8	2023	2023	n/a
21	Metropolitan Police Warehouse Garage, Ponton Road, SW8	2025	2025	n/a
23	Dairy Crest Milk Distribution Depot, 55 Sleaford Street, SW8	2019	2019	n/a
24	NCGMA - Entrance site	2016	2016	n/a
1	49-59 Battersea Park Road, SW8	2022	2022	n/a
26	NCGMA - Market site	2013	2016	2013-2016
29	Securicor Site, 80 Kirtling Street, SW8	2026	2026	n/a
32	Sleaford Street, SW8	2019	2019	n/a
33	Royal Mail Group Site, Ponton Road, SW8	2017	2017	n/a
35	Tideway Industrial Estate, Nine Elms, SW8	2014	2016	2014-2016
7	Brooks Court, Kirtling Street, SW8	2028	2028	n/a
8	Cable and Wireless, Ballymore Site 6, Unit 2a, Battersea Park Road, SW8	2030	2030	n/a
42	Keybridge House and Wyvil Road	2023	2023	n/a
14	Government Car and Dispatch Agency, Ponton Road, SW8	2024	2024	n/a
49	Miles St (South) and corner of Wandsworth Road	2025	2025	n/a
52	Nine Elms Sainsbury's, Wandsworth Road	2019	2019	n/a
58	Island Site Vauxhall Cross	2016	2016	n/a
9	Christies Auctioneers Depot, Ponton Road, SW8	2027	2027	n/a

7.2.15 This table of dates shows that the sites that have the longest period of boiler-only heat provision before the DH network is assumed to be implemented are the Ballymore Main Site (OAPF 17) and the NCGMA site (OAPF 26).

Figure 7-6 Central network NCGMA energy centre expansion diagram



7.2.16 This configuration (i.e. Energy Centre on NCGMA site) depends upon the availability of wayleaves / easements for a DH link through the linear park at the start of the scheme[9]. In comparison with the alternative configuration shown in Figure 7-5, this scheme implies a much higher initial cost, and a different growth strategy.

7.2.17 Even with the energy centre located in the NCGMA, the supply of heat from the remote US Embassy CHP can be integrated into the energy supply strategy. This will require some controls integration and linking communications media.

7.2.18 PB has undertaken financial analysis of these configurations of schemes. Inputs and results of this and other option modelling are shown in Section 8.

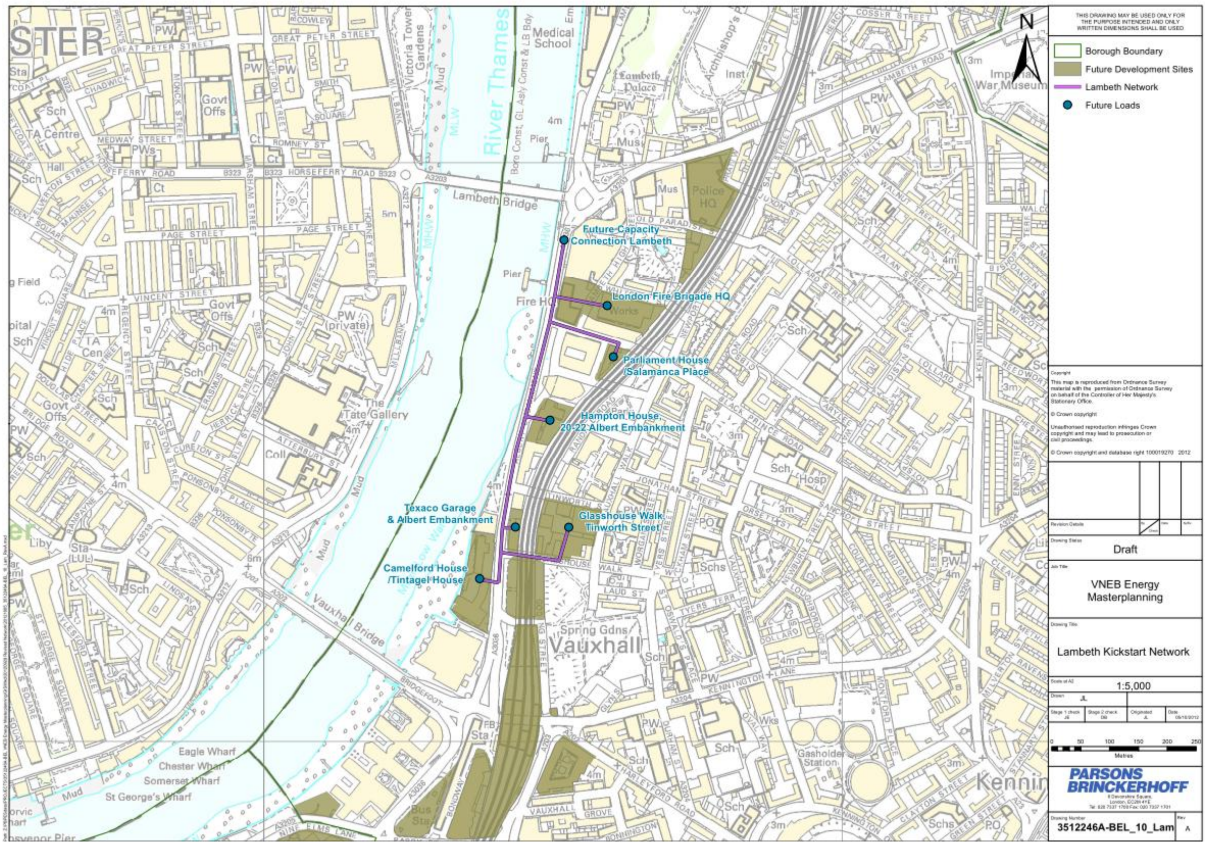
7.3 Northern Cluster (Lambeth)

7.3.1 Despite pursuing various avenues of enquiry, PB has not been able to obtain details of energy consumption nor system type for the MI6 building. The main buildings of the St George's Wharf development adjacent to Vauxhall Station are understood to be electrically heated, and due to the cost and unacceptability of the disruption of

[9] Some sites in this area are anticipated to come forward for development later – including OAPF no.s 9 and 14 – Christie's Depot and Government Car and Dispatch Agency.

retrofitting a 'wet solution' in this prestige block, this block has not been considered for DH integration. This lack of information from MI6 and unlikely compatibility of these two sites represents a barrier to the extension of the central network towards Lambeth. These two sites have been excluded from analysis of schemes in this report. A further kick-start network based around loads in Lambeth around the Albert Embankment has also been examined. The configuration of this network is as follows:

Figure 7-7 Northern Cluster Illustration



7.3.2 This cluster contains the following loads:

Table 7-3 Lambeth (Northern) Kick-start network loads

ID[10]	Name	Demand in 2016 (kWh heat)	Demand in 2035 (kWh heat)
48	Hampton House 20-22 Albert Embankment	2,296,439	2,315,893
57	Texaco Garage, 38-46 Albert Embankment	415,071	543,919
46	London Fire Brigade HQ, 8 Albert Embankment	676,254	1,061,935
47	81 Black Prince Road (Parliament House)	395,990	395,990
38	2 -14 Tinworth Street and 108 -110 Vauxhall Walk (Spring Mews)	0	1,630,535
40	Albert Embankment Riverside sites	0	454,554
Total demand		**3,783,754**	**6,402,826**

7.3.3 It can be seen from a comparison between the magnitude of the loads here and in the central scheme that there is a significant scalar difference between the two kick-start groupings.

7.3.4 There is a core group of loads that are expected to emerge over the next few years up to 2016, and thereafter there is a hiatus in proposed expansion until two further loads towards the south (38 and 40 in the table above), emerge at around 2023 and 2025.

7.3.5 On this basis, the following table of connections and boiler-only heat provision is proposed.

Table 7-4 Lambeth Kick-start network connection dates

OAPF no	Description	Date heat required	Notional DH connection date	Period during which building-based boiler-only heat provision required
48	Hampton House 20-22 Albert Embankment	2014	2016	2014-2016
57	Texaco Garage, 38-46 Albert Embankment	2016	2016	n/a
46	London Fire Brigade HQ, 8 Albert Embankment	2015	2016	2015-2016
47	81 Black Prince Road (Parliament House)	2014	2016	2014-2016
38	2 -14 Tinworth Street and 108 -110 Vauxhall Walk (Spring Mews)	2025	2025	n/a
40	Albert Embankment Riverside sites	2023	2023	n/a

7.3.6 Economic analysis of this and the other networks is contained within section 8.

[10] ID numbers refer to the OAPF map sites – as reproduced in Appendix D

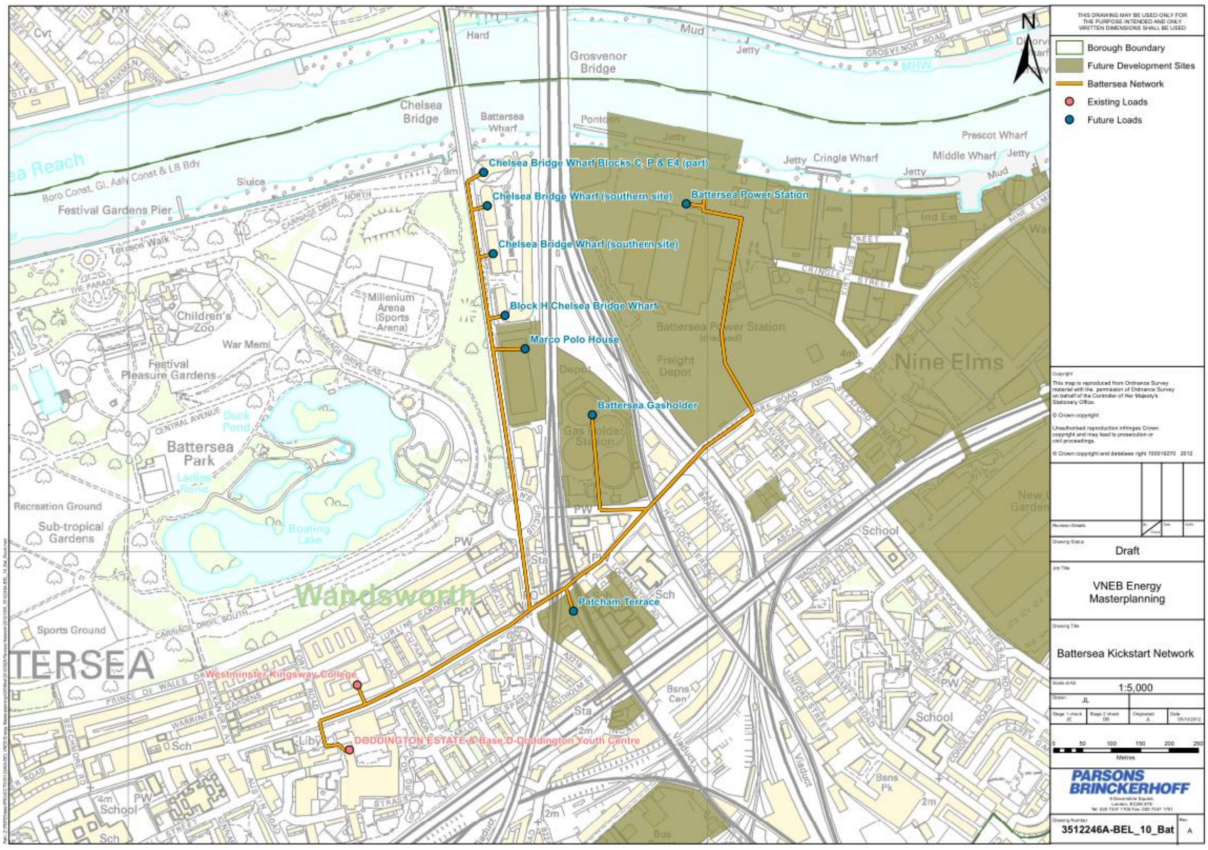
7.4 Battersea Kick-start Network

7.4.1 The development at the Battersea Power Station site is also now moving swiftly ahead, and the detailed application for Phase 1 has been submitted to Wandsworth Council (1st October 2012). A planning condition (33) for the BPS site (under BPS 2009/3575) secures an area of 6,574sq m for an energy centre, albeit this is likely to be in Phase 2 of the application.

7.4.2 The aim for this EMP must be to capture the development of the BPS site and to examine where extension to other neighbouring loads also appears to offer opportunity from an ESCo perspective.

7.4.3 The following kick-start network is proposed for the Battersea Area:

Figure 7-8 Battersea kick-start network



7.4.4 It is acknowledged that the connections to the west of the key railway links are likely to be difficult (and hence potentially expensive) to link to the main BPS network. However, it would be remiss at this stage to ignore these potential heat loads (the Doddington Estate, for example, is a large load that is compatible with a DH system) and the wider opportunity to 'open up' the potential of connection to further loads to the west of the BPS site. It is understood that the red line of the BPS application extends to the roundabout to the west of the railway, and hence it is recommended that the BPS site developers are encouraged through the detailed applications for later phases to include allowance for this connection.

7.4.5 It should also be noted that there maybe an alternative, easier route to access these loads by exploiting routes under the railway bridge adjacent to the Thames. It is recommended that this is investigated as part of the next phase of analysis to evaluate whether there is potential to link to the Chelsea Wharf site[11] from BPS via this more direct route.

7.4.6 This cluster contains the following loads:

Table 7-5 Battersea kick-start network loads

ID[12]	Name	Demand in 2016 (kWh heat)	Demand in 2035 (kWh heat)
3	Battersea Gasholders, Prince of Wales Drive, SW8	0	2,968,265
4	Battersea Power Station and Goods Yard, Kirtling Street, SW8	1,986,188	26,715,045
18	Marco Polo House, 346 Queenstown Road, SW8	290,050	1,104,324
28	Patcham Terrace (Network Rail Site) Battersea, SW8	0	1,873,854
603	Westminster Kingsway College	2,274,960	2,274,960
360	Doddington Estate	6,751,743	6,751,743
590	Chelsea Bridge Wharf Blocks C, P & E4 (part), 362-382 Queenstown Road	491,812	491,812
605	Chelsea Bridge Wharf (southern site), Queenstown Road	2,088,704	2,088,704
606	Chelsea Bridge Wharf (southern site), Queenstown Road	517,888	517,888
634	Block H Chelsea Bridge Wharf, 354 Queenstown Road	1,703,040	1,703,040
Total demand		**16,104,385**	**46,489,635**

7.4.7 The following table illustrates which loads would require interim boiler-only (or other local) heat provision whilst the DH network is implemented.

[11] NB A first stage in this investigation must also be to ensure that the existing Chelsea Wharf energy supply systems are compatible with a DH solution.
[12] ID numbers refer to the OAPF map sites – as reproduced in Appendix D

Table 7-6 Battersea load connection dates

OAPF no	Description	Date heat required by development	Notional DH connection date	Period during which local boiler-only heat provision required
3	Battersea Gasholders, Prince of Wales Drive, SW8	2018	2016	n/a
4	Battersea Power Station and Goods Yard, Kirtling Street, SW8	2013	2016	2013-2016
18	Marco Polo House, 346 Queenstown Road, SW8	2016	2016	n/a
28	Patcham Terrace (Network Rail Site) Battersea, SW8	2017	2016	n/a
603	Westminster Kingsway College	2011	2016	Existing heat provision continues until DH connection made
360	Doddington Estate	2011	2016	Existing heat provision continues until DH connection made
590	Chelsea Bridge Wharf Blocks C, P & E4 (part), 362-382 Queenstown Road	2011	2016	Existing heat provision continues until DH connection made
605	Chelsea Bridge Wharf (southern site), Queenstown Road	2011	2016	Existing heat provision continues until DH connection made
606	Chelsea Bridge Wharf (southern site), Queenstown Road	2011	2016	Existing heat provision continues until DH connection made
634	Block H Chelsea Bridge Wharf, 354 Queenstown Road	2011	2016	Existing heat provision continues until DH connection made

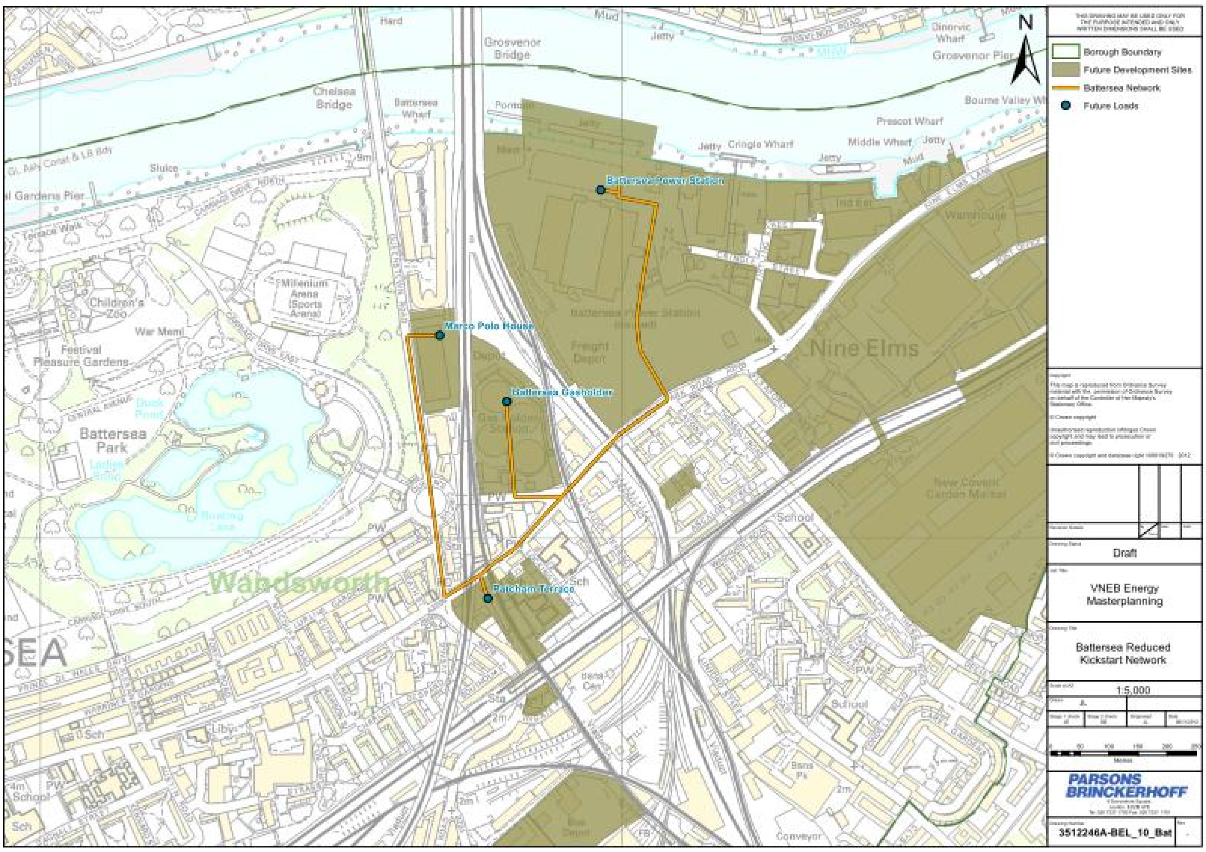
7.4.8 This table illustrates that, with the exception of the loads of the Power Station site itself, there is an opportunity to expand the network to all other sites illustrated and avoiding the need for these sites to install their own heating plant. This is a benefit for the network expansion as it should allow the ESCo or other party operating the network to benefit from a contribution towards the installation cost as a function of the avoided local energy plant costs. In the case of the existing facilities, this could equate to avoided plant replacement costs.

7.4.9 This assessment of early phase growth for the Battersea system has also been considered in the light of a possible interlinkage to the PDHU system. This heat source / use of the thermal storage unit is available immediately, and hence there is the potential to integrate this facility from the earliest date possible.

7.4.10 Reduced scale Battersea kick-start option

7.4.11 This study has not been able to determine with certainty whether the heating systems at Chelsea Bridge Wharf are compatible with a DH solution. The Doddington Estate has also recently been equipped with new boiler plant. On the basis of these two factors a somewhat reduced Battersea kick-start scheme has also been examined as shown below:

Figure 7-9 Battersea reduced network



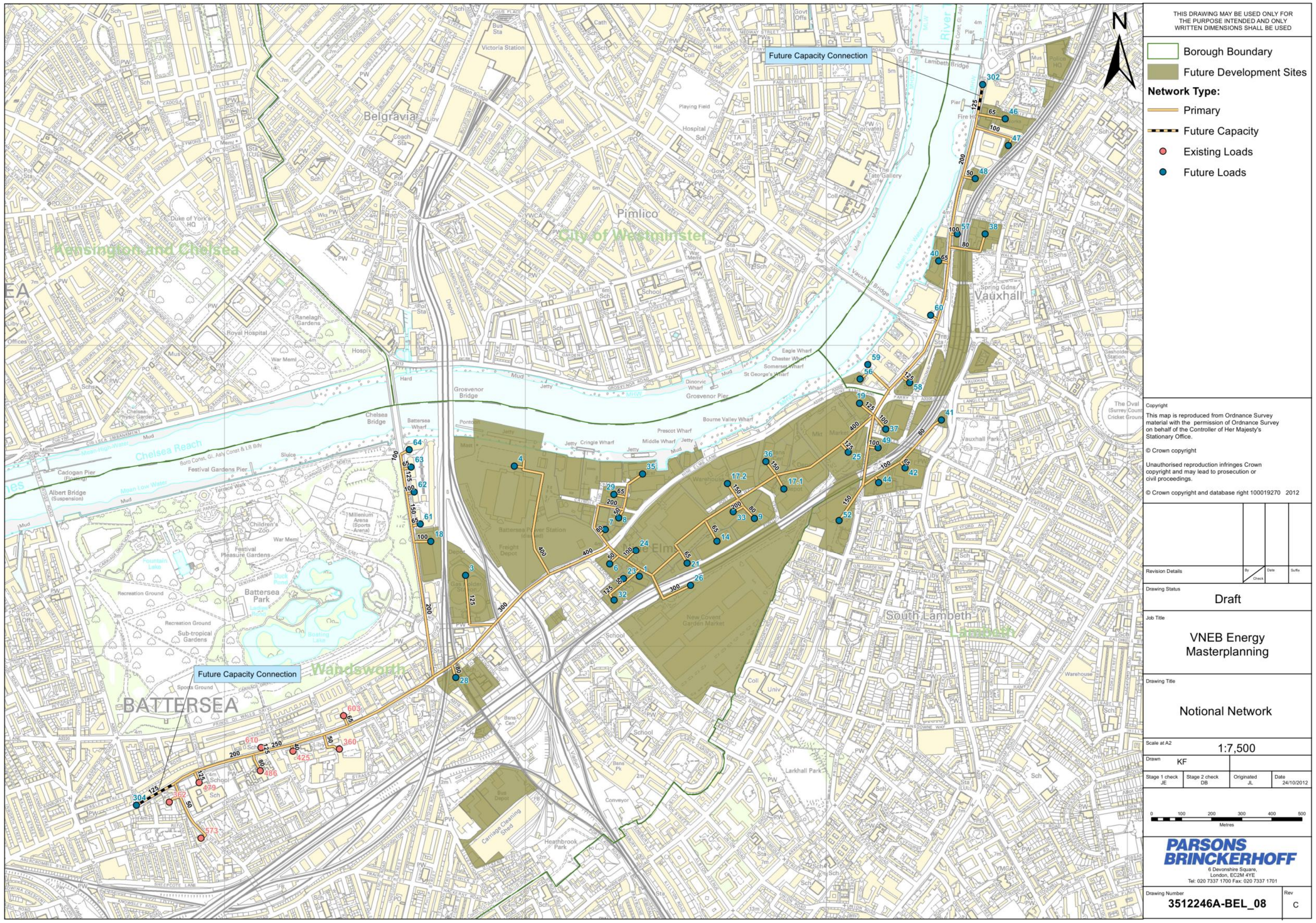
7.4.12 The results of financial analysis of this reduced scheme are shown in section 8.

7.5 Network considerations

7.5.1 The whole of the OA geography is intimately linked to the rail corridors that run through it. The heat network distribution routes proposed in the VNEB area have been conceived to capitalise on existing routes crossing underneath Network Rail assets. Some areas are particularly heavily crossed by railway assets (e.g. Stewarts Road), and loads such as the Silverthorne Rd bus depot are not included in network extents due to the difficulty of reaching these areas.

7.5.2 The overall proposal for a network (including nominal diameters of pipework) is shown overleaf:

Figure 7-10 Proposed network configuration with diameters



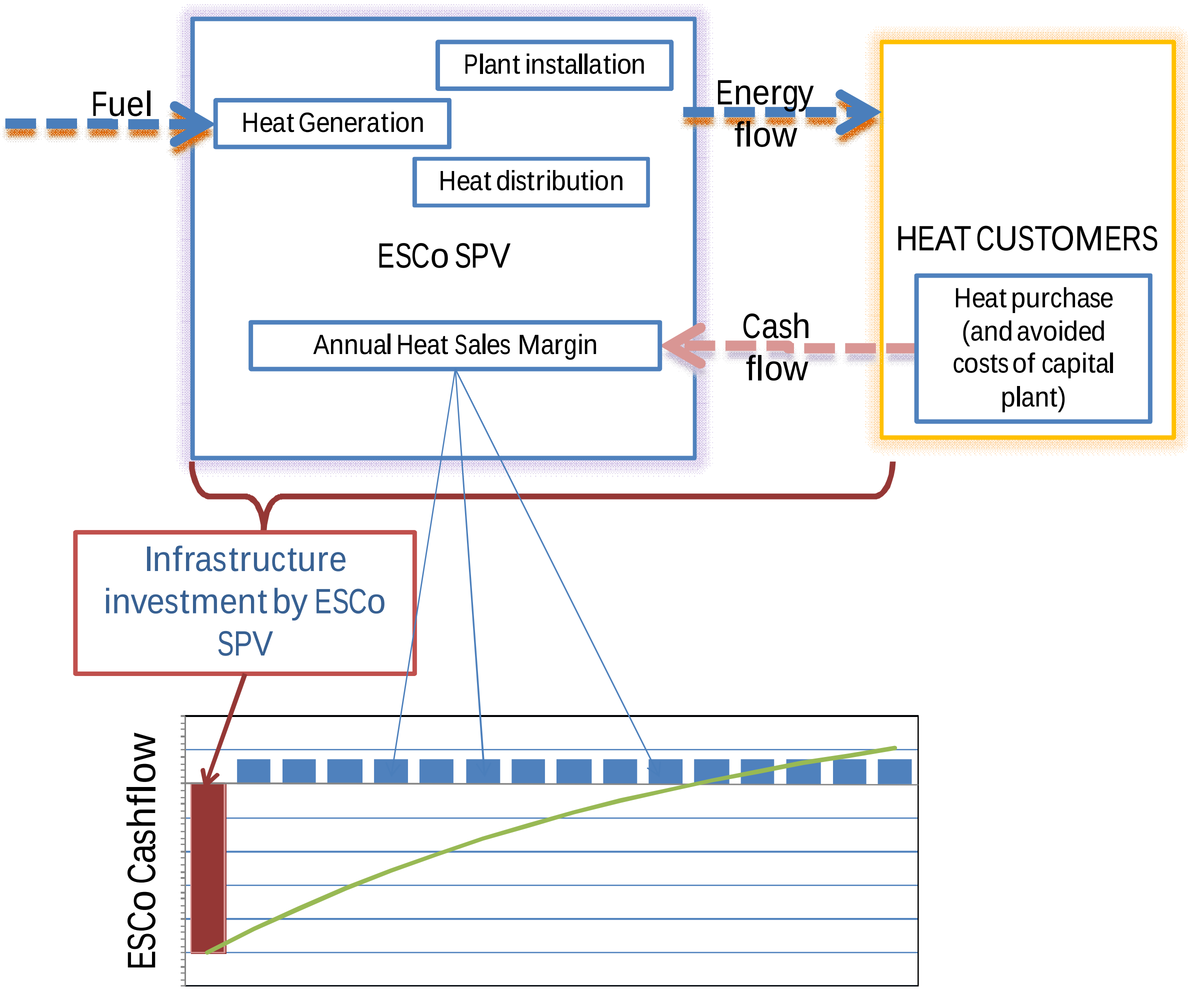
7.5.3 Network diameters have been calculated though adopting diversity figures on domestic hot water supply requirements that have been derived from Scandinavian studies of the typical co-incidence of demands from operational district heating systems. These figures reflect the fact that within a group of multiple dwellings, only a proportion of shower and tap usage is simultaneous.

8 FINANCIAL ANALYSIS

8.1.1 The networks illustrated above have been analysed on a kick-start network basis in order to establish to what degree their implementation appears viable.

8.1.2 The perspective adopted is that of an Energy Services Company, which would be anticipated to fund the installation of the infrastructure linking loads. The ESCo would then benefit from any annual margin it can generate between the cost of supplying heat and revenue from heat sales. This is illustrated below:

Figure 8-1 ESCo structure adopted



8.1.3 The demarcation of costs has been assumed to be at a single point of connection at each of the individual sites' premises. The cost assumed to be borne by the ESCo in this analysis therefore includes the district heating connection and heat interface units at individual sites. The costs of all secondary systems are assumed to be borne by individual plot developers.

8.1.4 A further assumption has been made in terms developer contributions towards connection to the district heating network. This is calculated on the basis that

Developers would see an avoided cost of not having to install their own low-carbon energy supply plant on-site. This avoided cost is expected to be passed to the ESCo as a DH connection charge. The scenarios envisaged for calculation of this connection charge are:

- Connection to a DH network is available before completion of the first units / elements of the Development. Under this scenario Developer avoids cost of all primary heat supply plant on site

- The connection to a DH network is available at some point between the first phase of completion and the total build-out of the site

Table 8-1 Connection scenarios and avoided costs

Scenario	Avoided costs
Connection to a DH network is available before completion of the first units / elements of the Development.	Developer avoids cost of all primary heat supply plant on site. This includes plant, flues, M&E installation and energy centre space.
Connection to a DH network is available at some point between the first phase of completion and the total build-out of the site	Developer avoids cost of installation of all primary heat supply plant on site, but requires the hire / installation of temporary boiler plant to meet demands of early phase development
Connection to a DH network is only available after the completion of the development (within 5 years)	Cost of primary low carbon plant (e.g. gas-fired CHP) is avoided, but development would be anticipated to install its own boiler plant.
Connection to a DH network is only available after the completion of the development (5 years or more afterwards)	No avoided costs – low-carbon plant must be installed as on-site measure.

8.1.5 The cost savings (and hence developer connection charges) seen by this project have been estimated on the basis of standard metrics of cost from Spons Mechanical and Electrical Services Price Books.

8.2 General input assumptions

8.2.1 The following represent the assumptions adopted within the financial modelling of scheme viability.

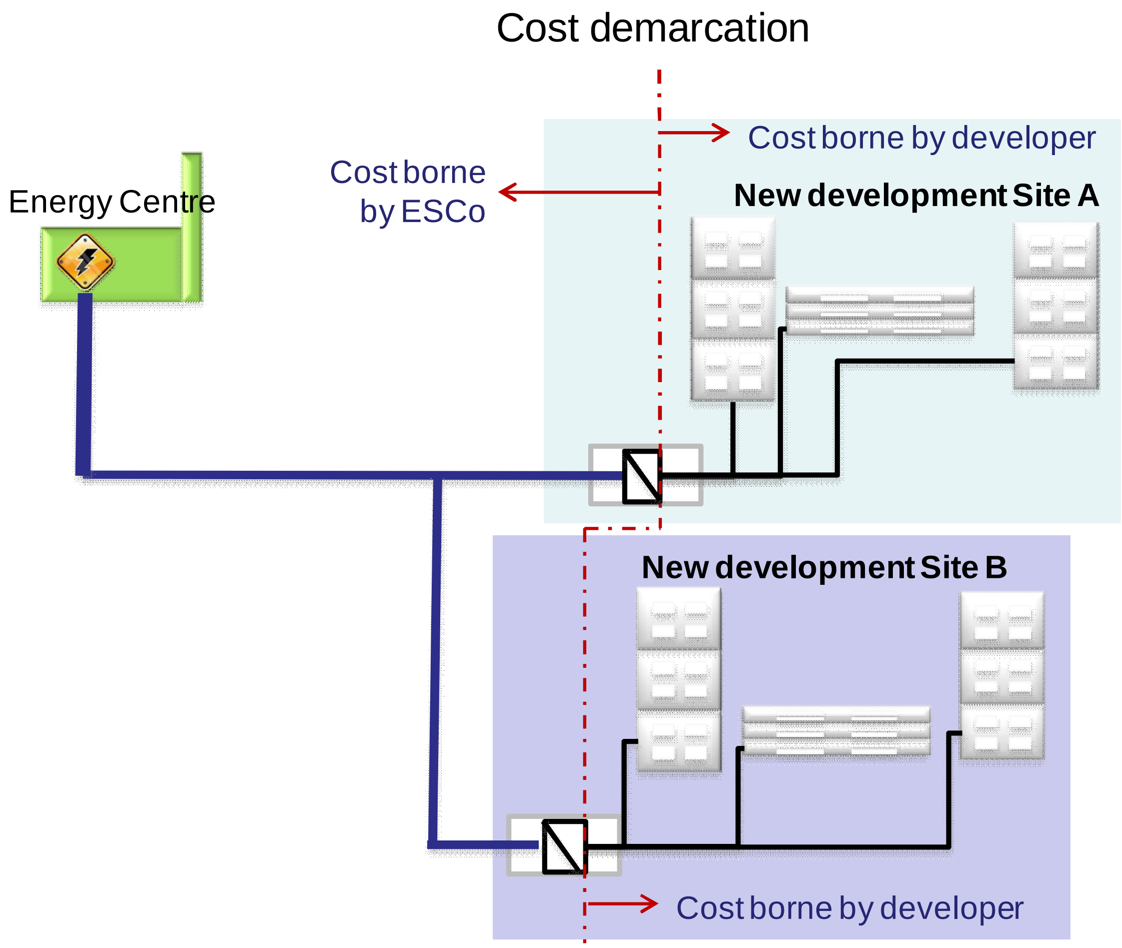
Table 8-2 Utility price assumptions

Utility	Price for 2012 (p/kWh)	Source notes
Gas (industrial)	2.90	DECC central 2012
Electricity industrial	12.15	DECC central 2012
Elec Wholesale	7.32	DECC central 2012
Woodchips	2.90	http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,59188&_dad=portal&_schema=PORTAL
Biofuel (liquid B100)	8.50	Estimate

8.2.2 PB would comment on the DECC projected prices that these values do not appear to match wholesale gas or electrical values that are currently seen within the UK. The current wholesale electricity value lies somewhat below the DECC price quoted above, as do typical natural gas prices. However, the use of the DECC projected figures is still considered appropriate for two reasons: First, the overall ratio between the DECC gas and electricity prices used here matches those seen in the markets currently and second, this study considers the implementation of schemes in around 2016 and there is a general expectation in the markets that some level of upward shift in prices will be seen.

8.2.3 It must also be noted that a key assumption in terms of capital cost demarcations is that this study has assumed that the heat distribution networks within each site would be funded by the developers of each plot. Hence the costs included within this study only encompass the linkages between points of heat supply that are already centralised on each plot.

Figure 8-2 Illustration of assumed cost demarcation

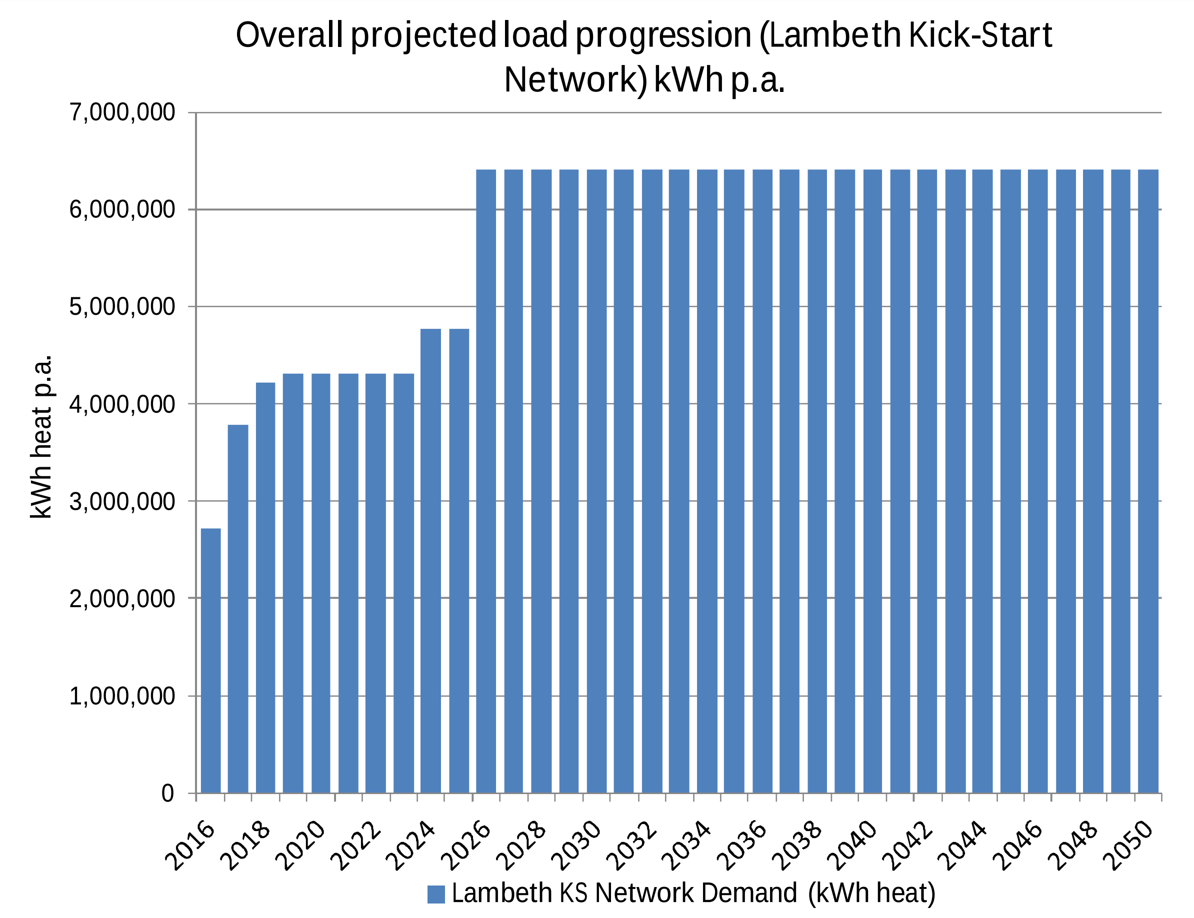


8.2.4 It should further be noted that the examination of the private wire option is notional at this stage. Whilst there is theoretically a large customer (TfL) which could have the ability to procure power on a long-term basis, the rates at which this would be negotiated are likely to be at, or lower than typical electrical wholesale costs. Hence the variation in electricity values illustrated within this report should be seen as representing notional routes of power sale - the realisation of which are yet to be determined.

8.3 Lambeth kick-start network

8.3.1 The following chart illustrates the load growth upon which analysis of the Lambeth kick-start network is based:

Figure 8-3 Growth of Lambeth Network

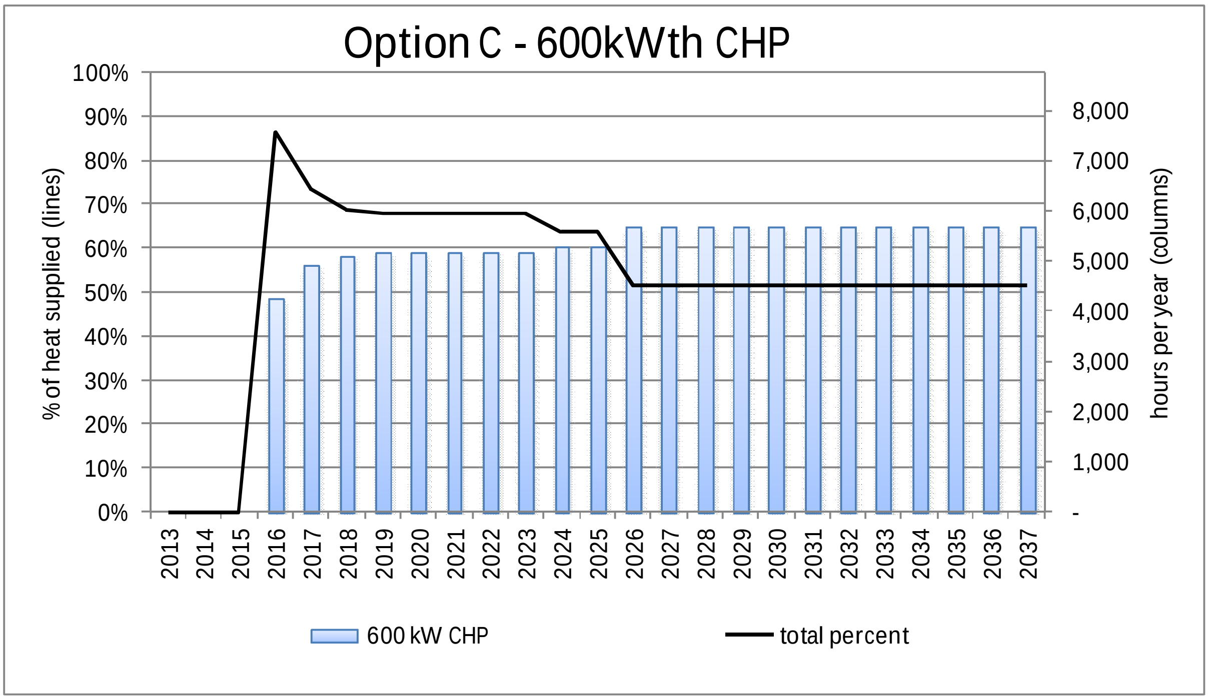


8.3.2 Plant sizing

8.3.3 The primary plant to meet these loads has been based primarily upon the loads available in the initial period 2016 to 2026. This is based upon the aspiration that after this date, connection to the central network could be made, thereby avoiding the need for additional investment in local low-carbon plant.

8.3.4 During the initial period, the loads suggest that a CHP unit with an output of approximately 600kWth would be well-suited to the load progression, as illustrated in the chart below:

Figure 8-4 600kWth CHP unit operation against Lambeth kick-start loads



8.3.5 This chart shows the 600kWth unit operating at very close to 5,000 hours per year during the initial kick-start period, meeting close to 70% of the heat demand of the system (a thermal store of 50 cubic metres capacity has been modelled here), i.e. the black line on this chart represents the total percentage of the overall heat demand (not shown on graphic) that is met by the operation of the CHP prime mover. The remaining heat demand is met by gas boilers.

8.3.6 Cost estimates

8.3.7 There is no energy centre location that has been identified for the Lambeth kick-start cluster, and the assumption is made that one of the existing plant rooms could be expanded to house the plant required to supply the full kick-start network.

8.3.8 The cost of plant for this scheme has been based, therefore, upon the cost of installation of the primary plant and an assumed additional energy centre area for the additional plant to meet the whole kick-start scheme's needs. A high-level breakdown of total costs is as follows:

Table 8-3 Lambeth kick-start network cost estimate

	Gas CHP option 600kWth gas CHP, 50 m3 TS, and gas boilers	Assumed date of capital spend
Energy centre primary plant	£503,000	2015
Ancillaries	£361,000	2015
M&E installation	£194,000	2015
DH network costs[13]	£665,000	2015
Energy Centre Additional Area	£100,000	2015
Utilities	£141,000	2015
Contingency	£294,600	2015
TOTAL (kick-start)	£2,258,600	
DH extension costs	£245,000	2022
TOTAL	£2,503,600	

8.3.9 The following table illustrates a high-level assumption of avoided costs for the connected loads.

Table 8-4 Developer contribution estimates

OAPF no	Description	Period during which building-based boiler-only heat provision required	Developer contribution basis (based on notional £400/kWth)	Base case CHP assumed (kWe approx)	Estimated Developer contributions (£)
48	Hampton House 20-22 Albert Embankment	2014-2016	Avoided CHP cost	230	92,000
57	Texaco Garage, 38-46 Albert Embankment	n/a	Avoided CHP, boiler and ancillaries	55	33,000
46	London Fire Brigade HQ, 8 Albert Embankment	2015-2016	Avoided CHP cost	105	42,000
47	81 Black Prince Road (Parliament House)	2014-2016	Avoided CHP cost	40	16,000
38	2 -14 Tinworth Street and 108 -110 Vauxhall Walk (Spring Mews)	n/a	Avoided CHP, boiler and ancillaries	160	96,000
40	Albert Embankment Riverside sites	n/a	Avoided CHP, boiler and ancillaries	45	27,000

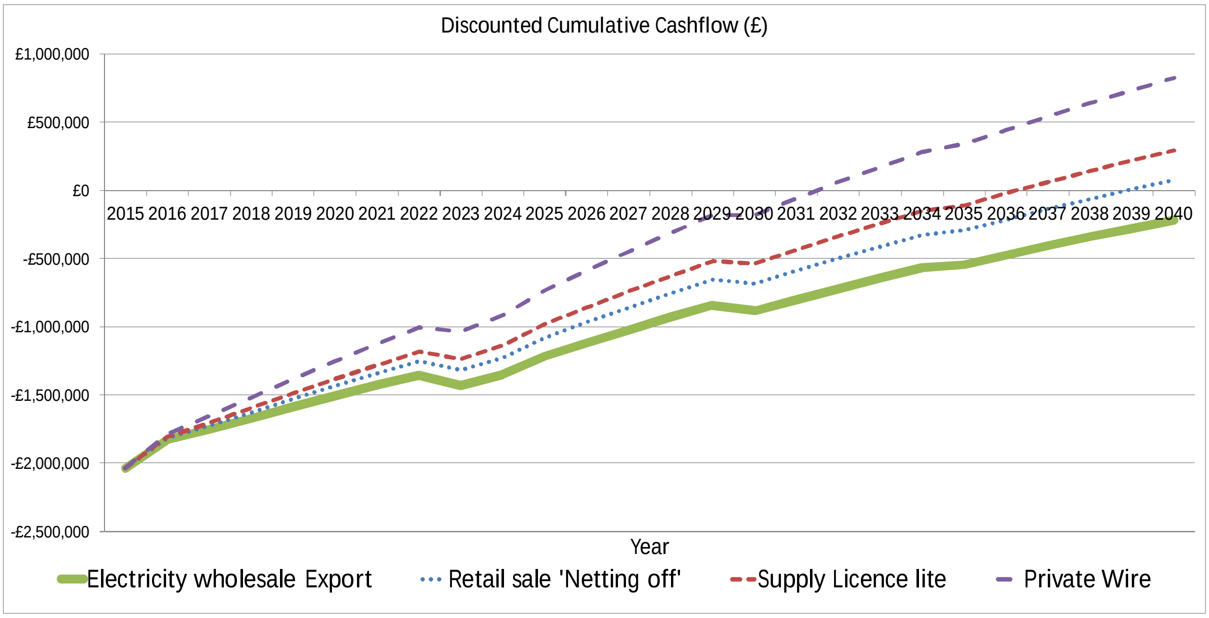
8.3.10 Whole life cost analysis (Lambeth kick-start)

8.3.11 The following illustrates the calculated performance of the kick-start scheme on the basis of the assumptions listed above. The chart shows a discounted cumulative

[13] At kick-start installation.

cashflow for the scheme when operating with a private wire electricity sales arrangement.

Table 8-5 Lambeth kick-start scheme discounted cumulative cashflow (3.5% discount rate)



8.3.12 This chart shows that over the course of a 25 year period, under three of the four electricity sale scenarios considered, the scheme results in a positive NPV.

8.3.13 For this scheme (and the others considered in this report), it is not clear that there is an immediate opportunity for the scheme operator to benefit from any of the ‘improved’ electricity sales routes that are shown above, particularly in the timeframe available to the proposed date of instigation of this network. There is no known large user of power in the immediate vicinity of the Lambeth scheme, and the willingness of electricity suppliers to enter into ‘netting off’ or ‘supply licence lite’ arrangements is not proven.

8.3.14 On this basis, it is the ‘wholesale export’ scenario that must be given greatest weight here, and this demonstrates a negative 25yr cumulative cashflow at 3.5% discount rate.

8.3.15 This result illustrates that it is highly unlikely that the private sector would have immediate interest in pursuing this opportunity from an ESCo perspective. This analysis suggests that in order to implement this network a significant level of public sector ‘pump-priming’ and de-risking of the investment opportunity will be required.

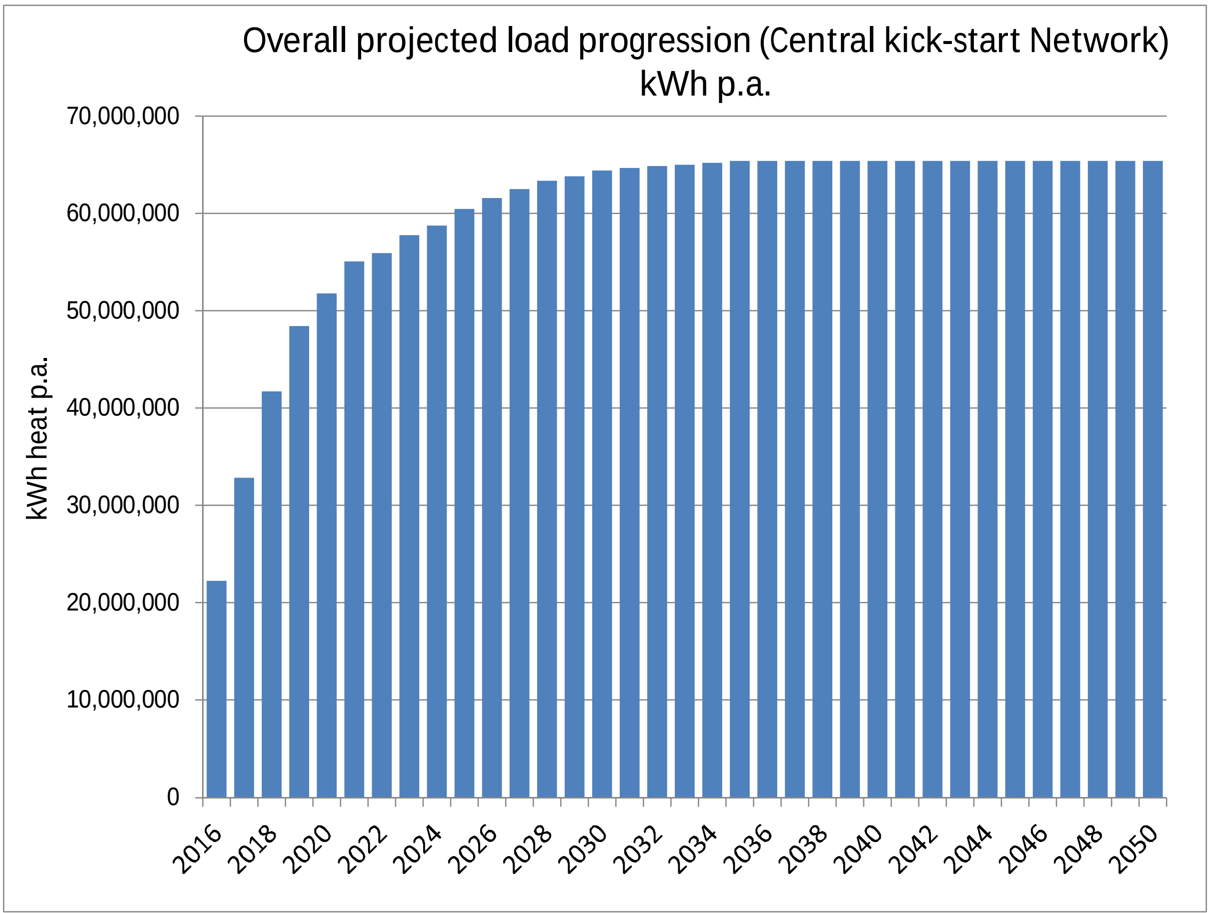
8.4 Central scheme (kick-start network)

8.4.1 This scheme has been considered in two variants depending on energy centre location. However, the minor differences in terms of connection dates of particular loads is not considered significant enough to warrant separate modelling of options at this stage. Hence a single financial model has been developed around the NCGMA case (assumed to have a worse cashflow given the extended DH network required in the early years), in order to represent both options.

8.4.2 Central scheme - Energy Centre location in NCGMA

8.4.3 The central cluster of loads of the kick-start network and potential contribution from the US Embassy in terms of heat is shown in Figure 7-4 Comparison of Central Kick-start cluster of demands and US Embassy CHP heat exportFigure 7-4. The following chart shows the same core cluster with the additional loads that have been considered for the 'central scheme' (as listed in Table 7-2).

Figure 8-5 Central scheme load growth



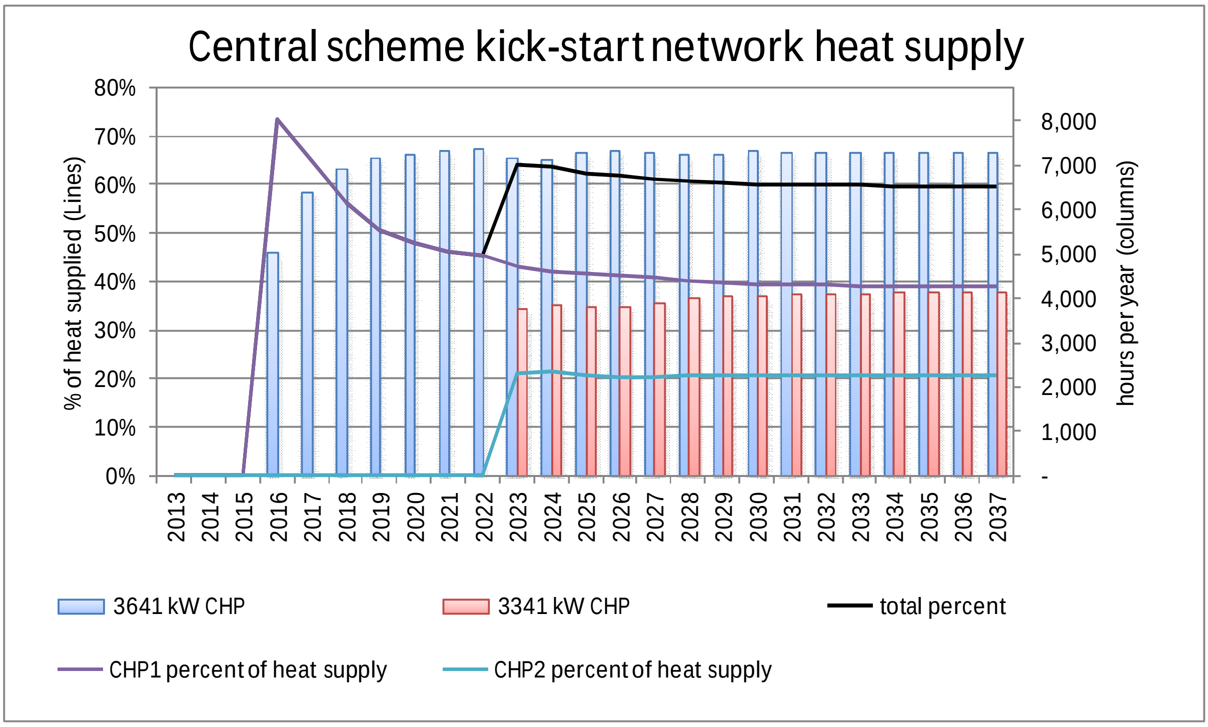
8.4.4 Given the level of contribution of heat from the US Embassy, the financial performance of this scheme is heavily dependent upon the price at which this heat is made available to the ESCO operating the wider DH network. One potential technical option this scheme would be for an ESCO only to provide top-up and standby boiler plant in the early years, and to use the output of the US Embassy as the only source of low-carbon heat until there is sufficient demand to warrant additional capacity.

There are a number of contractual issues to resolve around this type of arrangement, the detail of which goes beyond the scope of this study. The supply of heat from the US Embassy CHPs and the location of top-up and standby boiler plant at the other end of the network would also represent a technical challenge but one which can be overcome with modern control technology.

8.4.5 The following modelling illustrates the range of heat costs at which it would appear to be viable for an ESCo to operate the central scheme on the basis of heat purchase from the US Embassy.

8.4.6 The following chart shows the contribution of heat from the Embassy and a CHP unit over the course of the load growth.

Figure 8-6 Central scheme heat supply make-up



8.4.7 This analysis suggests that an approx 3MWe CHP unit would be appropriately sized to contribute to the overall supply of heat from around 2023.

8.4.8 The following costs for the implementation of this scheme have been adopted in modelling:

Table 8-6 Central scheme cost estimates

	US Embassy heat supply with later phase CHP
Energy centre primary plant	£3,199,000
Ancillaries	£2,074,000
M&E installation	£2,188,000
US Embassy Interface	£250,000
DH network costs	£3,538,000
Energy Centre Additional Area	£1,000,000
Utilities	£480,000
Design and management	£1,272,900
Contingency	£1,909,350
TOTAL (kick-start)	£15,911,250
DH extension costs	£697,000
TOTAL	£16,608,250

8.4.9 On this basis the following heat sales purchase costs from the US Embassy have been calculated in order to deliver a zero NPV at different discount rates over 25 years. Only results for the electricity wholesale export scenario have been calculated:

Table 8-7 Heat purchase cost from US Embassy to deliver zero NPV at varying discount rates

Discount rate	3.50%	6.00%	9.00%	12.00%
Heat purchase cost to deliver zero NPV (p/kWh)	7.07	6.05	4.67	3.14

8.4.10 All of these heat purchase rates would offer considerable annual income to the US Embassy, and appear to be in a commercially viable range, and hence this set of values appears to confirm the potential for a scheme based around heat purchase from the US Embassy to emerge.

8.4.11 This approach has further been analysed from the position of the US Embassy on a marginal cost of heat generation basis. This excludes the capital cost of the plant at the US Embassy, and only considers operating costs. The following calculation illustrates the point at which heat sales allow generation of heat and power at the US Embassy to generate a 20% margin on the costs of generation.

8.4.12 The figures used in this analysis in terms of CHP output at the US Embassy are based upon the planning application document as illustrated below:

Figure 8-7 CHP output at US Embassy from Planning Application document

CHP Parameters

Natural Gas CHP (CAT G3516B CHP)		Units
Elec Output	3,495	kW
Heat Output	4,284	kW
Heat Collection Efficiency	0.85	
Useful heat output	3,641	kW
Fuel Input	9,168	kW
Run hours	8,760	
Elec Output	30,616,200	kWh/yr
Heat Output	31,898,664	kWh/yr
Fuel Input	80,311,680	kWh/year
Overall System Efficiency	85%	
Electrical Efficiency	38%	
Thermal Efficiency	47%	
Revised Thermal Efficiency for 0.85 heat collection efficiency	40%	

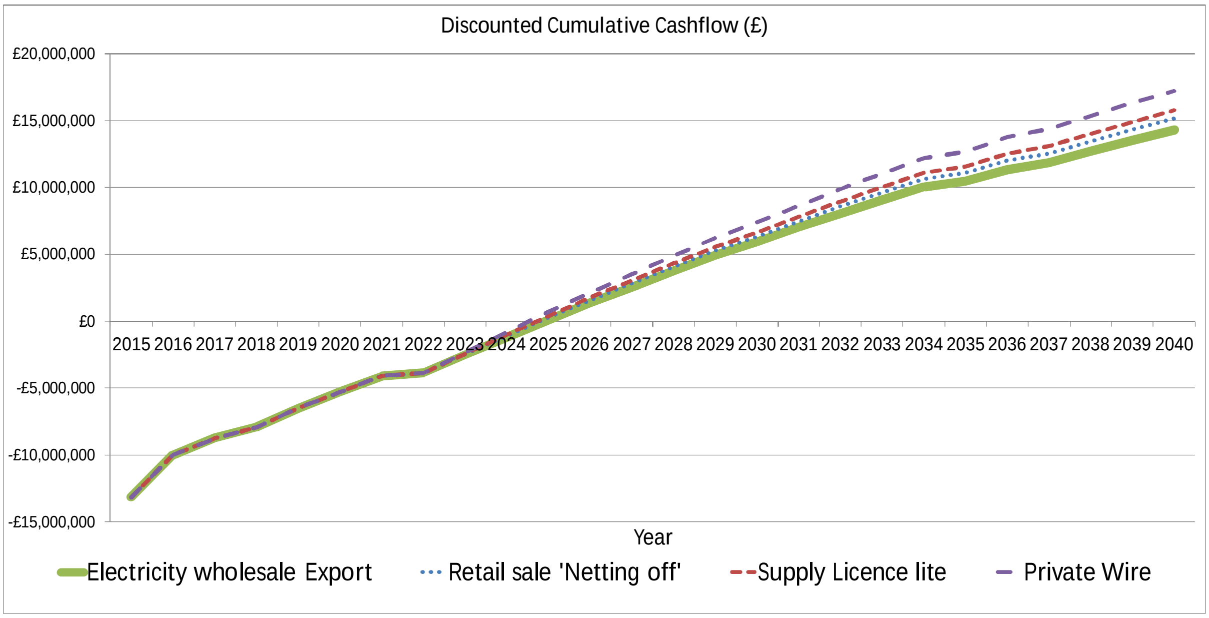
Table 8-8 Marginal cost of heat generation calculation at US Embassy

Marginal cost of heat generation calculation			
	kWh pa.	**kW rating**	**% efficiency**
Fuel use	80,311,680	9,168	
Heat output	31,898,664	3,641	39.7%
Electricity output	30,616,200	3,495	38.1%
	p/kWh		**£k p.a.**
Fuel	2.9		2,329
Heat sales to network	**3.12**		995
Electricity value	7.32		2,241
Maintenance	1.2		367
Subtotal costs			2,696
Margin (of costs)	**20%**		539
Total costs			**3,236**
Total income			**3,236**
Balance			0

8.4.13 This table illustrates that in order to generate a 20% margin on operating costs, the US Embassy would have to sell its generated heat at a value of 3.12p/kWh.

8.4.14 At this cost of heat to the Central scheme network the following whole life cost analysis is generated:

Figure 8-8 Discounted Cumulative Cashflow for Central Scheme (heat purchase from US Embassy at 3.12p/kWh)



8.4.15 As for the Lambeth scheme, it is suggested that the 'wholesale export' scenario is the most likely route for electricity sales.

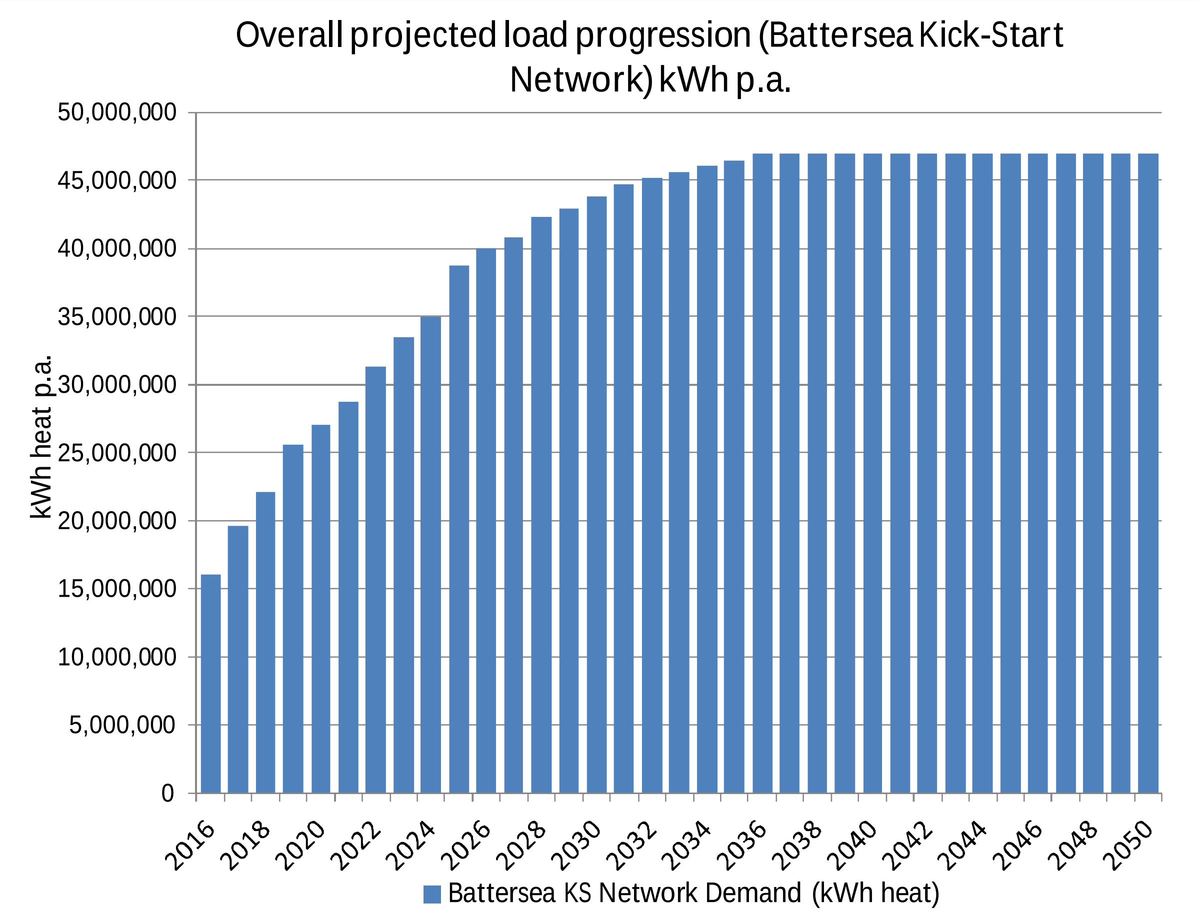
8.4.16 This scheme shows very positive whole life costs suggesting that this configuration of scheme should be attractive to private sector investors. There are, however, a number of both supply (US Embassy CHP operation) and demand (private sector reluctance to commit to long-term heat purchase agreements) risks which may require even higher private sector rates of return for the initial phases whilst the scheme is established. Public sector intervention at the start may be necessary to help overcome this and avoid excessive risk-related costs being passed to customers. Given that there is little or no public sector customer base for this scheme, the de-risking of the potential investment for the private sector may have to take the form of an equity stake in the early years of the ESCos operation until the commercial model is proven and the risk associated with establishing a stable customer base is reduced.

8.4.17 Assuming the US Embassy CHP plant is installed as per the planning permission documents, it is recommended that a further CHP unit with an approximate output of 3MWe would be suitable for the loads of the scheme.

8.4.18 Battersea kick-start network

8.4.19 The following chart illustrates the load growth upon which analysis of the Battersea kick-start network is based:

Figure 8-9 Growth of Battersea Network



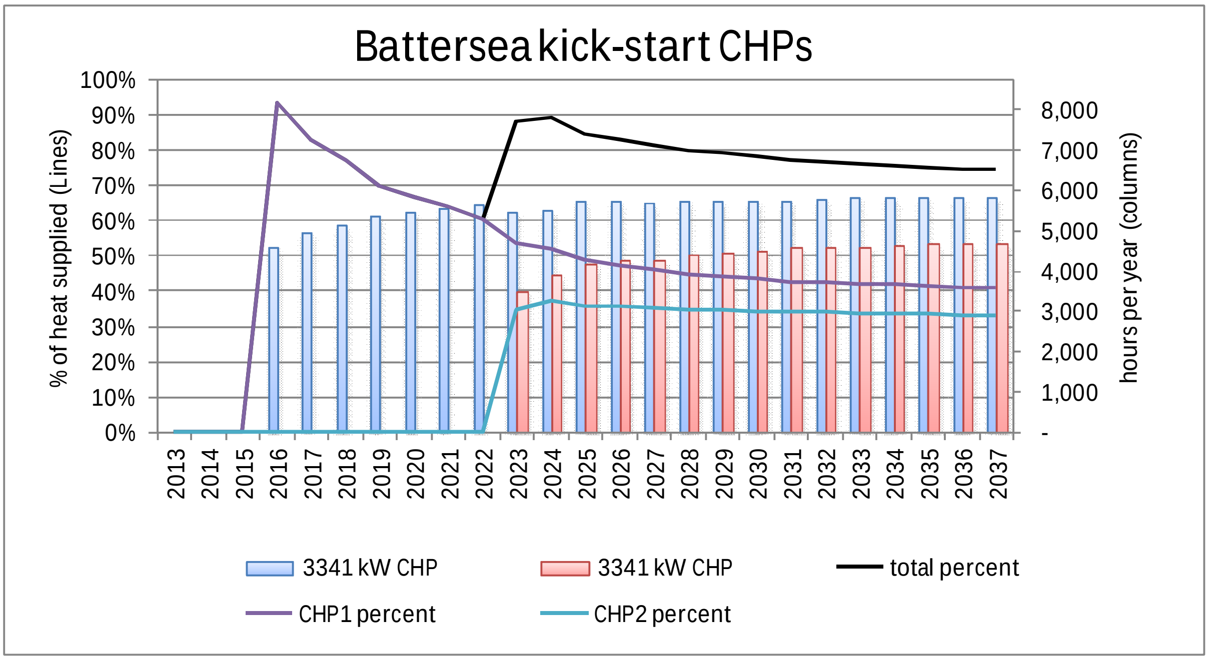
8.4.20 It can be seen that this scheme has a fairly steady growth of heat demand projected over a period of around 20 years, but also with a significant level of demand from the initial phase of Battersea Power Station's development and the existing loads incorporated within the scheme.

8.4.21 Plant sizing

8.4.22 The primary plant to meet these loads has been based upon sizing CHP plant to meet demands without significant periods of under-utilisation of plant.

8.4.23 During the initial period the loads suggest that a CHP unit with an output of approximately 3,000kWth would be well-suited to the load progression, with a further unit of the same capacity installed around 2023:

Figure 8-10 Two no. 3,000kWth CHP unit operation against Battersea kick-start loads



8.4.24 This chart shows the first 3MWth unit operates to meet between 85% and around 60% of the system heat demand during the initial kick-start period, before a further CHP is installed which allows the percentage of heat met through the primary plant to rise to close to 90% again before reducing to its final level of around 75%. This system has been modelled under the assumption that there is an operational link to the PDHU thermal storage vessel, and that this link allows the CHP units to charge the store and benefit from its discharge.

8.4.25 Cost estimates

8.4.26 Cost allowance has been made in this scheme for an increased energy centre capacity, a link to the PDHU system, and other associated plant.

Table 8-9 Battersea Kick-start network cost estimate

	Gas CHP option 2 no. 3MWth units, link to PDHU TS, and gas boilers	Assumed date of capital spend
Energy centre primary plant	£2,883,000	2015 and 2022
Ancillaries	£1,538,000	2015
M&E installation	£1,325,000	2015
Customer interface units	£684,000	2015
DH network costs	£2,637,000	2015
Energy Centre additional area	£1,000,000	2015
PHDU link	£300,000	2015
Utilities	£607,000	2015
Contingency	£1,646,100	2015
TOTAL (kick-start)	£12,620,100	
DH extension costs	£ 254,000	2016-2017
TOTAL	£12,874,100	

8.4.27 The following table illustrates a high-level assumption of avoided costs for the connected loads.

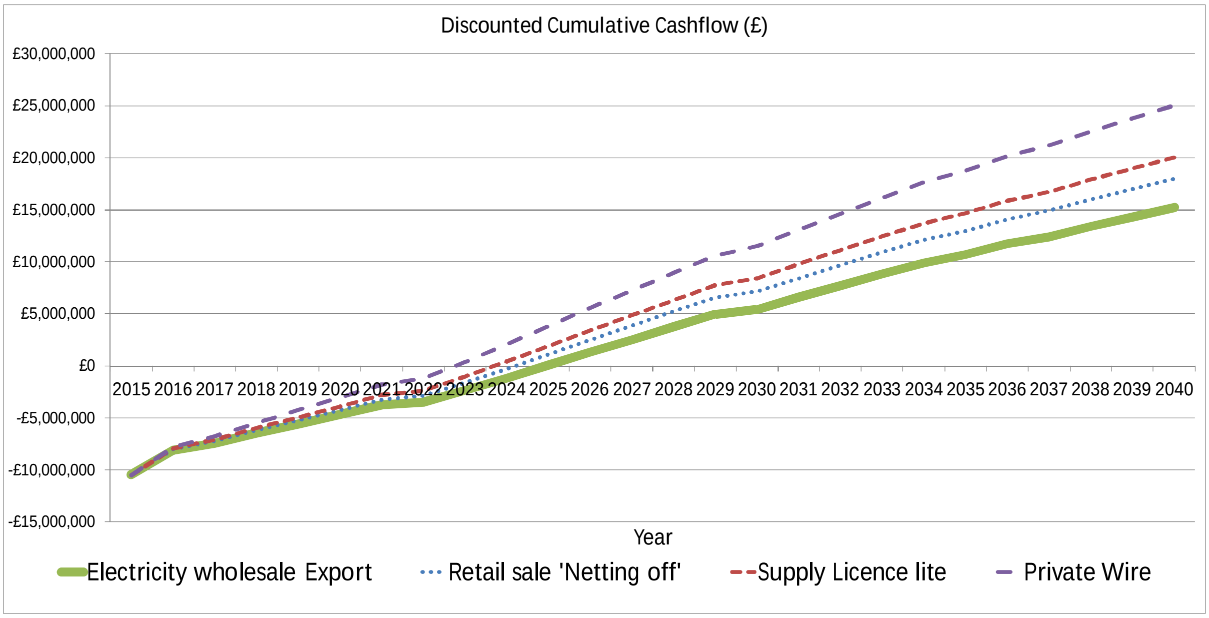
Table 8-10 Developer contribution estimates

OAPF no	Description	Period during which building-based boiler-only heat provision required	Developer contribution based around	Base case CHP assumed (kWe approx)	Estimated Developer contributions (£)
3	Battersea Gasholders, Prince of Wales Drive, SW8	n/a	Avoided CHP, boiler and ancillaries	346	208,000
4	Battersea Power Station and Goods Yard, Kirtling Street, SW8	2013-2016	Avoided CHP, boiler and ancillaries except for Phase 1	3,168	1,901,000
18	Marco Polo House, 346 Queenstown Road, SW8	n/a	Avoided CHP, boiler and ancillaries	129	78,000
28	Patcham Terrace (Network Rail Site) Battersea, SW8	n/a	Avoided CHP, boiler and ancillaries	219	132,000
603	Westminster Kingsway College	Existing heat provision continues	Avoided plant replacement	265	11,000
360	Doddington Estate	Existing heat provision continues	Avoided plant replacement	788	32,000
61	Chelsea Bridge Wharf Blocks C, P & E4 (part), 362-382 Queenstown Road	Existing heat provision continues	Avoided plant replacement	57	3,000
62	Chelsea Bridge Wharf (southern site), Queenstown Road	Existing heat provision continues	Avoided plant replacement	244	10,000
63	Chelsea Bridge Wharf (southern site), Queenstown Road	Existing heat provision continues	Avoided plant replacement	60	3,000
64	Block H Chelsea Bridge Wharf, 354 Queenstown Road	Existing heat provision continues	Avoided plant replacement	199	8,000

8.4.28 Whole life cost analysis (Battersea kick-start)

8.4.29 The following illustrates the calculated performance of the kick-start scheme on the basis of the assumptions listed above. The chart shows a discounted cumulative cashflow for the scheme when operating under a range of electricity sales routes.

Figure 8-11 Battersea kick-start scheme discounted cumulative cashflow (3.5% discount rate)



8.4.30 This chart shows that over the course of a 25 year period, this scheme appears to deliver a positive NPV under all electricity sales options.

8.4.31 The following tables summarises the results of the whole life costing analysis of this scheme at different discount rates.

Table 8-11 NPV results at varying discount rates (Battersea kick-start)

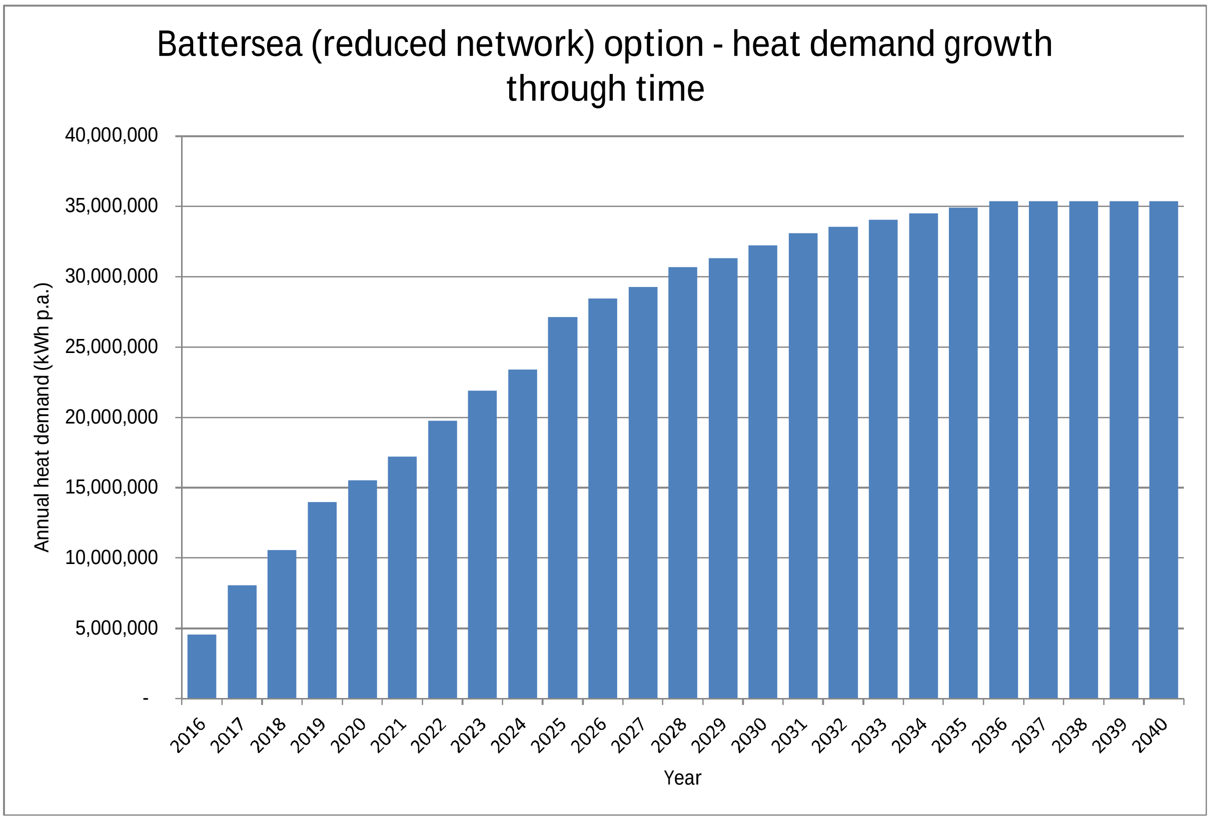
NPV (£k, 25 yrs, various discount rates)	3.50%	6.00%	9.00%	12.00%
Electricity wholesale Export	**16,859**	**9,848**	**4,393**	**866**
Retail sale 'Netting off'	19,935	12,130	6,056	2,129
Supply Licence lite	22,196	13,808	7,279	3,057
Private Wire	27,714	17,902	10,263	5,321

8.4.32 This table illustrates that this scheme shows positive whole life costs even at commercial discount rates, suggesting that this configuration of scheme should be attractive to private sector investors. There are however a number of demand risks which may require even higher private sector rates of return for the initial phases. Public sector intervention at the start may be necessary to overcome this. This intervention could be in the form of equity involvement in the scheme, or providing long-term heat purchase commitments for loads within the public sector's control i.e. Doddington Estate.

8.5 Battersea reduced network scheme

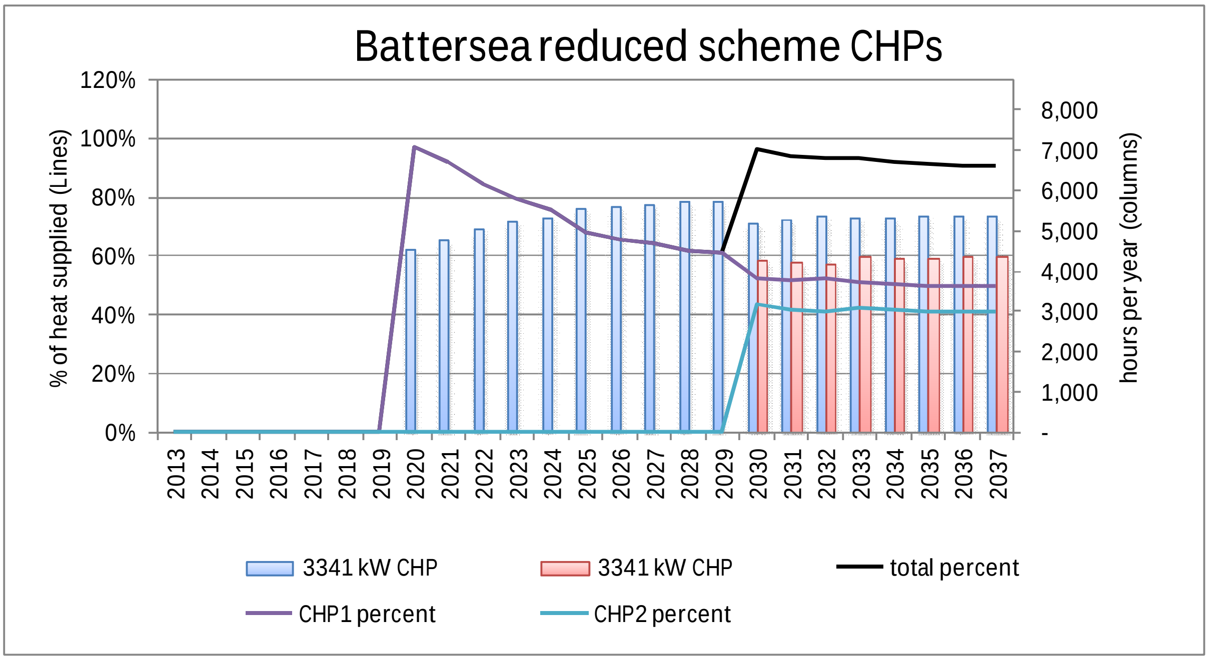
8.5.1 This analysis is based upon the network as shown in Figure 7-9. The load growth of this scheme would be as illustrated below. This shows a reduced 'existing' demand in comparison with the wider network option shown above.

Figure 8-12 Battersea reduced network load growth



8.5.2 Under this scenario of load growth CHP installation dates against the full 'kick-start' network have been modelled as delayed, with the first larger unit proposed for 2020, and a second unit in 2030. The performance of these units is illustrated below:

Figure 8-13 CHP unit operation (Battersea reduced scheme)



8.5.3 Delaying CHP unit installation, reduced network costs, and other factors lead to the following overall results:

Table 8-12 Battersea reduced network whole life cost results

NPV (£k, 25 yrs, various discount rates)	3.50%	6.00%	9.00%	12.00%
Electricity wholesale Export	9,954	4,804	888	-1,576
Retail sale 'Netting off'	12,010	6,241	1,859	-896
Supply Licence lite	13,520	7,298	2,572	-397
Private Wire	17,207	9,876	4,312	821

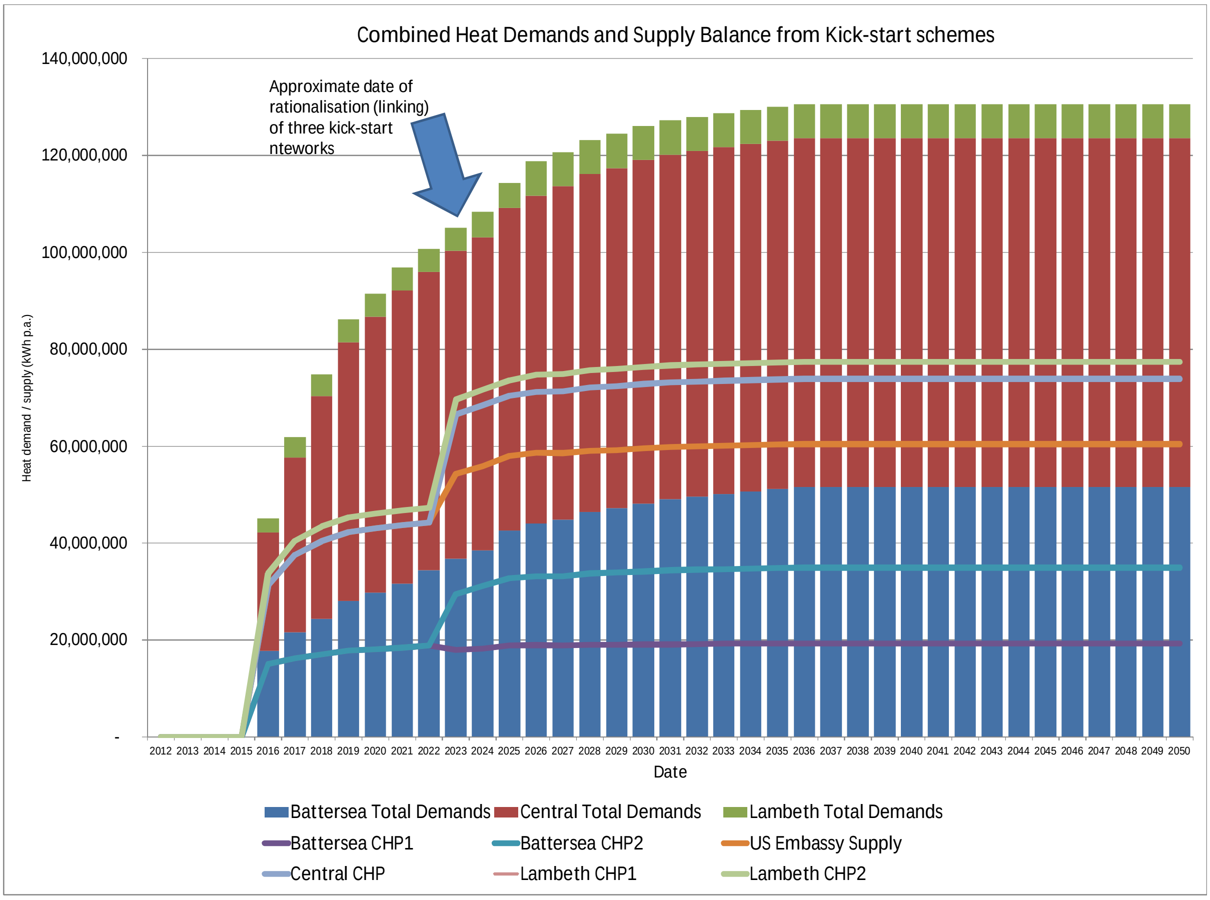
8.5.4 This scenario has delayed the installation of CHP units (rather than changing their size), in order to retain good compatibility with the potential rationalisation of networks (as discussed below). Improved financial performance could be delivered by installing smaller CHP units earlier in the scheme's growth cycle.

8.6 Later-phase network rationalisation

8.6.1 The analysis of the individual network kick-start schemes illustrated above shows that there is potential for these networks to generate revenue streams capable of attracting financial support (either from the public or, in the case of the Battersea and Central schemes, the private sector).

8.6.2 An aim of this masterplan, however, is to consider how these kick-start schemes could be rationalised into a single low-carbon energy supply system. The proposed installation of primary plant for the individual schemes, and the balance of demands across the three schemes is illustrated below:

Figure 8-14 Combined demands and supply balance (kick-start networks)



8.6.3 The graph above shows a number of aspects of the system balance:

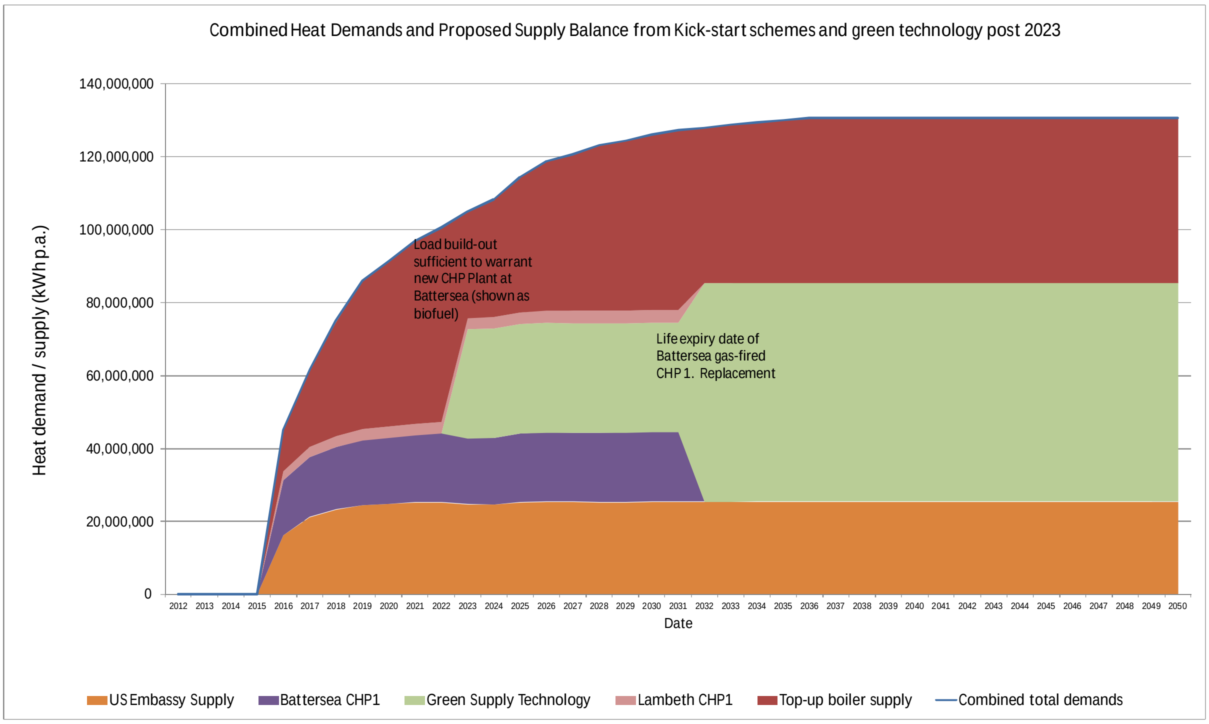
- That the Lambeth network only represent a small fraction of the overall demand of the area
- That one clear potential point of rationalisation of the kick-start networks could be at the point where additional primary plant would otherwise be installed (i.e. at around 2022 / 2023).

8.6.4 Equally, on the basis of an approximate life-span of 15 years for the initial CHP installations shown here, a further potential point of rationalisation of primary supply will be at around 2030 or 2031. This rationalisation would thereby benefit from the avoided cost of replacing primary plant.

8.6.5 **The suggested date at which rationalisation should occur is around the time of additional plant installation (2022 / 2023).** This represents a sufficient initial period of de-risking of the scheme in terms of technical installation, and at this point in time the remaining challenge would be to eliminate the technical risk around the renewable heat supply technology chosen.

8.6.6 The potential heat supply scenario envisaged is as follows:

Figure 8-15 Proposed heat supply scenario with modular renewable heat supply post 2023



8.6.7 This figure above illustrates the scenario that has been modelled in terms of the overall system financial viability.

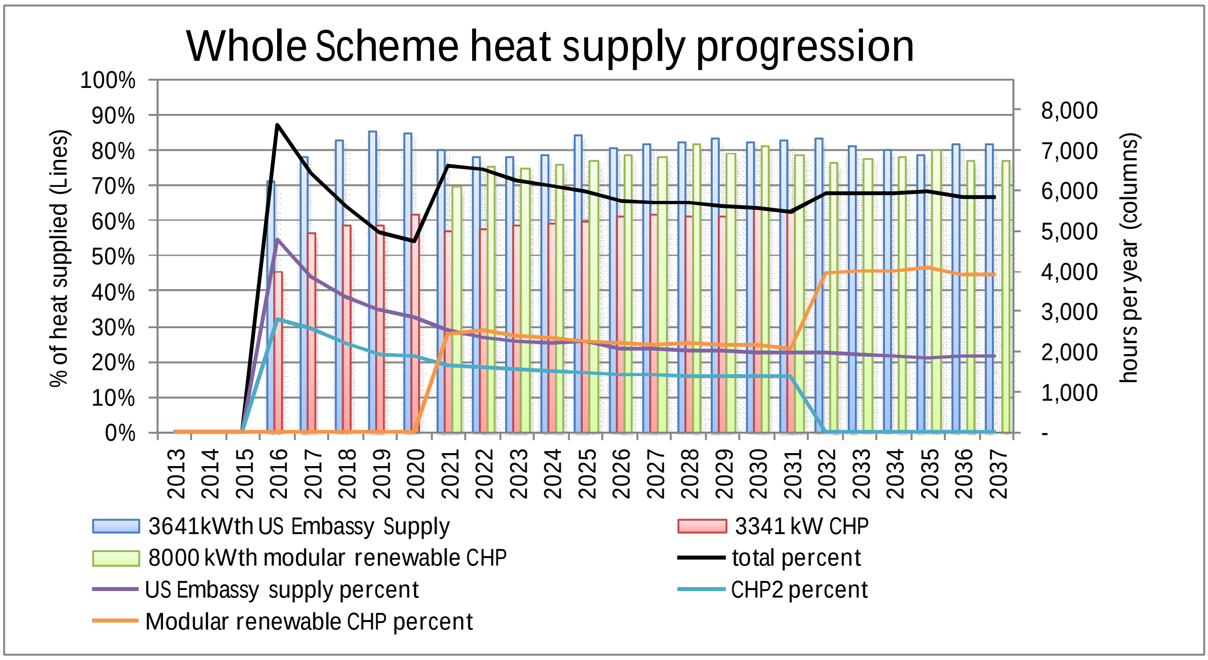
8.6.8 The technology adopted for the scenario is biofuel CHP in the first instance. The proposal is to install a single 4MWth biofuel CHP unit in 2023, and then a further 4MWth unit at the time when the gas-fired CHP of the Battersea scheme becomes life-expired. The prospects for this technology have recently been boosted by a DECC announcement of consultation proposals that consider the option of increasing bio liquid CHP support to 4.1p/kWh[14].

8.6.9 Whilst unconfirmed at this stage, this technology has been analysed in terms of its financial viability on the basis of this proposed level of RHI support.

8.6.10 The progression of heat supply plant modelled, and its operation against the available heat load is as shown below:

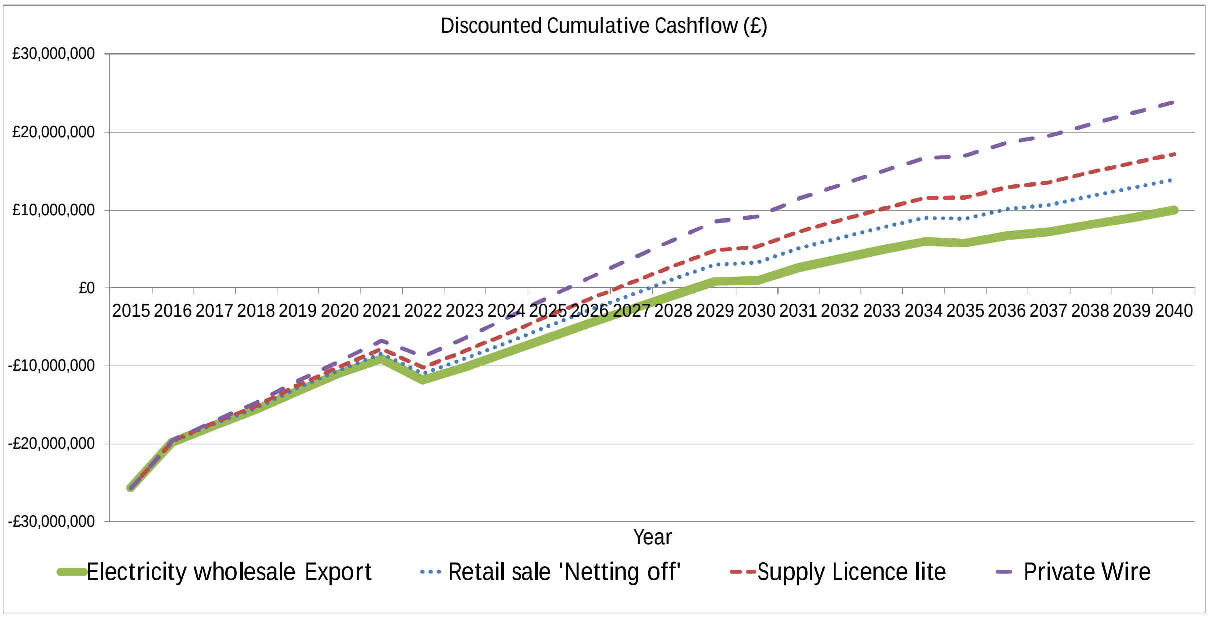
[14] http://www.decc.gov.uk/en/content/cms/news/pn12_106/pn12_106.aspx, accessed 4th October 2012

Figure 8-16 Whole scheme heat supply plant changes



8.6.11 On the basis of this operational scenario, the following whole life cost analysis is generated:

Figure 8-17 Cumulative cashflow for rationalised network with biofuel CHP supply (3.5% discount rate)



8.6.12 As for the previous options, PB would comment that in the current framework conditions it is arguably unlikely that electricity sales values higher than 'wholesale export' are achievable, and hence the other electricity sales values should be considered as theoretical sensitivities rather than immediately commercially achievable routes.

8.6.13 This analysis aggregates the cashflows from the individual schemes, and therefore effectively assumes that a single organisation would deliver all three of the kick-start schemes, and the rationalisation of the network to a single system.

8.6.14 This cashflow graph shows a positive whole life cost under all electricity sale scenarios, and therefore supports the aspiration to create an area-wide network based around this supply of renewable fuel.

8.6.15 This system delivers the following whole life cost results:

Table 8-13 Whole system combined whole life cost results including kick-start networks

NPV (£k, 25 yrs, varying discount rate)	3.50%	6.00%	9.00%	12.00%	IRR
Electricity wholesale Export	11,021	3,230	-3,078	-7,348	7.2%
Retail sale 'Netting off'	15,381	6,427	-785	-5,638	8.4%
Supply Licence lite	19,019	9,113	1,161	-4,171	9.4%
Private Wire	26,407	14,510	5,013	-1,312	11.1%

8.6.16 The aggregated system delivers somewhat worse financial performance than the sum of the individual gas-fired CHP systems, but the systems are not directly comparable. The individual kick-start systems are based upon a proven technology based around natural gas as a fuel, which is a commodity that benefits from a well-established distribution infrastructure. The aggregated system is based around a biofuel solution. Biofuel generation delivers greater carbon savings but also comes at a higher cost of fuel, reflecting the on-going emergence of this product on the market.

8.6.17 The two systems should further not be compared directly because, as time progresses, the continued operation of a gas-fired CHP system will not deliver sufficient network decarbonisation in order to satisfy increasingly stringent carbon reduction requirements. The current wave of planning applications can be evaluated in the light of gas-fired CHP delivering an acceptable level of carbon saving, but future tightening of Building Regulation will require additional supply-derived savings that can only be delivered by renewable fuels (typically in a CHP configuration).

8.6.18 The financial benefit of carbon savings has not been taken into account in the models presented in this report. This is because in the current carbon accounting framework, domestic properties are not subject to carbon taxation in the same form as non-domestic customers. Given that the supply of heat in the VNEB area will be predominantly to domestic customers the inclusion of carbon related costs was not considered appropriate.

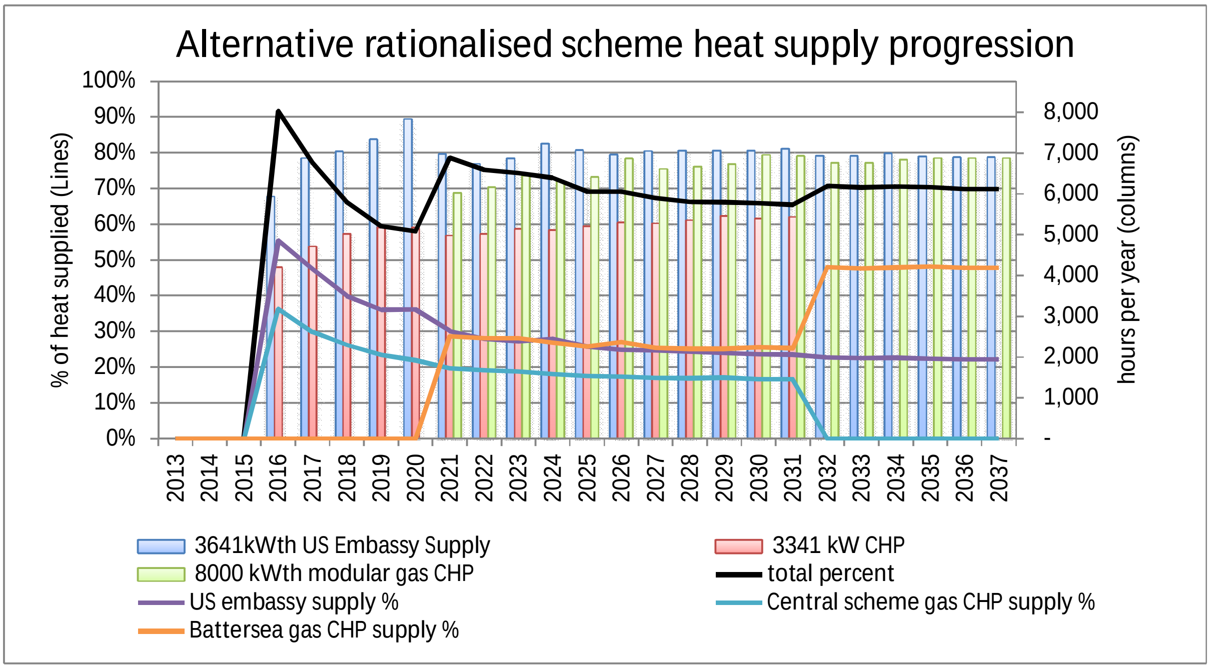
8.7 Alternative rationalised case

8.7.1 An alternative rationalised case may seek to maximise the economic performance of the scheme, at the expense of reduced carbon savings and reduced overall extent of network (and hence expansion potential). This has been considered here as a rationalisation of only the Central and Battersea schemes, and with the continued use of gas as the primary fuel for both CHPs and boilers throughout the whole-life cost evaluation period.

8.7.2 The applicability of this approach will be determined by the framework and implementation of Building Regulations and planning policy.

8.7.3 The energy balance of this solution will be very similar to that of the biofuel version of this system (with gas instead of biofuel). The contribution of different primary plant to meeting demands is shown here:

Figure 8-18 Alternative rationalised scheme heat supply progression



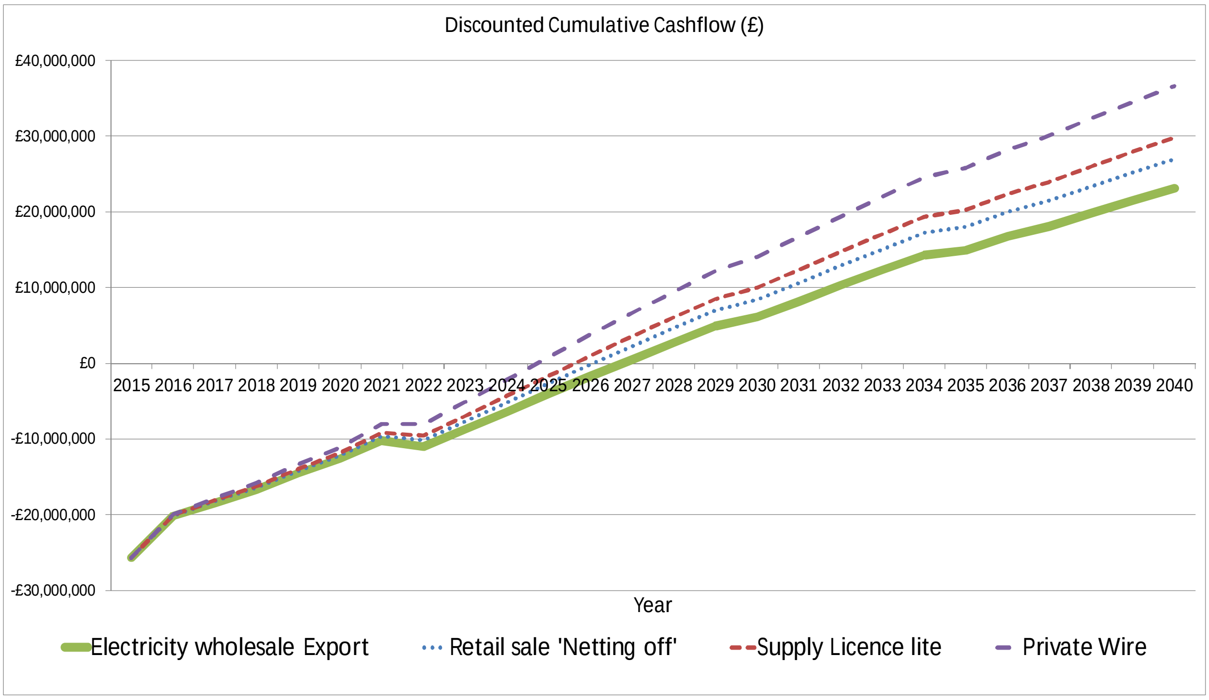
8.7.4 This chart shows a very similar combination of heat sources contributing to meeting overall demand as the combined system with biofuel above, albeit with different supply technology modelled.

Table 8-14 Alternative rationalised scheme financial results

NPV (£k, 25 yrs, varying discount rate)	3.50%	6.00%	9.00%	12.00%	IRR
Electricity wholesale Export	25,634	12,953	3,016	-3,466	10.1%
Retail sale 'Netting off'	29,866	16,048	5,231	-1,816	10.9%
Supply Licence lite	32,976	18,324	6,860	-604	11.6%
Private Wire	40,565	23,875	10,833	2,355	13.0%

8.7.5 This table and the chart below illustrate a good level of financial return is achievable for this alternative combined scheme under all electricity sales routes.

Figure 8-19 Alternative rationalised system cumulative cashflow



9 CARBON CALCULATION

9.1.1 The value to developers of connection to a district energy system will depend on a number of factors. These include the value of land / space saved through the avoided need for extensive energy centres and the cost of achieving environmental standards by alternative means on a particular site. However, an important element in this is confidence that the district heating supply will provide the appropriate level of decarbonisation of the supply to allow the development to meet its regulatory and planning targets. This section outlines the carbon baseline assumed, and the anticipated level of saving from the kick-start and overall network proposed.

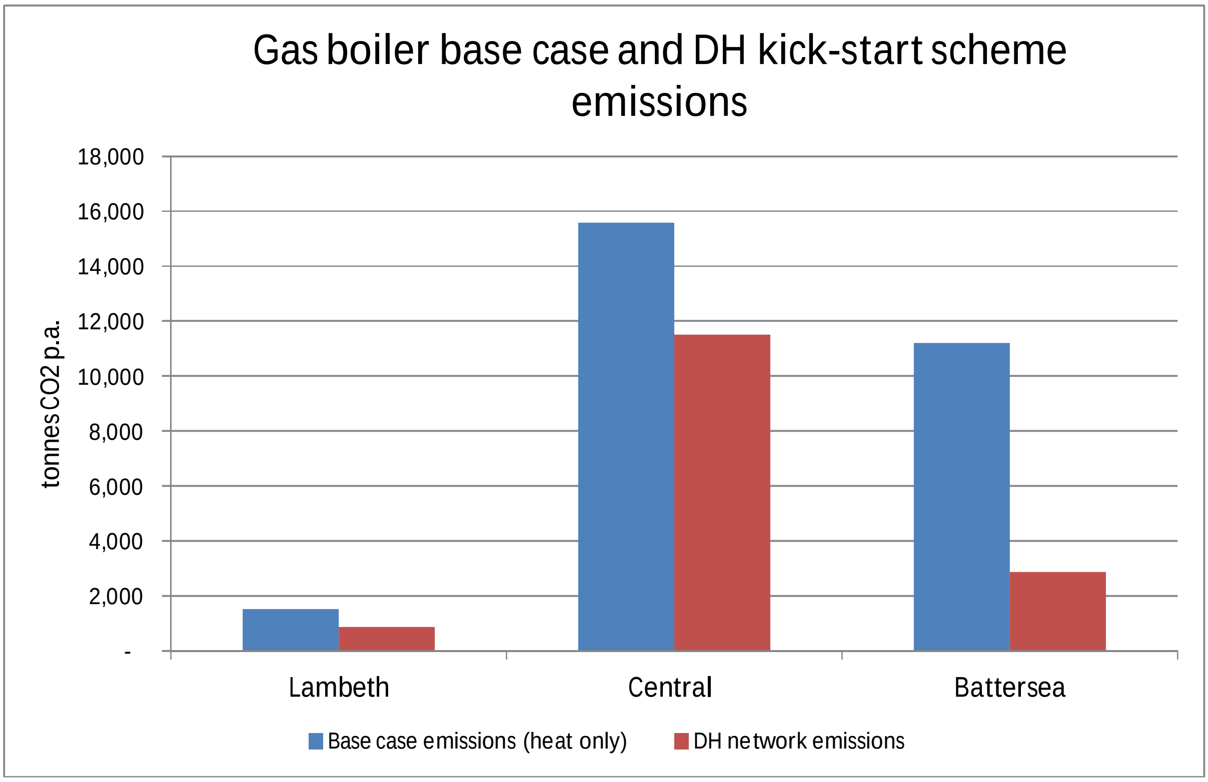
9.1.2 One complexity in the calculation of carbon savings for the DEN is evaluation of a suitable baseline, 'business as usual' case. It must be assumed that all buildings will comply with the relevant planning and Building Regulation standards in place at the time of their construction / application. This implies a changing set of framework conditions against which the operation of the distributed energy network must be assessed.

9.1.3 For buildings where an energy statement has been submitted as part of a planning application PB has attempted to derive from this energy statement report, the quantum of the overall carbon reduction that is derived from heat supply. This has been only partially successful, as there is a degree of variation in the way in which emissions are reported in energy statement submissions (e.g. including or excluding un-regulated emissions). An alternative, more transparent approach has been adopted for reporting here – assessing the proposed solution against the alternative solution of heat from gas boilers.

9.2 Kick-start networks

9.2.1 The following charts illustrate the emissions savings predicted over a boiler-only method of heat provision illustrated for full build-out of the different options:

Figure 9-1 Base case and kick-start network emissions



9.2.2 There is considerable variance in the percentage savings in emissions predicted for these schemes as shown in the table below:

Table 9-1 Percentage emissions savings of kick-start schemes

	Lambeth	Central	Battersea
Emissions savings (%)	44	26	74

9.2.3 This variation results from a number of factors. The Lambeth scheme shows a 'typical' level of savings on heat only emissions for its scale of network demand. The Battersea level of savings are high for gas-fired CHP scheme, and this is attributable both to the higher efficiencies achieved by engines of the scale that match the network loads, and also to the configuration modelled which allows the primary plant to benefit from the thermal storage vessels at PDHU.

9.2.4 The Central scheme is illustrated as only achieving a relatively low level of emissions savings for the key reason that it is assumed that the US Embassy would wish to 'capture' at least a large proportion of the emissions savings that its own plant would generate. To count these full savings for the DH network would represent a form of double-counting. On this basis, PB has assumed an emissions factor for the heat purchased from the US Embassy as show below[15]:

Table 9-2 Emissions factor assumed for US Embassy heat

	US Embassy Heat
Emissions factor for heat assumed	0.150 kgCO_2 / kWh

9.2.5 This assumed factor represents a saving (for the DH network operator) of around 37% over a gas-boiler scenario (for those units of heat supplied from the US Embassy). This split would allow the US Embassy to generate emissions reductions equivalent to more than the total (Notional Building) emissions shown in Section 3.12 of the planning application.

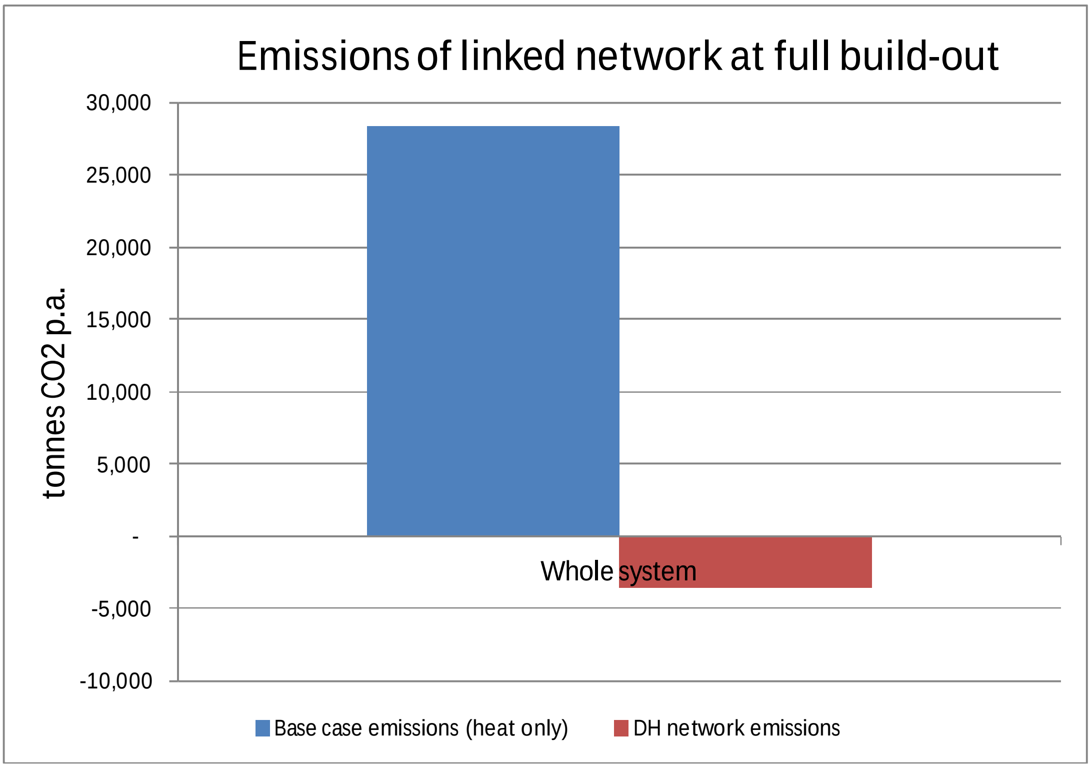
9.3 Whole network solution

9.3.1 The same comparison is also shown below for the entire network at completion, where it is assumed that the primary heat supply is derived from a mix of heat purchased from the US Embassy and supply from bio-fuel CHP units.

9.3.2 The emissions savings predicted from this supply method are shown below:

[15] The US Embassy planning application document indicates an emissions factor for heat of 0.198kgCO2 / kWh. This figure implies an emissions saving only equivalent to boiler efficiency. However, this does not allow the DEN to benefit significantly (in an emissions saving sense) from the purchase of heat from the Embassy, and hence this is not considered to be a viable proposal for the VNEB DEN. Hence this figure has not been adopted in modelling.

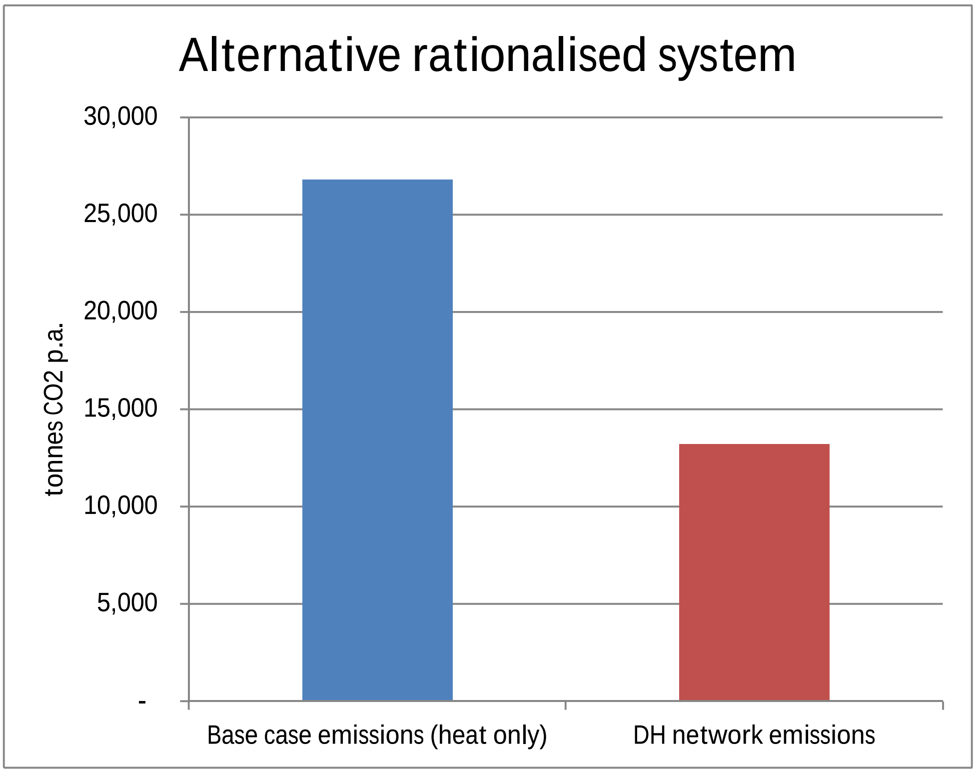
Figure 9-2 Emissions from whole network



9.3.3 This graph shows a negative emissions figure for the proposed option. This is derived from the emissions savings derived from the export of generated power from the bio-fuel CHP units proposed.

9.3.4 The alternative rationalised case delivers the following levels of carbon emissions reduction:

Figure 9-3 Alternative rationalised system emissions reduction



10 PROJECT PLAN & RISKS

10.1.1 Key elements to a successful project delivery plan are:

- A supporting statutory planning framework
- Engagement with stakeholders
- A delivery vehicle with appropriate governance
- A risk register that is maintained and updated as a live document as the project progresses

10.2 Planning framework

10.2.1 The following are considered to be some of the key considerations in the development of a supporting planning framework for the delivery of the EMP as conceived in this document:

- Ensuring that from an early point in time (i.e. around 2015 / 2016) that wayleaves / easement through the linear park area are in place such that utility infrastructure can be installed to link key loads.
- Ensuring that the planning framework is strengthened to ensure that:
    - New developments are obliged to be designed in a manner fully compatible with the DH system including appropriate design of building systems to minimise return temperatures
    - New developments must connect to the DH system if that DH network is operational within, say, 5 years of the development being commissioned
    - That it is clear that developers will be expected to contribute towards the costs of the DH network in line with the avoided costs of their own plant installation.

10.3 Engagement Strategy

10.3.1 The emergence of a DE network requires commitment from multiple stakeholders, and engaging in an appropriate manner with these organisations is a key aspect of project delivery. The following engagement actions are suggested for critical stakeholders:

- Engage with developments currently moving forward to ensure that secondary systems being designed are fully compatible with a DH solution
- Continue to engage with St George's Wharf and MI6 with a view to obtaining details of compatibility of systems
- Continue to engage with the US Embassy to reassure them that there is likely to be a market for any heat generated by CHP plant installed on their site

- Engage with PDHU with a view to opening discussions around re-instating the operational hydraulic link to the PDHU pumphouse, particularly in terms of accessing the thermal storage capacity located there
- Engage with the Battersea Power Station site developers to ensure that sufficient space is allocated within the Phase 2 development for an energy centre to serve the full rationalised OA network with renewable heat plant.

10.4 Delivery vehicle

10.4.1 The network proposed as an output of this energy masterplan is effectively a sub-regional energy system, and an appropriate vehicle must be developed in terms of how this solution could be governed and implemented. Some key considerations for delivery are:

- Does the economic viability of the individual kick-start networks and the rationalised system suggest that a private sector organisation will be willing to support the delivery of the system?
- Is a fully private delivery vehicle desirable?
- Do other elements of the project need to be de-risked in order to make the implementation viable?
- How could the interaction between the kick-start network and the rationalised system work?

10.4.2 Potential vehicles for the delivery of a project of this nature include:

- Private sector ESCO
- Public sector controlled SPV
- SPV as a partnership between public and private sector

10.4.3 It is beyond the scope of this project to identify the most appropriate vehicle for delivery but PB would highlight the following for the VNEB masterplan:

- The high heat density of both the Battersea and the Central schemes suggests that there should be considerable private sector interest from ESCos in the operation of an energy solution if there can be guarantee of heat loads connecting to the system (via policy).
- The swift growth of load projected for the area has lead to the recommendation that implementation of a rationalised network linking the three kick-start networks should happen relatively quickly (i.e. around 2023). A single SPV controlling all three networks is recommended to simplify this process of rationalisation, from both a technical and commercial perspective
- In the Central network in particular, but as a general observation of the all of the networks identified, the majority of key customers for the DH system are private sector new developments, with a residential focus. This suggests that the public sector would perhaps have little interest in the on-going operation of the network, once principles of affordability and environmental

performance have been secured from the outset, and the extent of the system expansion established. It is suggested therefore that the public sector role in this instance could be one of de-risking project development as far as possible through policy, and of ensuring the implementation of the systems is in line with the overall public sector vision for the area.

- There may still be a need for a range of additional public sector inputs to get the schemes started as private sector investment requirements for the riskier start-up phase may cause difficulties in getting to a financial close.

10.5 Other Actions

10.5.1 The proposed approach contained within this EMP has implications for the utilities solution developed for the OA. The outputs of this study should therefore be adopted in informing long-term planning of utility provision to the OA.

10.5.2 Key details in terms of utility planning are considered to be:

- Making allowance for 400mm nominal diameter (circa 600-700mm allowing for insulation thickness) flow and return pipework within the linear park
- In addition to all non-heating related loads (noting that electric induction cooking may be the preferred solution in all domestic dwellings connected to the heat network), planning for the following electrical plant within the VNEB area:

Table 10-1 Electrical generation capacities proposed

	Lambeth	Battersea	Central scheme (either NCGMA or US Embassy area)
Kick-start CHP (2016 to around 2023)	600kWe	3,333kWe	US Embassy supply (approx 4MWe)
Rationalised system (2023 onwards)	n/a	2 no 4,000kWe biofuel CHP	US Embassy supply retained (approx 4MWe)

- The supply of heat to the area via these systems also has implications in terms of the gas requirements in these energy centre locations. The anticipated peak gas requirements for these network energy centres are shown below (excludes the US Embassy's own requirements, and other non-connected loads):

Table 10-2 Gas capacity requirements

	Lambeth	Battersea	Central scheme (either NCGMA or US Embassy area)
Kick-start (2016 to around 2023)	Approx 8MW	Approx 60MW	Approx 75MW
Rationalised system (2023 onwards)	n/a	Approx 125MW	n/a

10.5.3 This proposed system would also have a need for biofuel deliveries to Battersea (or other energy centre location). Battersea is the recommended location for this later-phase plant for two primary reasons. First, as it may be possible to secure biofuel deliveries from the river, and second as the hydraulic connection to PDHU would allow the thermal storage capacity to be utilised. A further advantage of the Battersea site over other potential locations is that the existing (protected) structure of BPS could provide an excellent way to integrate the required flues for the energy generation plant.

10.6 Risk Register

10.6.1 PB has developed the risk register contained within the appendices to this document. From this initial assessment, PB has derived this shortlist of the most significant risks as foreseen for the project at this stage:

Table 10-3 Risk Summary

No.	Risk	Possible Consequences	Mitigation Action	Score (from max of 25) (post mitigation)
1	Gas network supply cost to energy centre renders project unviable	Expense of gas network reinforcement to be able to guarantee heat supply renders project unviable	Obtain quotation from gas network special projects team	10
2	Existing utilities make installation of DH network complex	Dh and overall project cost increases	Undertake sufficient investigations into the DH route and clearly identify existing utilities. Ensure the DH contractor has a solid track record of installing DH in high density urban environments	8
3	The district heating network cannot be installed as required	DH installation is required to be diverted with cost implications	Undertake sufficient investigations into the DH route and clearly identify existing utilities. Ensure the DH contractor has a solid track record of installing DH in high density urban environments	8

No.	Risk	Possible Consequences	Mitigation Action	Score (from max of 25) (post mitigation)
4	Unforseen physical barriers to DH may delay installation	Increased total cost. Possibly prevents scheme progressing.	Detailed analysis of utilities maps prior to construction. Ongoing early stage discussion with British Waterways, National Grid, Network Rail, Borough Highways dept etc to ensure the scheme is aligned with existing infrastructure and requirements for interaction with it.	8
5	Changing elected leadership and political priorities may lower priority of scheme delivery	Scheme loses political support, preventing progression.	Try to ensure early buy-in of political leadership across all parties, demonstrate value of scheme to wide audience	8
6	Issues obtaining the necessary wayleaves for energy centre location and DH route	DH network cannot be installed in preferred route, and costs increase as a result	Early engagement with necessary parties, use of council owned / controlled land where possible for network routes	6
7	Private sector customers do not connect to the scheme	Reduced heat load reduces scheme income and viability	Lambeth and Wandsworth councils to use their influence and planning powers to require private sector organisations to connect to the scheme where deemed technically feasible	6
8	Inaccurate forecasting of demand changes may lead to a different availabilty demand and income for the scheme	Scheme is no longer commercially viable.	Conduct additional sensitivity modelling around demand changes. Take account of risk in business model formulation.	6
9	Burden of contract negotiation may have significant costs that outweigh some of the benefits	Scheme is no longer commercially viable.	Base contractual model on previous experieicne of developing successful schemes to expedite negotiation process,	6
10	DE does not represent the least cost means of reducing CO2	Other projects take precdence and sufficient funding is not available	Mitigation measures may include optimising system size and costs to increase carbon saved per £ spent.	6
11	Lack of (or high costs of) bio-fuel resource	Scheme may not deliver required carbon savings	Identify local resources where possible and consider means to benefit from large-scale river deliveries	6

11 DELIVERY PLAN

11.1.1 At this stage the delivery plan comprises the notional kick-start schemes proposed for the period 2016 to 2022 / 2023. Thereafter it is suggested that these networks are linked and that a single 4MWth biofuel CHP is installed to operate alongside the existing CHP units at Battersea (linked to PDHU), US Embassy and the Lambeth plant.

11.1.2 Thereafter, at the end of life of the CHP units installed at the inception kick-start schemes, it is proposed that these satellite units and boilers are decommissioned, and that heat supply is fully rationalised to a single energy centre at Battersea Power Station.

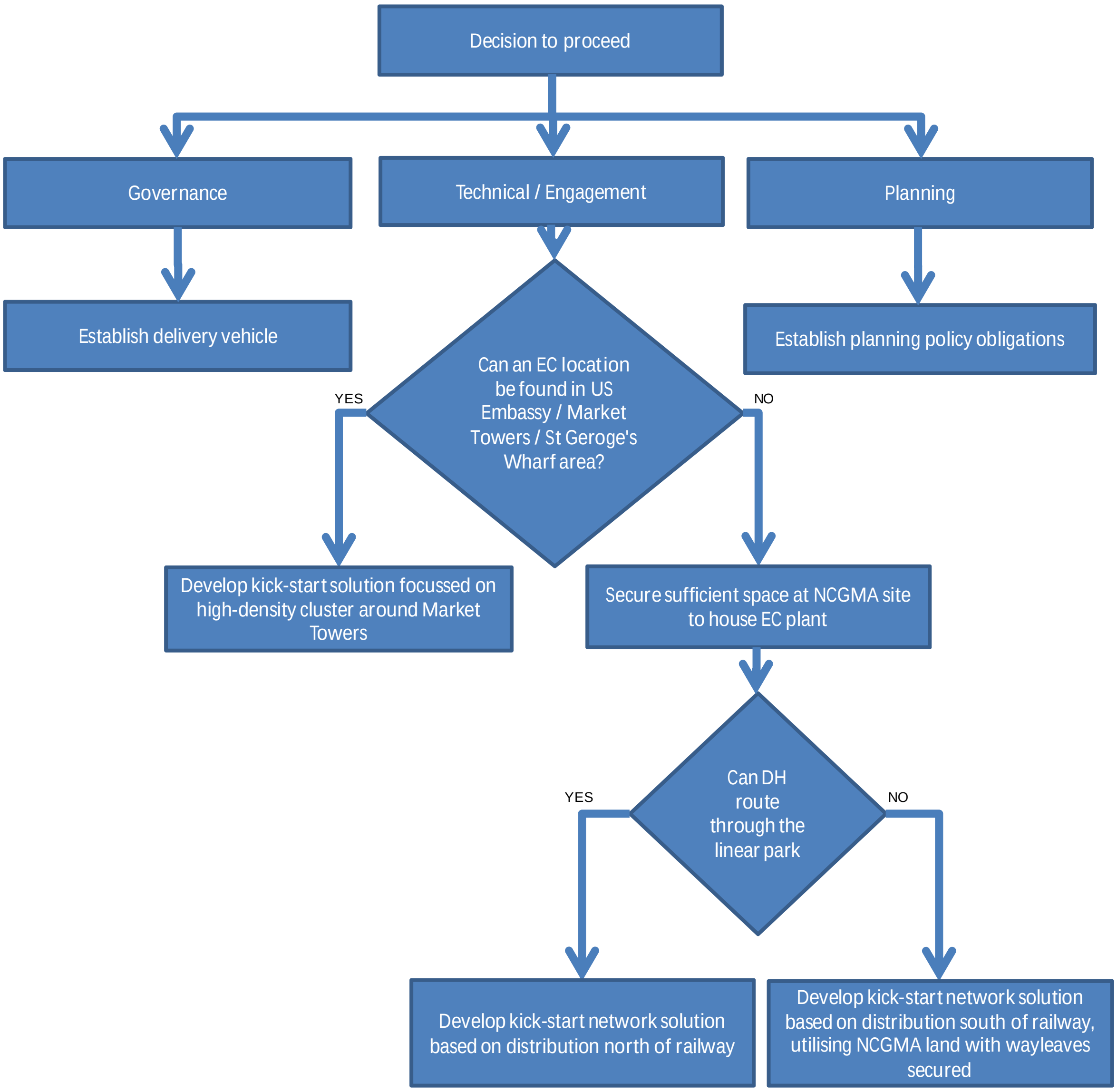
11.1.3 At this point in time a further 4MWe biofuel CHP unit should be installed at Battersea to complement the continuing supply at the US Embassy. Top-up and standby plant would be installed at Battersea energy centre.

Table 11-1 Delivery plan programme

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	onwards
Operation of Lambeth kick-start network	■	■	■	■	■	■	■												
Operation of Battersea kick-start network	■	■	■	■	■	■	■												
Operation of Central scheme kick-start network	■	■	■	■	■	■	■												
Linking of all three kick-start networks								■											
Period of operation of kick-start network energy centres supplying rationalised system								■	■	■	■	■	■	■	■	■			
Decommissioning of Lambeth and Central scheme energy centres																■			
Operation of single energy centre at Battersea																	■	■	■

11.1.4 A few key decision points are highlighted in the chart below:

Figure 11-1 Decision tree for key technical considerations



12 CONCLUSIONS AND NEXT STEPS

12.1.1 It is PB's view that further development of a robust economic case for the 'kick-start' networks and creating a clear pathway to their implementation is important in securing the delivery of this project.

12.1.2 The key 'next steps' for VNEB must focus upon de-risking the project, and identifying other processes that should assist the progression of the energy masterplan to delivery. The primary actions in PB's view in this are:

- Ensuring that policy obligations are in place to ensure that all developments coming forward connect to the emerging DH system
- Developing further definition of the key schemes to be taken forward from a technical and programme perspective
- Engaging with key stakeholders to ensure compatibility and engagement with the scheme design / development as appropriate
- Further development of the utility masterplan to match this energy strategy for the site
- Engagement with UKPN (potentially via the utility masterplanning project) to develop a mutually acceptable and beneficial location for a primary substation for the area
- Continue to engage with the GLA in relation to a delivery vehicle for the schemes identified
- SPV structures – identify and develop commercial structure options which deliver robust governance and controls for the long term benefit of the community it serves
- Heat supply assurances – identify and develop an energy services delivery mechanism which provides for the delivery of secure, robust and well-maintained energy
- Cost competitiveness – identify and develop a services delivery mechanism which provides long-term assurances for competitively priced services
- Pursue establishment of an appropriate scale energy centre on the BPS site for the rationalised network
- Pursue establishment of an energy centre on either the NCGMA site or an alternative location close to the US Embassy for the Central kick-start scheme.

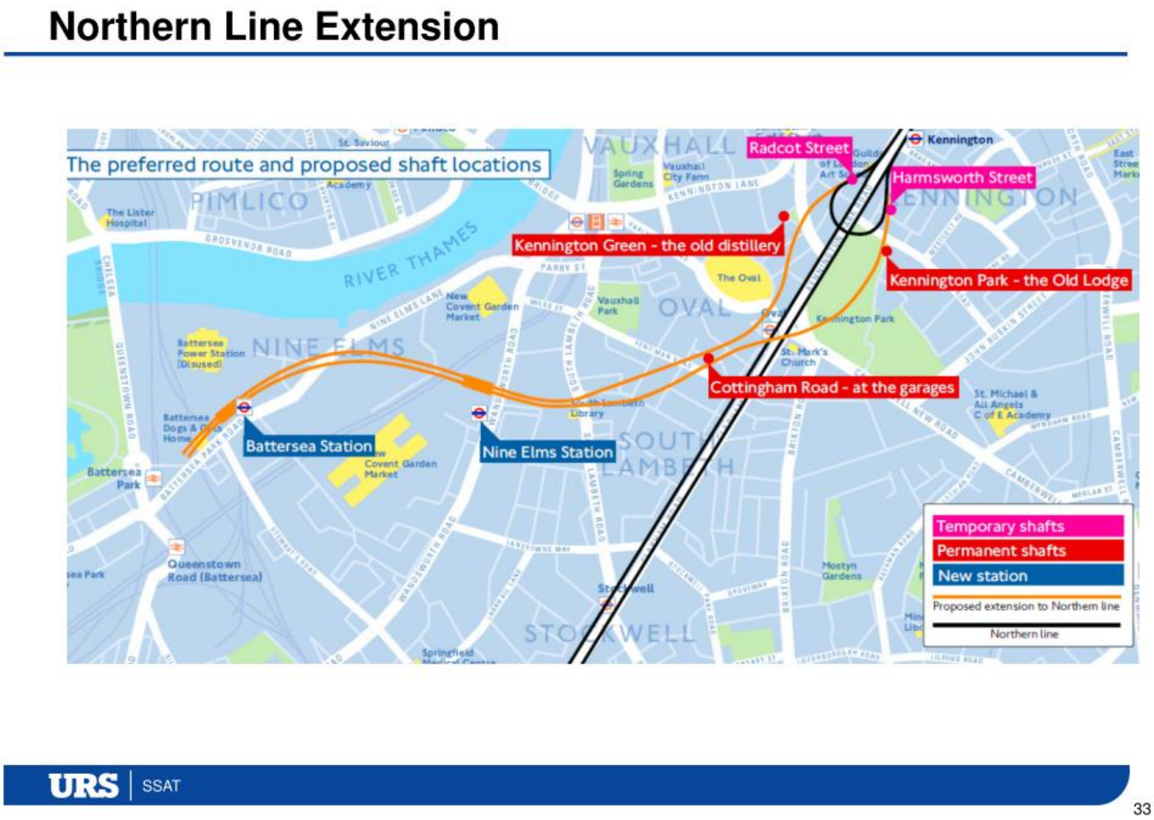
13 APPENDICES

13.1 Appendix A – Notional timeline for DH installation

13.1.1 The following illustrates a timeline that is considered realistic for the installation of a DH network serving key loads in the VNEB area as a kick-start scheme.

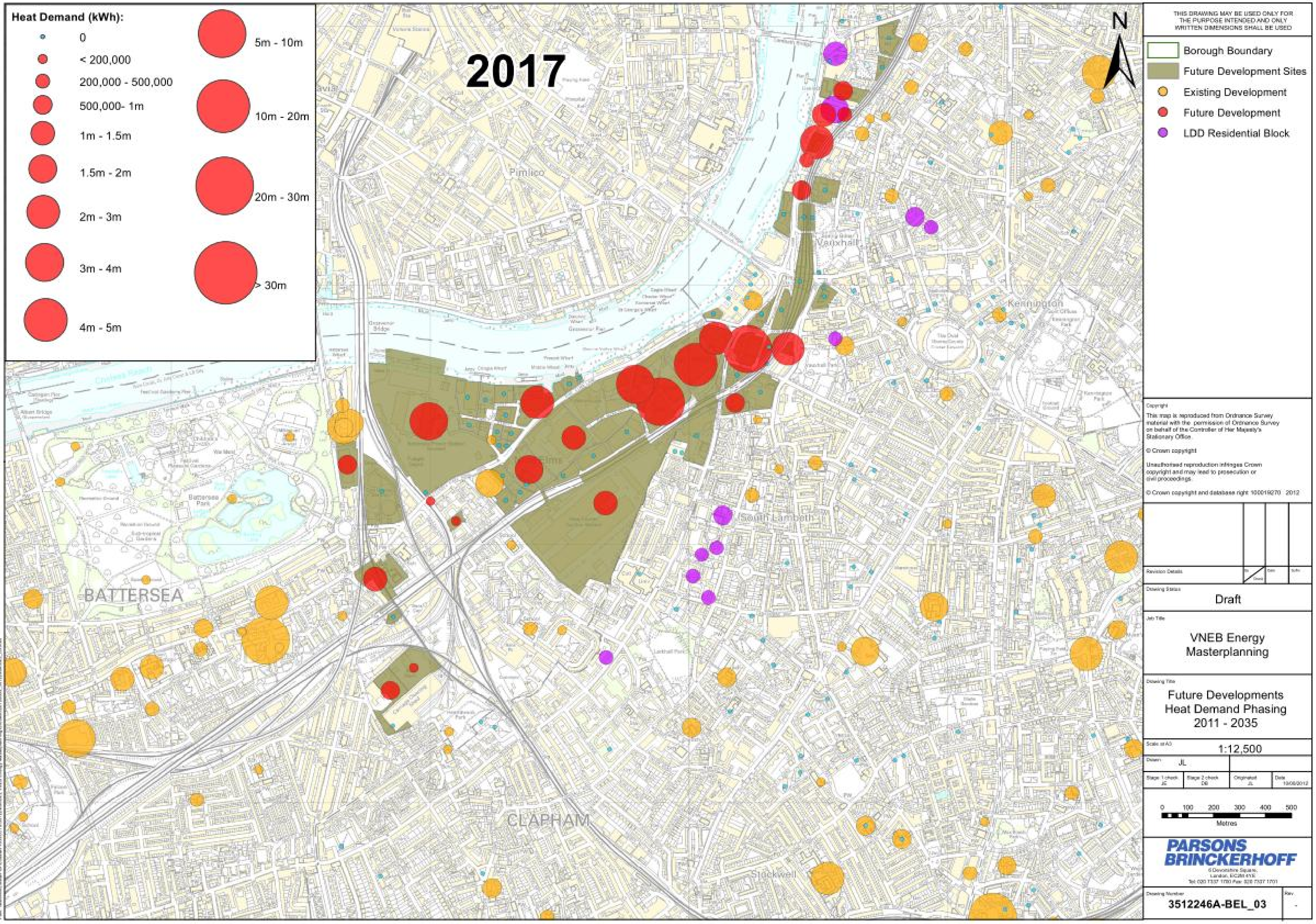
	2012	2013				2014				2015				2016
	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr
Energy masterplanning complete														
Feasibility study and scheme development														
Development of business case														
Formation of SPV														
Obtaining commitment of heat customers														
Development of procurement documentation														
Procurement process														
Construction for initial phase														

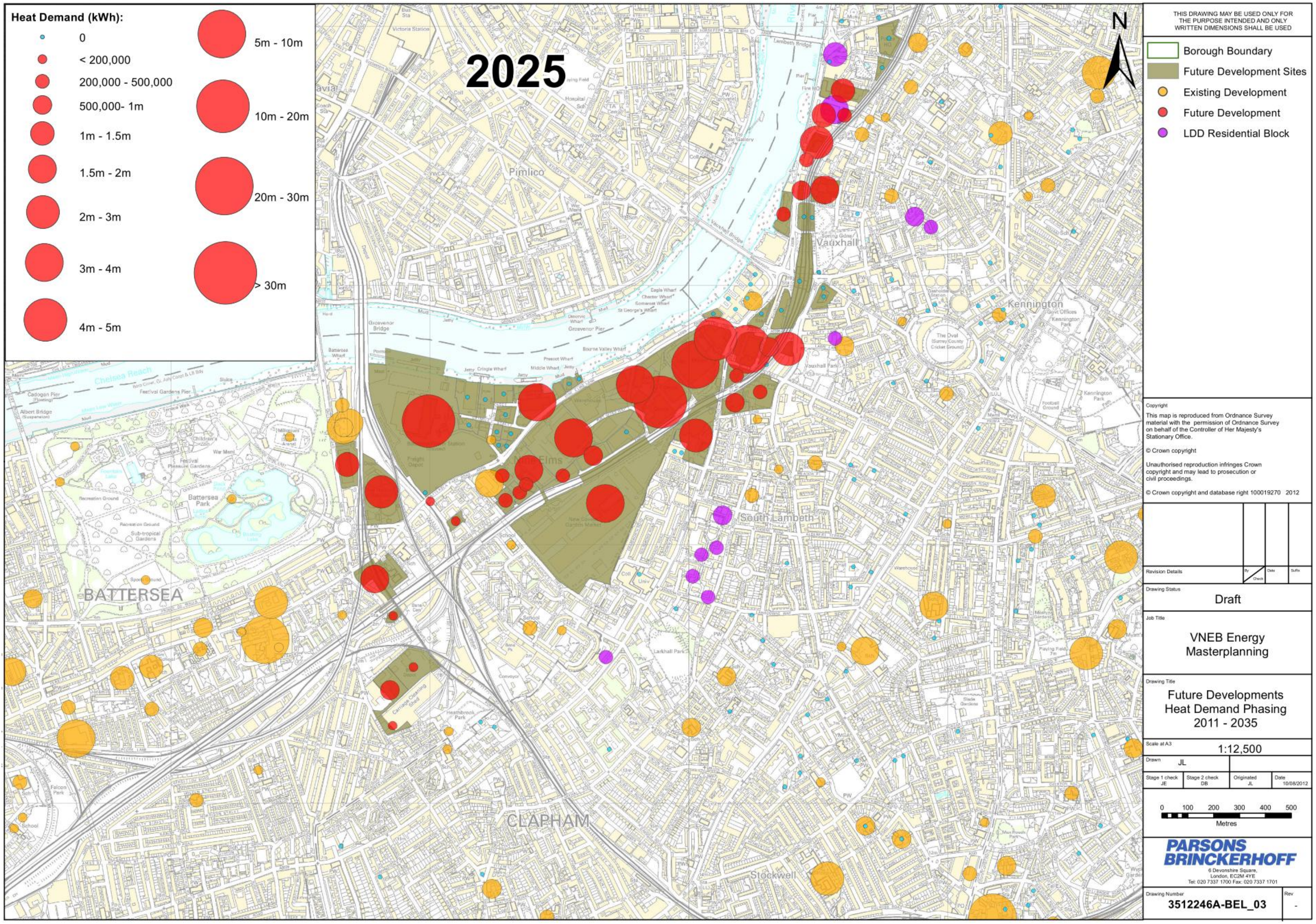
13.2 Appendix B – Northern Line Extension consultation information



This diagram illustrates that the permanent ventilation shafts currently proposed for the Northern Line Extension are some distance from the VNEB OA. On this basis the option of utilising waste heat from these locations has not been further pursued at this stage.

13.3 Appendix C – Illustrative maps of load development over time – 2017, 2025, 2035




Heat Demand (kWh):
0
< 200,000
200,000 - 500,000
500,000- 1m
1m - 1.5m
1.5m - 2m
2m - 3m
3m - 4m
4m - 5m
5m - 10m
10m - 20m
20m - 30m
> 30m
2025
N
THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED
Borough Boundary
Future Development Sites
Existing Development
Future Development
LDD Residential Block
Copyright
This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationary Office.
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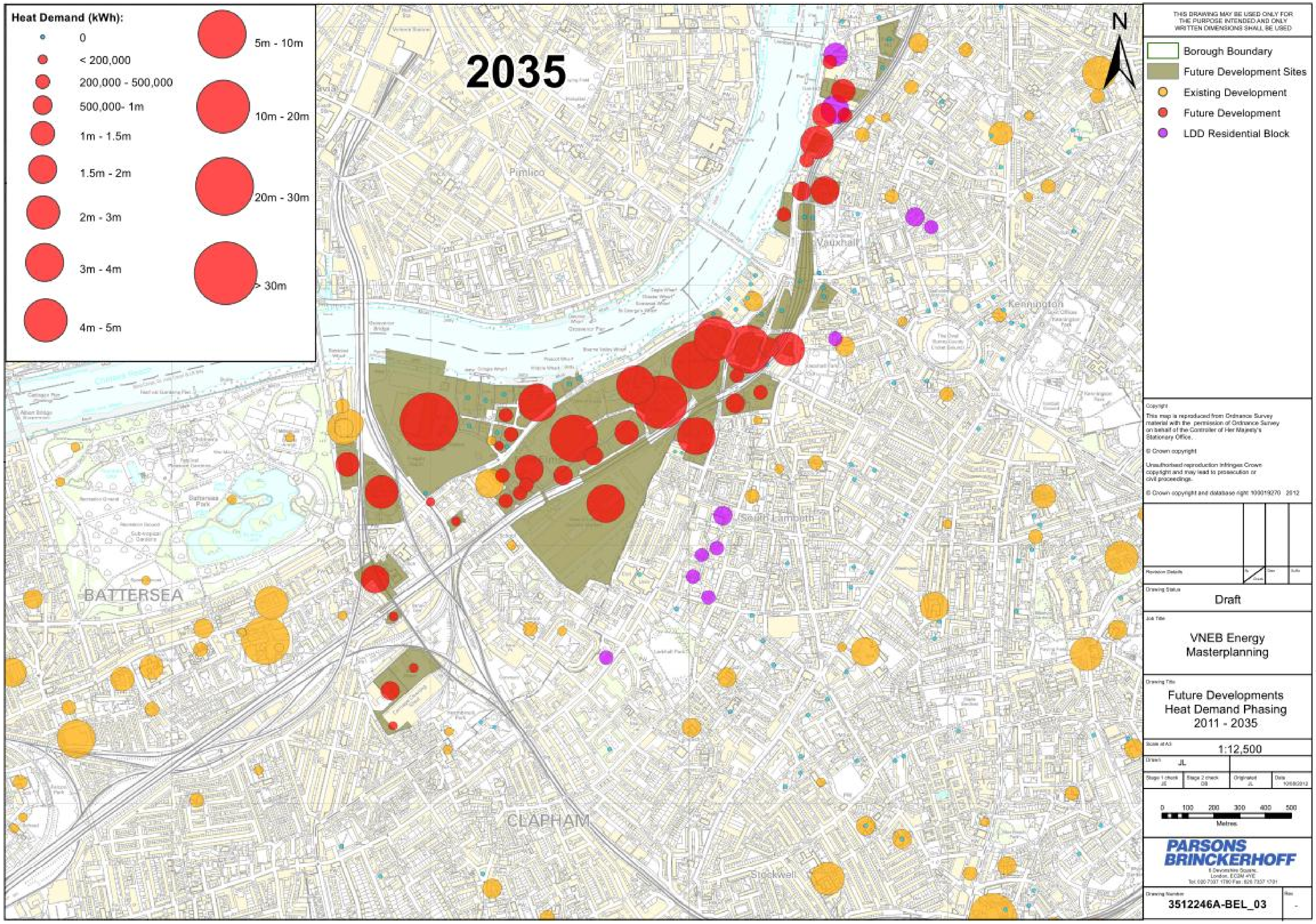
© Crown copyright and database right 100019270 2012
Revision Details
Drawing Status
Draft
Job Title
VNEB Energy Masterplanning
Drawing Title
Future Developments Heat Demand Phasing 2011 - 2035
Scale at A3
1:12,500
Drawn
JL
Stage 1 check JE
Stage 2 check DB
Originated JL
Date 10/08/2012
0 100 200 300 400 500
Metres
PARSONS BRINCKERHOFF
6 Devonshire Square, London, EC2M 4YE
Tel: 020 7337 1700 Fax: 020 7337 1701
Drawing Number
3512246A-BEL_03
Rev
-
Pimlico
Vauxhall
Kennington
South Lambeth
BATTERSEA
CLAPHAM
Stockwell


Heat Demand (kWh):
0
< 200,000
200,000 - 500,000
500,000- 1m
1m - 1.5m
1.5m - 2m
2m - 3m
3m - 4m
4m - 5m
5m - 10m
10m - 20m
20m - 30m
> 30m
2035
N
THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED
Borough Boundary
Future Development Sites
Existing Development
Future Development
LDD Residential Block
Pimlico
Vauxhall
Kennington
South Lambeth
BATTERSEA
CLAPHAM
Stockwell
Draft
VNEB Energy
Masterplanning
Future Developments
Heat Demand Phasing
2011 - 2035
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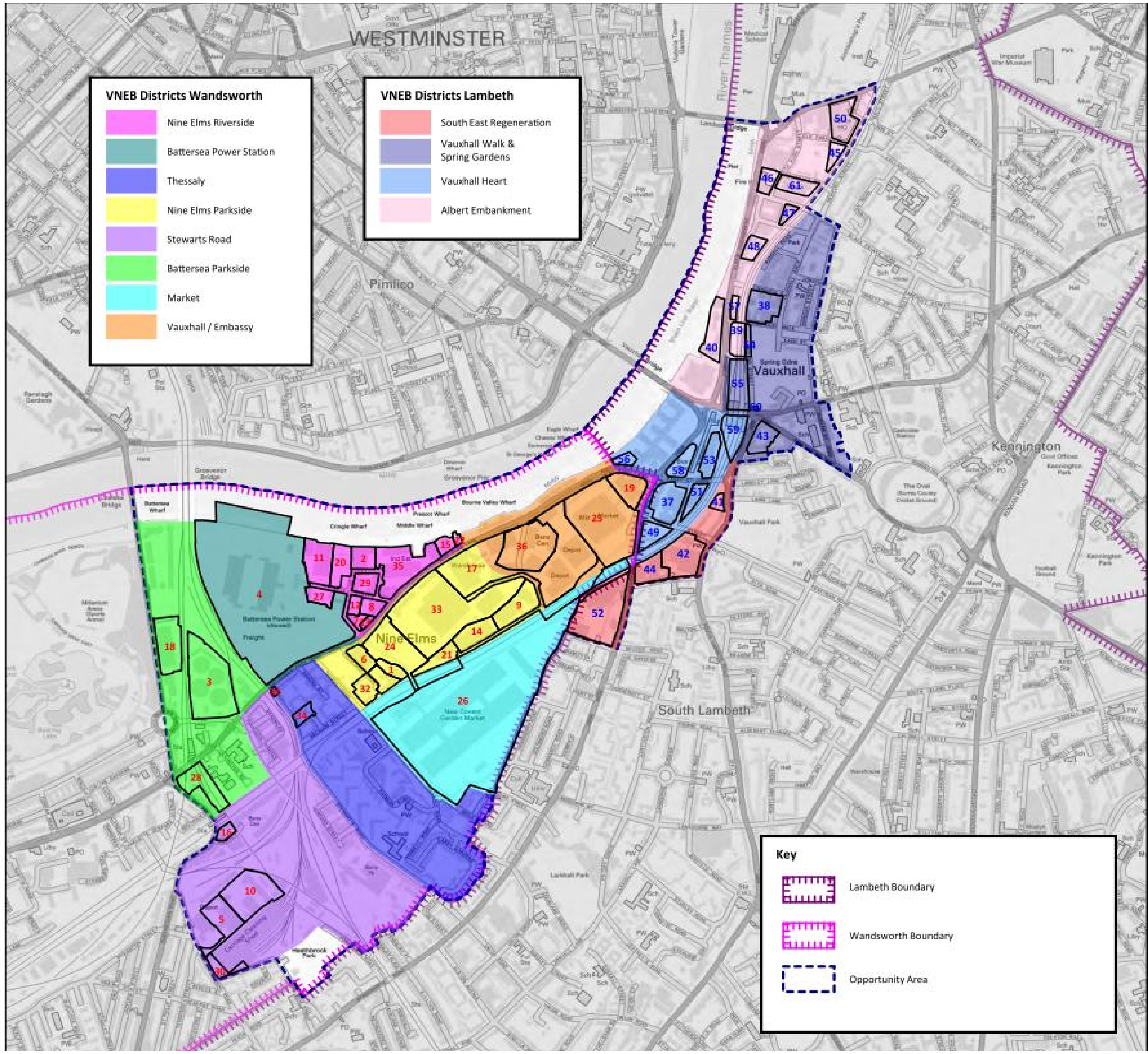
13.4 Appendix D – Copy of OAPF map illustrating site IDs



Sites in Wandsworth

No	Name
1	49 to 59 Battersea Park Road
2	88 Kirtling Street
3	Battersea Gasholder
4	Battersea Power Station
5	Battersea Studios
6	Booker Cash and Carry
7	Brooks Court
8	Cable and Wireless
9	Christies Auctioneers Depot
10	Coach depot, Silverthorne road
11	Cringle Dock (Safeguarded Wharf)
12	Depot, Kirtling Street
13	Former Petrol filling Station, 2 Battersea Park Road
14	Government Car and Dispatch Agency
15	Heathwall Pumping Station, 54 - 56 Nine Elms Lane
16	Ingate Place
17	Main Site Ballymore
18	Marco Polo House
19	Market Towers
20	Metro Greehham (Safeguarded Wharf)
21	Metropolitan Police Warehouse Garage
22	Middle Wharf (Safeguarded Wharf)
23	Milk Depot, 55 Sleaford Street, SW8 5AB
24	New Covent Garden Market, Entrance Site
25	New Covent Garden Market, Flower Market
26	New Covent Garden Market, Main Market
27	Operational land, Cringle Street
28	Patcham Terrace
29	Securicor
30	Silverthorne Road
31	Site Adjacent 103 To 125, Battersea Park Road
32	Sleaford Street Industrial Estate
33	The Post Office sorting depot
34	Tidbury Court, Stewarts Road, London, Greater London, SW8 4DW
35	Tideway Industrial Estate Kirtling Street
36	US Embassy

Sites in Lambeth

No	Name
37	1 Wandsworth Road – bounded by Parry Street, Bondway and Miles Street
38	2-14 Tinworth Street, 108-110 Vauxhall Walk and rear of Glasshouse Walk
39	Albert Embankment Arch Units & Open Space
40	Albert Embankment Riverside sites
41	Billboard Site, South Lambeth Road
42	BT Offices, Keybridge House site: 80 South Lambeth Road
43	Cobalt Square (Metropolitan Police Headquarters)
44	Corner of Wandsworth Road and Wyvil Road
45	Costa Brewing House
46	Fire Station, 8 Albert Embankment, SE11 6AT
47	Former London Research Centre, 81 Black Prince Road and adjoining sites
48	Hampton House, 20-22 Albert Embankment
49	Miles Street (South) and corner of Wandsworth Road
50	MPS Office Building, 109 Lambeth Road
51	Parry Street East (Bondway South)
52	Sainsbury's Nine Elms
53	South Lambeth Place Bondway North
54	Spring Gardens Railway Arch No.1
55	Spring Gardens, Railway Arch No.2
56	St George Tower, St. George's Wharf, Albert Embankment
57	Texaco Garage, 38-46 Albert Embankment
58	Vauxhall Island site
59	Vauxhall Station Arches
60	Vauxhall Tavern, 372 Kennington Lane
61	Warehouse, c/o Lambeth High Street & Whitgift Street

13.5 Appendix E – Comparison of distributed absorption chilling vs local electric chillers

Parsons Brinckerhoff - Energy Solutions

Comparison of distributed absorption chilling and local electric chilled water provision

INPUTS

Boiler efficiency		CHP elec efficiency	37% GCV	pump power		losses		heat rjection powwer	
80% GCV		CH heat efficiency	40% GCV	2%	% of heat delivered	10%		2%	% of heat rejected
								COP	
Emissions factors		Cost factors						0.7	
gas	0.198 kgCO2/kWh	gas	2.8 p/kWh						
elec expo	0.529 kgCO2/kWh	elec export	7 p/kWh						
elec impo	0.517 kgCO2/kWh	elec import	10 p/kWh						

DISTRIBUTED ABS CHILLER SYSTEM

ENERGY CENTRE					DISTRICT HEATING NETWORK	CONNECTED BUILDING		
							pump / fan power required: 48,571 kWhe; 25,111.43 kgCO2; 4,857 £	
							heat rejection: 2,428,571 kWh heat	
fuel: 2,946,429 kWh gas; 583,393 kgCO2; 82,500 £	CHP 75%	heat output: 1,178,571 kWh heat						
	1,090,179 kWhe power output; 576,704 kgCO2; 76,313 £		pump power: 31,429 kWhe; 16,249 kgCO2; 3,143 £	heat required: 1,571,429 kWh heat	losses: 142,857 kWh heat	heat input requiRed to: 1,428,571 kWh heat	Abs chiller	chilled water: 1,000,000 kWh
fuel: 491,071 kWh gas; 97,232 kgCO2; 13,750 £	Boilers 25%	392,857 kWh heat						
Total CO2: 145,281 kgCO2								
Total cost: 27,938 £								

LOCAL ELECTRIC CHILLER SYSTEM

	BUILDING SYSTEM		
		Elec chiller COP: 3	
		pump / fan power required: 26,667 kWhe; 13,786.67 kgCO2; 2,666.67 £	
		heat rejection: 1,333,333 kWh heat	
	power input required: 333,333 kWhe; 172,333 kgCO2; 33,333.33 £	Elec chiller	chilled water: 1,000,000 kWh
Total CO2: 186,120 kgCO2			
Total cost: 36,000 £			

SAVINGS GENERATED THROUGH USE OF ABSORPTION CHILLING SYSTEM

Total CO2	40,839	kgCO2
Total savir	8,063	£

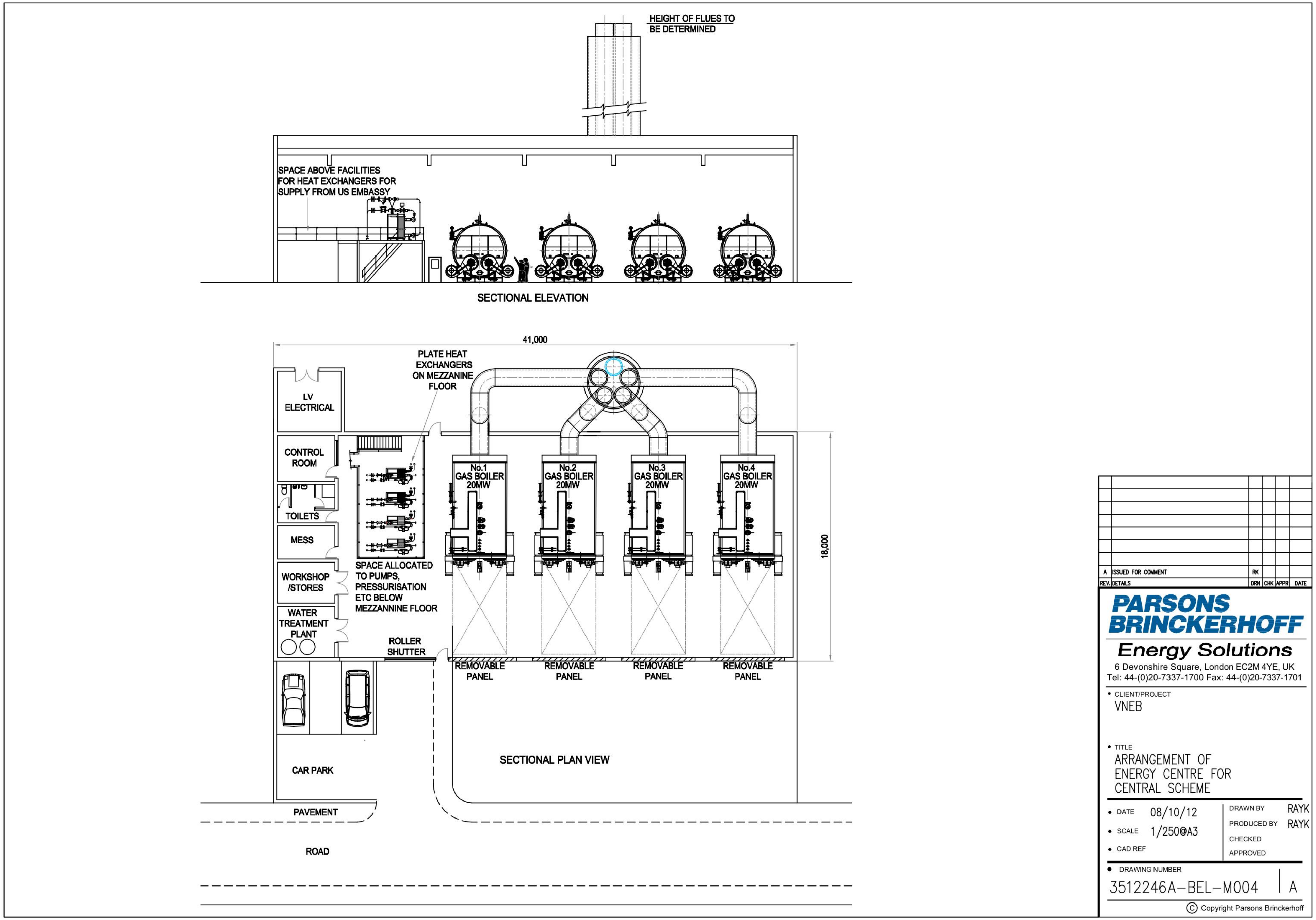
VNEB OA Risk Matrix

PARSONS BRINCKERHOFF

				Pre mitigation score				Post mitigation score		
				Potential impact (A)	Likelihood of occurrence	Gross risk severity (unmitigated)		Potential impact (A)	Likelihood of occurrence	Net risk severity (post mitigation)
	Risk category	Project Stage	Risk description	1 = minor impact, 5 = show stopper	1 = very unlikely, 5 = extremely likely	Grid 1 matrix	Potential mitigation	1 = minor impact, 5 = show stopper	1 = very unlikely, 5 = extremely likely	Grid 1 matrix
1	Technical / infrastructure	Feasibility	Tendered DH network costs are higher than were allowed for in feasibility study	3	3	Significant	Ensure that recent tender prices are used in feasibility and outline business case work - test prices with suppliers	3	1	Minor
2	Technical / infrastructure	Feasibility	Customers who have expressed interest in network connection do not sign up for delivery of heat	2	2	Minor	Ensure that commercial / carbon terms incentivise connection of all customers	2	1	Minor
3	Technical / infrastructure	Feasibility	Project sponsors do not have funds to implement scheme	5	2	Significant	Ensure that all funding soures are explored (DEPDU)	5	1	Significant
4	Technical / infrastructure	Feasibility	Cost of capital too high to make project viable	5	2	Significant	Ensure that potential access to low-cost funding is explored	5	1	Significant
5	Technical / infrastructure	Feasibility	ESCo / 3rd party goes bankrupt after before or during operation	3	1	Minor	If scheme is viable then other operators will have interest in operating scheme	3	1	Minor
6	Technical / infrastructure	Feasibility	The capex used in concept stages is not sufficient to deliver schemes	4	2	Significant	Ensure that capex estimates are realistic. At implementation phase, mitigation options might include reduce scope of scheme / find other funding sources / increase customer base	4	1	Significant
7	Technical / infrastructure	Feasibility	Redevelopment of existing building stock will reduce heat demand	1	2	Minor	Structure heat sales tariffs to mitigate loss of income to DEN?	1	1	Insignificant
8	Technical / infrastructure	Feasibility	Future proofing networks results in too high an upfront capex for network which renders project unviable	4	1	Significant	Plan phased expansion such that viability is maintained	4	1	Significant
9	Technical / infrastructure	Feasibility	Government incentives favour alternative renewable technologies- i.e. RHI promotes biomass, heat pumps (from natural source) and solar thermal, making scheme less competitive with alternatives	5	3	Severe	Scheme is likely to be dependent on subsidies to a greater or lesser extent, hence mitigation measure is to convince funding bodies of wider benefits of scheme that may not be reflected in financial modelling. High level support	5	1	Significant
10	Technical / infrastructure	Feasibility	DE does not represent the least cost means of reducing CO_2	2	4	Significant	Mitigation measures may include optimising system size and costs to increase carbon saved per £ spent.	2	3	Significant
11	Technical / infrastructure	Feasibility	DH mains are very expensive to install because of high density of existing burried services/other barriers	2	2	Minor	Obtain as much information as possible on existing services at detailed design stage and use realistic cost throughout process	2	1	Minor
12	Technical / infrastructure	Feasibility	Life cycle costs are greater than expected, for example replacement and maintenance	2	1	Minor	Use realistic costs in design works	1	1	Insignificant
13	Technical / infrastructure	Feasibility	Indexation/ cost changes over project lifespan	1	1	Insignificant	Use appropriate risk evaluation tools during project design to evaluation risks of utility / indexation changes	1	1	Insignificant
14	Technical / infrastructure	Feasibility	Unexpected increase in wholesale electricity prices increases heat generation cost at incinerator and erodes viability	2	1	Minor	Allow for margin in design, and be prepared to change scope of scheme if strategic expansion is no longer viable with increased electricity prices - a technology mix of heat sources would mitigate this risk	2	1	Minor
15	Technical / infrastructure	Feasibility	Fuel price variability	1	2	Minor	Tradional' fuel prices should be largely decoupled from overall heat generation costs, due to low level of top-up boiler use required.	1	1	Insignificant
16	Technical / infrastructure	Feasibility	Market driven heat sales price may not be sufficient to cover costs	3	2	Significant	Ensure carbon savings and other benefits are reflected in the heat sales price. Value engineer cost reductions in installation. Increase customer base.	2	2	Minor
17	Technical / infrastructure	Feasibility	Overspend on capital during delivery stage	3	2	Significant	Ensure that competent project management and design review processes are implemented	3	1	Minor
18	Technical / infrastructure	Feasibility	National debt levels result in removal of funding, ability of SPV to obtain borrowing is restricted	4	2	Significant	Ensure that the project has demonstrable 'bankability' if possible	4	1	Significant
19	Technical / infrastructure	Feasibility	Availability of council or private partner to commit to longer term financial inputs	4	2	Significant	Ensure maximum commercial performance of the scheme to encourage investment.	3	1	Minor
20	Technical / infrastructure	Feasibility	Failure of ESCO leaves Wandsworth / Lambeth the supplier of last resort	4	2	Significant	Seek legal and financial advise on structuring of contracts to safeguard against losses in the even of ESCo failure	2	1	Minor
21	Technical / infrastructure	Feasibility	Poor level of service from DE operator	3	2	Significant	Ensure minimum service levels are cleatly defined in the contractual arrangement with the DE operator	2	1	Minor
22	Technical / infrastructure	Feasibility	Lack of sufficient demarcation of responsibilities leads to disruption to service?	3	2	Significant	Ensure clear demarcation of responsibilities is included in contractual arrangements with all parties	2	1	Minor
23	Technical / infrastructure	Feasibility	Disruption to public services/transport during construction phase leads to public protest	2	3	Significant	Where possible avoid routing the network through busy routes. In new developments, coordinate installation of network with other utilities. Ensure timely and wide-reaching public information campaign prior to construction. Where possible, limit works in busy areas to less busy times. Provide suitable traffic diversions.	2	1	Minor
24	Technical / infrastructure	Feasibility	ESCO may conflict with public sector vision	1	1	Insignificant	Clear contractual arrangements around profit and plant replacement schedules.	1	1	Insignificant
25	Technical / infrastructure	Feasibility	Changing elected leadership and political priorities may lower priority of scheme delivery	4	3	Severe	Try to ensure early buy-in of political leadership across all parties, demonstrate value of scheme to wide audience	4	2	Significant
26	Technical / infrastructure	Feasibility	Environmental /political targets change over lifespan of project	3	2	Significant	By ensuring a good carbon saving and economic performance, the DEN should be resistant to changes in environmental and political targets over time. Note that the recent Heat Strategy pledges UK political support for DH schemes in the medium to long term.	3	1	Minor
27	Technical / infrastructure	Feasibility	Poor operational management results in reduced CO_2 reduction potential	3	2	Significant	Include an element for meeting carbon reduction targets in the contractual arrangement with the DH operator	3	1	Minor
28	Technical / infrastructure	Feasibility	Requirement to upgrade local/ customer connections to make compatible with new DH	2	1	Minor	The cost of ensuring compatabilitiy with the scheme would come under Borough estate renewal budgets	1	1	Insignificant
29	Technical / infrastructure	Feasibility	Unforseen physical barriers to DH may delay installation	4	3	Severe	Detailed analysis of utilities maps prior to construction. Ongoing early stage discussion with British Waterways, National Grid, Network Rail, Borough Highways dept etc to ensure the scheme is aligned with existing infrastructure and requirements for interaction with it.	4	2	Significant
30	Technical / infrastructure	Feasibility	Can design provide sufficient contribution to carbon reduction targets for developers (e.g. Meridian Water)?	2	2	Minor	Inclusion for installation of a biomass boiler during three year period where incinerator is undergoing overhaul. This will ensure carbon performance of heat supply for developers and heat customers.	1	1	Insignificant

31	Technical / infrastructure	Feasibility	Poor design leads to lower environmental benefits than anticipated	2	3	Significant	Include a performance guarantee within the design element of the project.	2	1	Minor
32	Technical / infrastructure	Feasibility	Stakeholders not properly engaged during scheme development	2	2	Minor	Hold stakeholder workshops prior at key stages of scheme development	1	1	Insignificant
33	Technical / infrastructure	Feasibility	Burden of contract negotiation may have significant costs that outweigh some of the benefits	3	3	Significant	Base contractual model on previous experieicne of developing successful schemes to expedite negotiation process,	3	2	Significant
34	Technical / infrastructure	Feasibility	Contract risks being overcomplicated and difficult to administer	3	3	Significant	Base contractual model on previous experience of developing successful schemes	2	2	Minor
35	Technical / infrastructure	Feasibility	Risk that systems operate with higher return temperatures than modelled in feasibilty or later design stages	3	2	Significant	Include a return temperature requirement in contractual arrangement with heat customers.	3	1	Minor
36	Technical / infrastructure	Feasibility	Inaccurate forecasting of demand changes may lead to a different availabilty demand and income for the scheme	3	3	Significant	Conduct additional sensitivity modelling around demand changes. Take account of risk in business model formulation.	3	2	Significant
37	Technical / infrastructure	Feasibility	Timings of key Developments as such that they cannot be integrated into phased expansion of DEN, leading to reduced overall viability	3	2	Significant	Ensure that developments are made to be 'DEN-ready' such that connection can be established at a later date at low cost.	2	2	Minor
38	Technical / infrastructure	Feasibility	Gas network supply cost to energy centre renders project unviable	5	2	Significant	Obtain quotation from gas network special projects team	5	2	Significant
39	Technical / infrastructure	Feasibility	Regulatory change (particularly in terms of heat sales market)	3	2	Significant	Ensure that tariff structures are market-rate based, and that there is transparency in tariff setting.	1	1	Insignificant
40	Technical / infrastructure	Design	The district heating network cannot be installed as required	4	3	Severe	undertake sufficient investigations into the DH route and clearly identify existing utilities. Ensure the DH contractor has a solid track record of installing DH in high density urban environments	4	2	Significant
41	Technical / infrastructure	Design	It is not possible to supply the energy centre with sufficient gas volume & pressure	5	2	Significant	Early engagement with Southern Gas Networks regarding the gas connection. Identified routes and mechanisms to be agreed as soon as possible.	5	1	Significant
42	Technical / infrastructure	Design	It is not possible to connect the energy centre to the electrical infrastructure	5	3	Severe	Early engagement with UKPN regarding the electrical connection. Identified routes and mechanisms to be agreed as soon as possible.	5	1	Significant
43	Political / regulatory / social	Design	Air quality issues from energy centre combustion equipment	3	3	Significant	undertake flue gas modelling to ensure the air quality is not adversely affected	3	1	Minor
44	Technical / infrastructure	Design	contaminated land issues identified on construction sites	3	3	Significant	undertake sufficient investigations into the DH route and energy centre to identify all known contaminated land issues	3	1	Minor
45	Technical / infrastructure	Design	structural suitability of land - made ground, mine workings etc	4	3	Severe	undertake sufficient investigations into the DH route and energy centre to determine the ground conditions	3	1	Minor
46	Political / regulatory / social	Design	archaeological constraints identified on construction sites	3	2	Significant	undertake sufficient investigations into the DH route and energy centre to identify all known areas of archaeological interest	2	1	Minor
47	Political / regulatory / social	Design	visual impact of energy centre causes local opposition	3	3	Significant	employ architect with understanding of local architectural style to develop designs. Undertake consultation during planning process to help gain local support	3	1	Minor
48	Technical / infrastructure	Design	existing utilities make installation of DH network complex	4	3	Severe	undertake sufficient investigations into the DH route and clearly identify existing utilities. Ensure the DH contractor has a solid track record of installing DH in high density urban environments	4	2	Significant
49	Technical / infrastructure	Design	conflicting requirement for road closures with other developments / construction projects	3	2	Significant	undertake a process to identify potential conflicts and ensure all potential affected parties are fully consulted. Use of detailed programme to reduce risk of conflicts	3	1	Minor
50	Political / regulatory / social	Design	DH network route conflicts with priority transport routes	3	2	Significant	liaise with highways department to ensure they are fully consulted and up to speed with the proposed network route and installation programme	3	1	Minor
51	Political / regulatory / social	Design	DH route conflicts with future redevelopment plans	2	2	Minor	liaise with redevelopment / major projects team to ensure they are fully aware of the proposed network routing in relation to development plans - ensure linear park has DH section reserved in it	2	1	Minor
52	Technical / infrastructure	Operation	Initial phase spark Ignition gas engine CHP is superseded in cost reduction and CO_2 saving by another technology	3	2	Significant	ensure the design of the energy centre is future proofed to allow for a swap out of technology as and when there is an economic driver to do so. Undertake periodic reviews of cost performance of technology.	2	1	Minor
53	Technical / infrastructure	Design	waste heat at a suitable grade for distribution becomes available from a local source	2	2	Minor	ensure the design of the energy centre is future proofed to allow for a swap out of technology as and when there is an economic driver to do so. Undertake periodic reviews of cost performance of technology.	2	1	Minor
54	FINANCIAL / COMMERCIAL	Business case review	Public sector customers do not connect to the scheme	2	2	Minor	Wandsworth and Lambeth council to use their influence and planning tools to encourage / require public sector organisations to connect to the scheme where deemed technically feasible and viable	2	1	Minor
55	FINANCIAL / COMMERCIAL	Business case review	Private sector customers do not connect to the scheme	3	3	Significant	Lambeth and Wandsworth councils to use their influence and planning powers to require private sector organisations to connect to the scheme where deemed technically feasible	3	2	Significant
56	FINANCIAL / COMMERCIAL	Business case review	It is not possible to procure the construction within budget	4	2	Significant	maintain a robust cost plan throughout the project, in conjunction with experienced quantity surveyors and a well defined procurement specification.	4	1	Significant
57	FINANCIAL / COMMERCIAL	Business case review	Cost overrun on project budget	4	2	Significant	Use of earned value analysis tools to allow the project manager to keep a tight check on the project budget throughout the programme. Use of value engineering, facilitated by experienced cost planner and quantity surveyor.	4	1	Significant
58	FINANCIAL / COMMERCIAL	Business case review	Cost of capital is greater than that included in the business plan	4	2	Significant	use of prudential borrowing with agreed cost of capital	3	1	Minor
59	Political / regulatory / social	Design	Issues obtaining the necessary wayleaves for energy centre location and DH route	5	3	Severe	early engagement with necessary parties, use of council owned / controlled land where possible for network routes	3	2	Significant
60	FINANCIAL / COMMERCIAL	Operation	Maintaining a competitive heat sales price in order to retain customers	4	3	Severe	use a pricing formula and indexation that reflect the alternative cost of heat production. Tariffs should be developed for the full range of customer types connected to the network	4	1	Significant
61	FINANCIAL / COMMERCIAL	Operation	Non - connection of private sector new development to VNEB DHN	3	3	Significant	the use of planning policy by Wandsworth / Lambeth to require 3rd party developers to connect to the network where technically feasible	3	1	Minor
62	FINANCIAL / COMMERCIAL	Operation	Keys developments do not proceed within assumed timeframes	2	2	Minor	close liaison with the major development teams to ensure full understanding of proposed development timeframes	2	1	Minor
63	FINANCIAL / COMMERCIAL	Operation	development thermal demand is significantly different from than that assumed	1	3	Minor	A reduced load on development will allow for the network to supply additional load elsewhere	1	1	Insignificant
64	FINANCIAL / COMMERCIAL	Operation	gas and electricity contracts for the energy centre are not negotiated at the same time, leading to a sub-optimal spark spread	3	3	Significant	coordinated procurement of gas for the energy centre and export of electricity generated will help to maximise value derived from the CHP. Negotiating the operation and maintenance contract to ensure that the long	3	1	Minor
65	FINANCIAL / COMMERCIAL	Operation	Housing developers do not connect to DHN because an alternative technology is deemed to be better value	4	3	Severe	a solid evidence base, supported by planning guidance from the council will help to ensure that the housing developers connect to the scheme	4	1	Significant
66	Political / regulatory / social	Design	Disposal of council assets leads to a reduced customer base / income for Battersea network	2	1	Minor	liaison with the council asset management team to understand the long term future of council assets that are to be connected to the scheme	2	1	Minor

13.7 Appendix G – Energy Centre Layouts


HEIGHT OF FLUES TO BE DETERMINED
SPACE ABOVE FACILITIES FOR HEAT EXCHANGERS FOR SUPPLY FROM US EMBASSY
SECTIONAL ELEVATION
41,000
PLATE HEAT EXCHANGERS ON MEZZANINE FLOOR
LV ELECTRICAL
CONTROL ROOM
TOILETS
MESS
WORKSHOP /STORES
WATER TREATMENT PLANT
SPACE ALLOCATED TO PUMPS, PRESSURISATION ETC BELOW MEZZANINE FLOOR
ROLLER SHUTTER
No.1 GAS BOILER 20MW
No.2 GAS BOILER 20MW
No.3 GAS BOILER 20MW
No.4 GAS BOILER 20MW
18,000
REMOVABLE PANEL
REMOVABLE PANEL
REMOVABLE PANEL
REMOVABLE PANEL
CAR PARK
SECTIONAL PLAN VIEW
PAVEMENT
ROAD
A ISSUED FOR COMMENT RK
REV. DETAILS DRN CHK APPR DATE
PARSONS BRINCKERHOFF
Energy Solutions
6 Devonshire Square, London EC2M 4YE, UK
Tel: 44-(0)20-7337-1700 Fax: 44-(0)20-7337-1701
CLIENT/PROJECT
VNEB
TITLE
ARRANGEMENT OF ENERGY CENTRE FOR CENTRAL SCHEME
DATE 08/10/12
SCALE 1/250@A3
CAD REF
DRAWN BY RAYK
PRODUCED BY RAYK
CHECKED
APPROVED
DRAWING NUMBER
3512246A-BEL-M004 A
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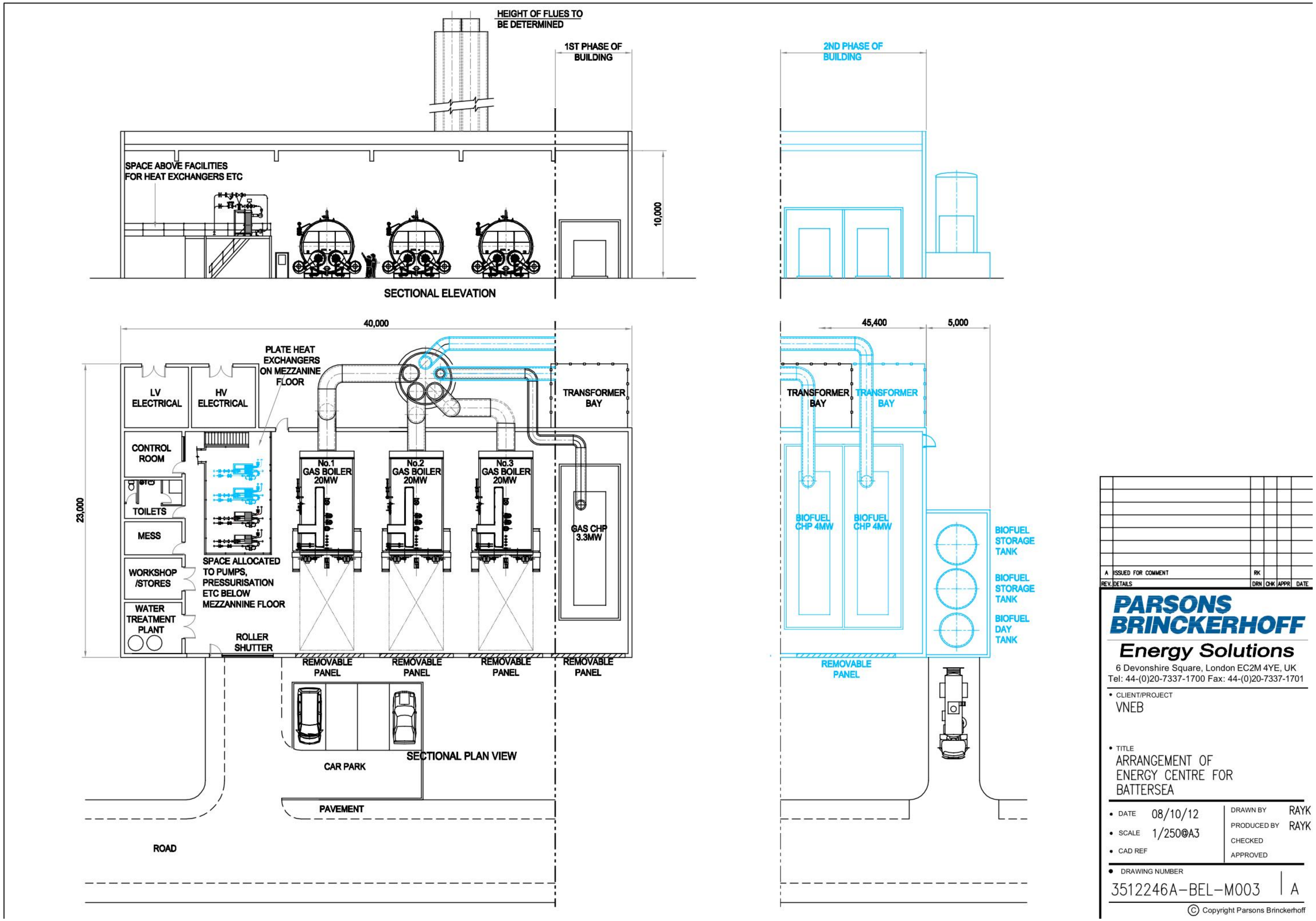
HEIGHT OF FLUES TO BE DETERMINED
1ST PHASE OF BUILDING
2ND PHASE OF BUILDING
SPACE ABOVE FACILITIES FOR HEAT EXCHANGERS ETC
10,000
SECTIONAL ELEVATION
40,000
45,400
5,000
23,000
PLATE HEAT EXCHANGERS ON MEZZANINE FLOOR
LV ELECTRICAL
HV ELECTRICAL
TRANSFORMER BAY
TRANSFORMER BAY
TRANSFORMER BAY
CONTROL ROOM
No.1 GAS BOILER 20MW
No.2 GAS BOILER 20MW
No.3 GAS BOILER 20MW
GAS CHP 3.3MW
BIOFUEL CHP 4MW
BIOFUEL CHP 4MW
BIOFUEL STORAGE TANK
BIOFUEL STORAGE TANK
BIOFUEL DAY TANK
TOILETS
MESS
WORKSHOP /STORES
WATER TREATMENT PLANT
SPACE ALLOCATED TO PUMPS, PRESSURISATION ETC BELOW MEZZANNINE FLOOR
ROLLER SHUTTER
REMOVABLE PANEL
REMOVABLE PANEL
REMOVABLE PANEL
REMOVABLE PANEL
REMOVABLE PANEL
SECTIONAL PLAN VIEW
CAR PARK
PAVEMENT
ROAD
A ISSUED FOR COMMENT RK
REV. DETAILS DRN CHK APPR DATE
PARSONS BRINCKERHOFF
Energy Solutions
6 Devonshire Square, London EC2M 4YE, UK
Tel: 44-(0)20-7337-1700 Fax: 44-(0)20-7337-1701
CLIENT/PROJECT
VNEB
TITLE
ARRANGEMENT OF ENERGY CENTRE FOR BATTERSEA
DATE 08/10/12
SCALE 1/250@A3
CAD REF
DRAWN BY RAYK
PRODUCED BY RAYK
CHECKED
APPROVED
DRAWING NUMBER
3512246A-BEL-M003 A
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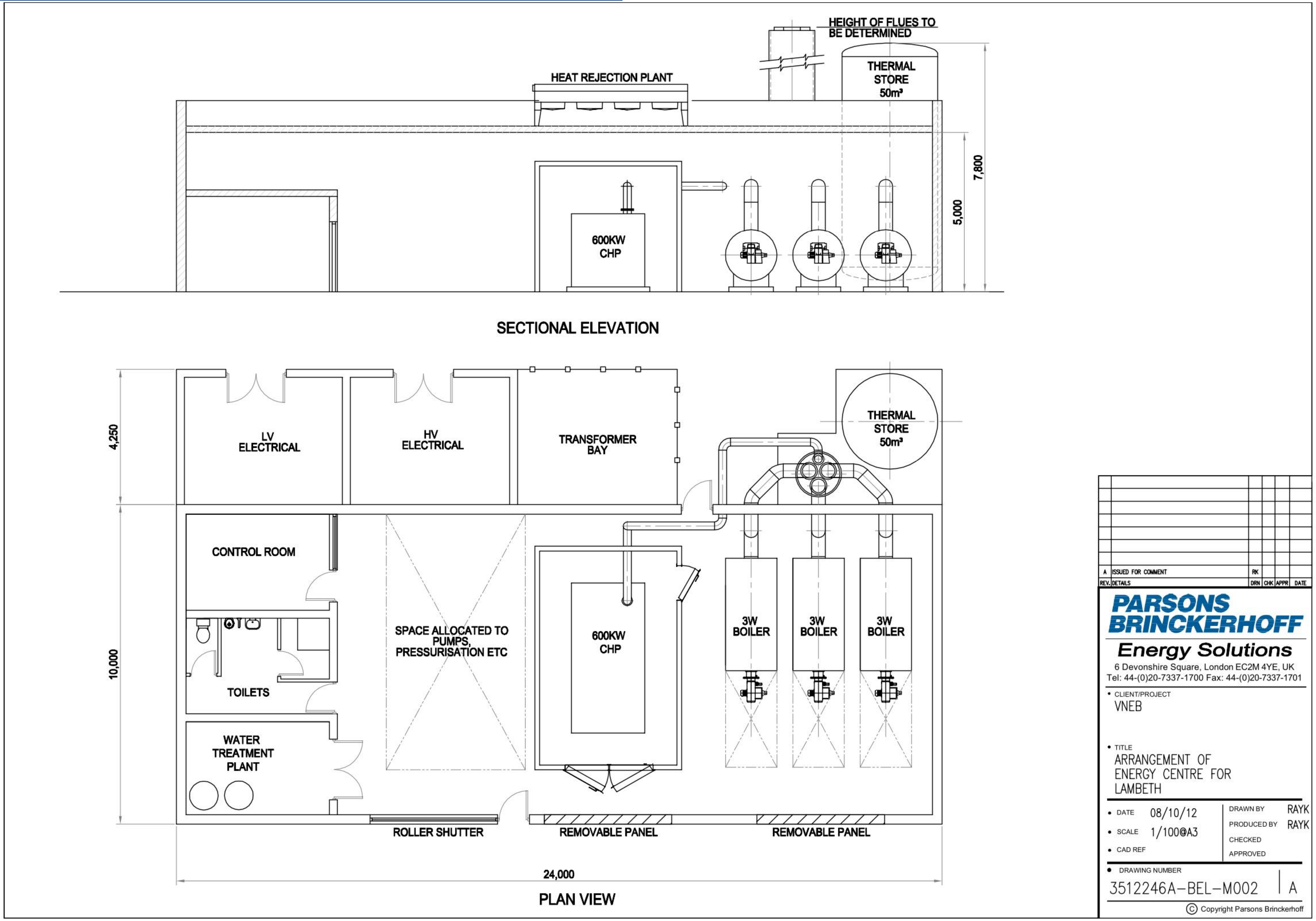
HEIGHT OF FLUES TO BE DETERMINED
HEAT REJECTION PLANT
THERMAL STORE 50m³
600KW CHP
7,800
5,000
SECTIONAL ELEVATION
4,250
10,000
LV ELECTRICAL
HV ELECTRICAL
TRANSFORMER BAY
THERMAL STORE 50m³
CONTROL ROOM
SPACE ALLOCATED TO PUMPS, PRESSURISATION ETC
600KW CHP
3W BOILER
3W BOILER
3W BOILER
TOILETS
WATER TREATMENT PLANT
ROLLER SHUTTER
REMOVABLE PANEL
REMOVABLE PANEL
24,000
PLAN VIEW
A ISSUED FOR COMMENT RK
REV. DETAILS DRN CHK APPR DATE
PARSONS BRINCKERHOFF
Energy Solutions
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Tel: 44-(0)20-7337-1700 Fax: 44-(0)20-7337-1701
CLIENT/PROJECT
VNEB
TITLE
ARRANGEMENT OF ENERGY CENTRE FOR LAMBETH
DATE 08/10/12
SCALE 1/100@A3
CAD REF
DRAWN BY RAYK
PRODUCED BY RAYK
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