

# **Old Kent Road Decentralised Energy Strategy**

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This study investigates the outline technical feasibility and financial viability of developing district heating networks in Southwark, based on plans and information available at the time of writing. Before implementation of any of the options further detailed study, design and costing, based on ground surveys, structural analysis etc. will be necessary.



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## Non-Technical Summary

### Introduction to the study

AECOM were commissioned by Southwark Council to appraise the potential for using an area-wide heat network<sup>1</sup> to provide a source of low carbon heat to serve new and existing development in the Old Kent Road Opportunity Area.

Where considered technically and financially viable, district heating (DH) networks can potentially offer a number of environmental and financial benefits, such as:

- lower CO<sub>2</sub> emissions associated with the supply of heat,
- lower cost for consumers and/or lower cost for developers to meet building regulations and planning policy requirements (though there will inevitably be trade-offs between upfront savings for developers and savings for end consumers),
- reduced overall space required for plant (relative to smaller plot-level systems or individual building systems), and
- reduced operational and management risks relative to smaller plot-level communal and/or district heating systems.

The benefits can however vary depending on the generation technology (both with regard to CO<sub>2</sub> savings and operational risks), the chosen delivery model for investment in DH infrastructure<sup>2</sup>, as well as the timing of when connection to the DH system becomes available (which may require individual plots to invest in temporary plant on site).

The principal aims of this study are to:

- Enable the London Borough of Southwark and other stakeholders to recognise the potential for district heating networks in the area.
- Support planning policy and project plans within the Area Action Plan (AAP) to promote low and zero carbon decentralised energy infrastructure, where viable.
- Identify specific heat network opportunities in the area that can be taken forward by further studies.

### Background

The Further Alterations to the London Plan, incorporated into the London Plan in March 2015, identify Old Kent Road as a new Opportunity Area (OA) with significant potential for residential-led development. The London Borough of Southwark, in collaboration with GLA, is preparing an Area Action Plan (AAP) for Old Kent Road (OKR) Opportunity Area (OA) that will provide the overall framework to manage growth in the area over the next 15 years and ensure that opportunities for sustainable growth are maximised.

The Area Action Plan (AAP) will form part of the statutory development plan and the council expects to publish a preferred options report in spring 2016. The boundary for the OA is yet to be formally agreed, which will be done at the preferred option stage of the AAP.

To inform the AAP, Southwark Council have commissioned a place-making study for the opportunity area that is identifying the framework for change, the principles that should guide intervention and the quantum of development that would be appropriate. The indicative development capacities produced as part of this place-making study have been used as the basis for appraising the viability of district heating for OKROA.

Key constraints specific to the Old Kent Road area that could have an impact on the suitability of specific energy supply technologies and on the viability of decentralised energy infrastructure include local air quality (with all of OKROA falling

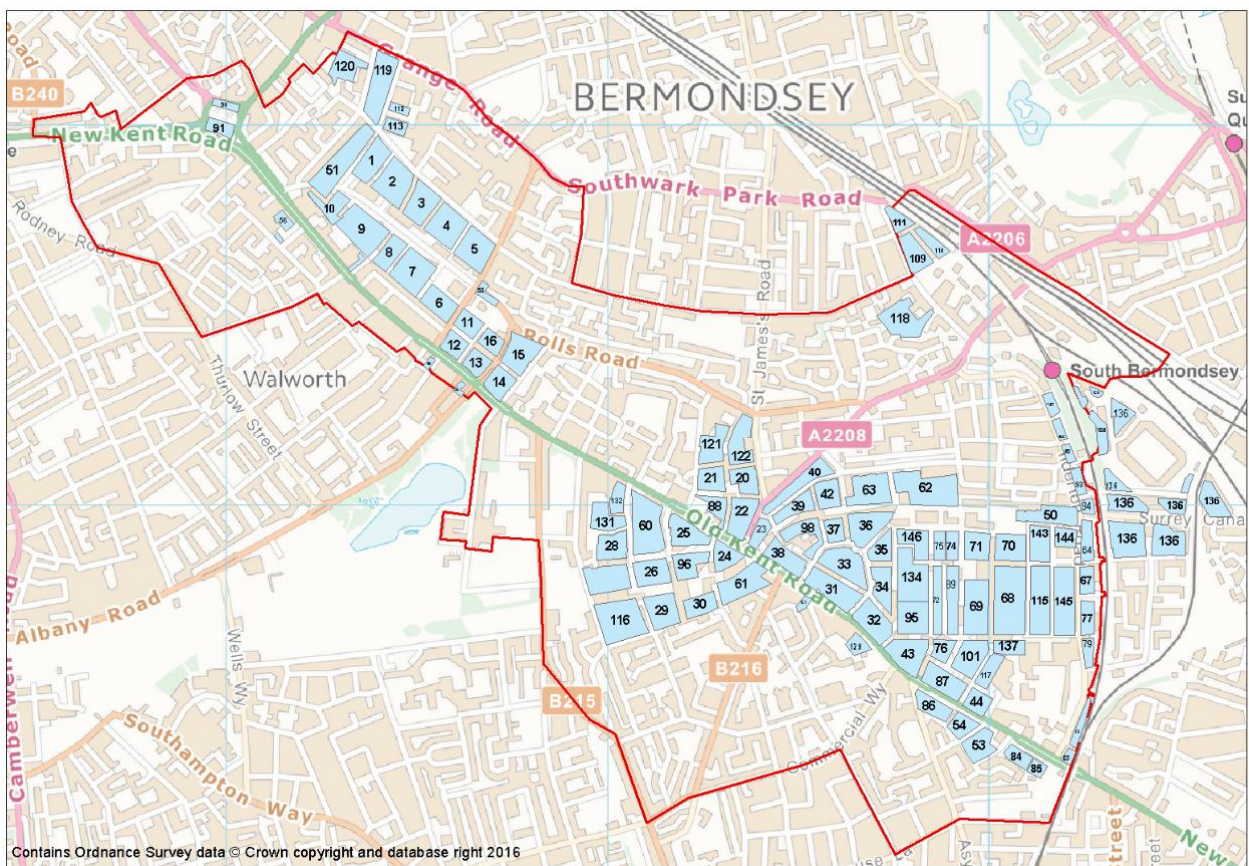
<sup>1</sup> This term is generally given to a system where a heat generating plant (using any one of a range of energy generation technologies) provides heat to surrounding buildings in the area by means of a network of pipes carrying hot water or steam.

<sup>2</sup> Alternative delivery models for decentralised energy infrastructure are discussed in Chapter 5.

within an air quality management area) and an archaeological priority zone that covers a significant part of the OA. Key opportunities include the proximity to SELCHP Energy Recovery Facility located in the London Borough of Lewisham outside the eastern edge of the indicative OKROA boundary.

**Policy context**

The headline climate change mitigation targets at the national level for the UK are to reduce CO<sub>2</sub> emissions by 80% by 2050 (on 1990 levels) and for 15% of the UK’s energy to come from renewable sources by 2020. These targets have led to



*Figure 1: Map of development plots in the OKROA*

significant changes to existing policies and regulations at both the national and local level in recent years, and have led to new policies and incentives to encourage uptake of sustainable energy technologies.

At the national level, the Energy Act 2013 updates energy legislation to reform the electricity market and encourage low carbon electricity generation. Feed-in tariffs (FITs) and the Renewable Heat Incentive (RHI) provide financial incentives for

the uptake of renewable electricity and heat generating technologies.

The energy and carbon performance requirements within national Building Regulations have also been progressively tightened. The 2013 edition of Part L, which is the current version, introduced a Target Fabric Energy Efficiency standard (TFEE) that sets the minimum energy efficiency performance for new dwellings.

At the regional level, the London Climate Change Mitigation and Energy Strategy (2011) sets out an even more ambitious trajectory for a 60% reduction in CO<sub>2</sub> emissions by 2025, and at least 80% by 2050. Additionally, the Mayor has set a target to supply 25% of London’s energy from secure, low carbon local sources. The decentralised energy programme, one of the key activities planned to deliver against these targets, aims to support the commercialisation of large-scale decentralised energy projects that can heat and power London’s existing and new buildings more carbon-efficiently.

Planning policy at the regional level, as set out in the London Plan (2015), requires developments to go beyond the Building Regulations minimum requirements, as set out in Table 1. Minor alterations to the London Plan (MALP) 2015 have been prepared in response to the housing standards review and are expected to be published in March 2016. The CO<sub>2</sub> targets as set out in Table 1 remain unchanged in the MALP though will be set relative to the 2013 Building Regulations baseline.

*Table 1: The London Plan (2015) targets for CO<sub>2</sub> emissions reduction from new developments*

Improvement on Building Regulations Part L 2010		
	Domestic	Non-domestic
2010	25%	25%
2013	40%	40%
2016	Zero Carbon	As building regulations
2019		Zero Carbon

In light of the government’s decision to postpone the proposed 2016 update to Part L of the Building Regulations, these CO<sub>2</sub> reduction targets may be revised in future reviews of the London Plan. The London Plan additionally includes policies to

drive the uptake of low and zero carbon energy technologies and decentralised energy (DE) solutions.

At the local level, Southwark’s Core Strategy (2011) requires major development to achieve a 44% improvement over Building Regulations Part L 2006 and to achieve a 20% reduction in CO<sub>2</sub> emissions from on-site (and/or local) low and zero carbon sources of energy. The Core Strategy also sets out an ambition to work with energy service providers and developers to deliver district energy networks across the borough. Southwark Council is reviewing the Core Strategy to prepare a new local plan which will set out the regeneration strategy from 2017 -2033. The preparation of the New Southwark Plan has now reached the ‘Preferred Option’ stage. Policy DM56 refers to the Mayor’s energy hierarchy as a means to demonstrate compliance with onsite CO<sub>2</sub> reduction targets. It additionally requires major developments to connect to existing or planned decentralised energy networks, and where this is not feasible, for developments to prioritise use of a site-wide communal heating system with CHP.

In summary, the current policy and regulatory environment at the national, regional and local level prioritises and incentivises the development of decentralised energy networks as part of a package of interventions required to deliver against the medium to long term climate mitigation targets.

**‘Low and Zero Carbon’ energy supply technologies**

A range of ‘Low and Zero Carbon’ (LZC) technologies have been appraised in terms of their suitability to be deployed at the community scale within the opportunity area, providing low carbon heat to new and/or existing buildings . These include gas-fired Combined Heat and Power (CHP), biomass heating, biomass CHP, heat pumps and ‘Energy from Waste’(EfW) technologies. The suitability of the different technology options have been assessed taking into account local opportunities and constraints, technical performance, likely CO<sub>2</sub> savings and potential risks. The findings are summarised in Table 2.

Table 2: Conclusions from the technology options appraisal on the suitability of alternative energy supply technologies for OKROA

Technology Suitability		Comments
Gas-fired CHP	✓	Mature technology that can deliver significant CO <sub>2</sub> reductions and financial benefits compared to individual gas boilers due to the production of local electricity (although savings expected to be eroded as carbon intensity of the electricity grid falls)
Fuel cell CHP	✗	Considered an immature technology, with lower financial viability compared with gas CHP engines
Communal biomass boilers	✗	Use considered to be constrained in this location due to impact on air quality (which will be further exacerbated by transport movements associated with delivery of fuel), space requirement for storage of fuel, and significant risk associated with future availability and cost of sustainably-sourced fuel
Biomass-fired CHP	✗	Similar challenges as with biomass boilers plus technology not as modular as gas-CHP, which will result in significant heat dumping in initial years
Heat pumps	✗ Potential future option	Relatively mature technology although offer a significant price premium for heat at current energy prices; unlikely to offer a significant CO <sub>2</sub> benefit given the current mix of grid electricity (if ground or air used as the source), but could complement gas-CHP systems in the medium to long term; have reduced air-quality implications compared with combustion technologies; care needed to avoid unintended impacts on heat source, for example, through changes in temperature; offers opportunities to capture sources of waste heat (e.g. from transport networks)
“On-site” EfW	✗	Typically operate at large scales and have a large footprint associated with fuel storage and processes

Technology Suitability		Comments
Waste heat from SELCHP	✓	The proximity of OKROA to SELCHP makes waste heat an attractive option for delivering low cost and low carbon heat though will be dependent on a number of commercial and financial considerations.

The appraisal concluded that gas CHP and waste heat from SELCHP would be most suited as the first wave of heat supply technologies for district heating networks in the OKROA.

Heat pumps (using waste heat from transport networks or other sources) are better suited as the second wave of technology that either complements or replaces gas-CHP at the end of its life. The expectation is that while average grid carbon intensity is expected to drop (due to a shift from high carbon fossil generation to a mix of nuclear, increased renewables, and use of carbon capture and storage) it will have different levels of CO<sub>2</sub> emissions at different periods depending on the electricity demands, and the amount of renewable electricity on the system. There will be periods when fossil fuel generation (high carbon) will be the marginal plant<sup>3</sup>, and also periods where there is excess renewable or low carbon electricity (low carbon). Gas CHP will still save CO<sub>2</sub> against the former, whilst electricity consuming systems (for example heat pumps) could make use of the low carbon electricity in times of excess.

By potentially operating a combination of heat pumps and gas CHP on a district heating network in the future, it may be possible to optimise the generation source under certain grid conditions so that CO<sub>2</sub> savings and financial returns are maximised (see Section 4.7 on future energy system).

<sup>3</sup> The marginal plant(s) refers to the generation plant(s) and/or energy source(s) that are expected to increase or decrease when there are marginal but sustained changes to energy demand or supply.



**Heat network development and analysis of options**

A heat map for the study area was produced using GIS (Geographic Information Systems) showing heating demand density from significant existing loads and proposed new developments in the area (Figure 2). Heat demand provides an indication of the potential environmental and financial benefits that could be derived from the creation of a heat network served by a low carbon energy technology.

For the options analysis, three network phases have been modelled to reflect the development phasing.

- Phase 1: models new floorspace added between 2015 and 2025 (assuming floor space build in early years is futureproofed to be connected to the DH network), plus any existing major loads in close proximity.

- Phase 2: models an extended network to include new floorspace added between 2025 -2030 plus any existing major loads in close proximity.
- Phase 3: models an extended network to include new floorspace added between 2030 and 2036 plus any existing major loads in close proximity.

A high level network design based on a single energy centre is shown in Figure 3. The energy centre locations are indicative at this stage and informed by initial consideration of development phasing, proximity to pockets of high heat demand and expected building heights, which in turn will impact on flue height for dispersion of exhaust gases. However, further analysis of this and other potential locations for the alternative network options would be required as part of any further development work.

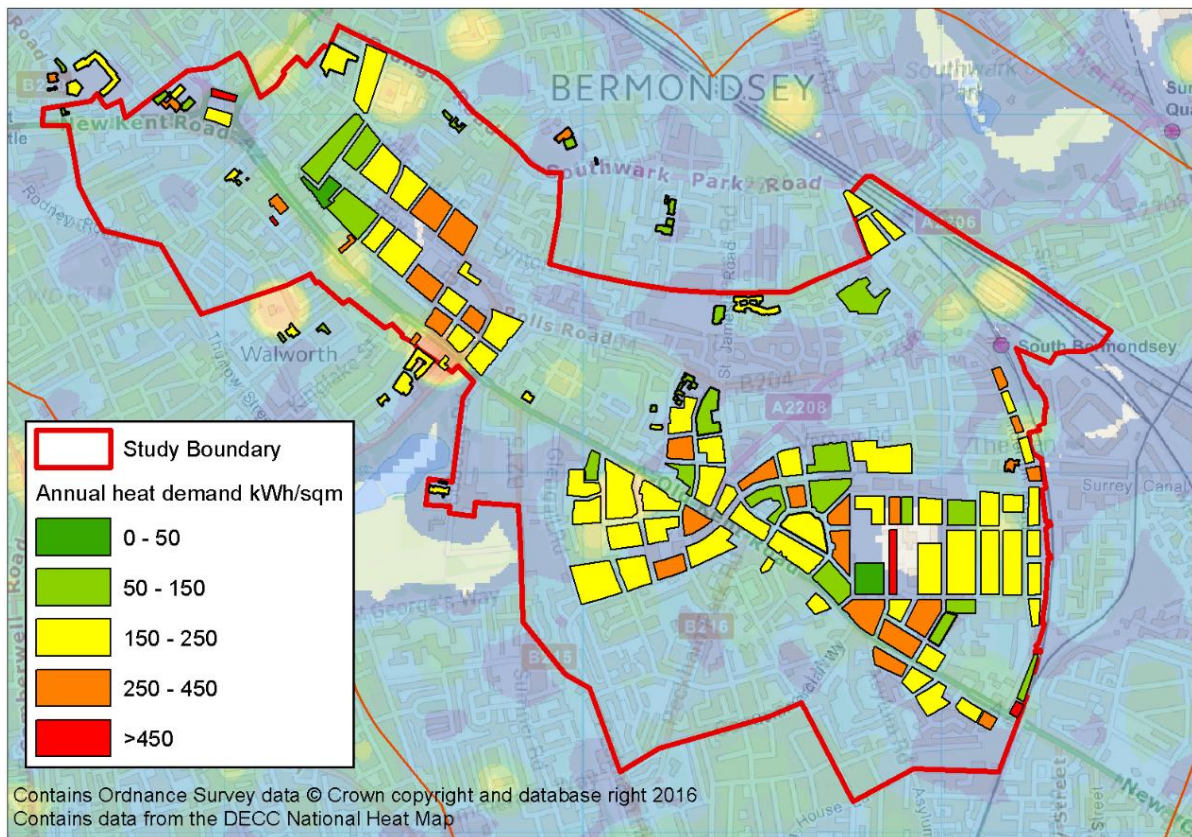


Figure 2: Heat demand density from significant existing loads and proposed new developments in OKROA

The key results for the three district heating network options for OKROA including CO<sub>2</sub> savings, capital costs and some key financial indicators are shown in the following tables. The results are broken down by phasing in line with development projection, and are based on the following parameters and/or assumptions.

- CHP sizing has been heat-led and optimised to maximise financial returns over its life.
- CO<sub>2</sub> savings have been calculated as a weighted average relative to a baseline scenario. The baseline scenario assumes individual gas boilers for small schemes (<100 residential units or <1,000sqm of non-domestic floorspace), gas-fired communal schemes for larger schemes (of 100 to 500 units), and communal systems

with gas-CHP for schemes with more than 500 residential units.

- Capital costs associated with delivery of heat network infrastructure have been modelled to the plot boundary, and do not include the cost of delivering a communal network within the plot boundary.
- A financial contribution is made by developers connecting to the proposed network that broadly reflects the savings associated with meeting planning policy and Building Regulations requirements for the baseline scenarios referred to above.

More detailed information about this part of the study is contained in the main report and details of the methodology and assumptions used are contained in the Appendix C.

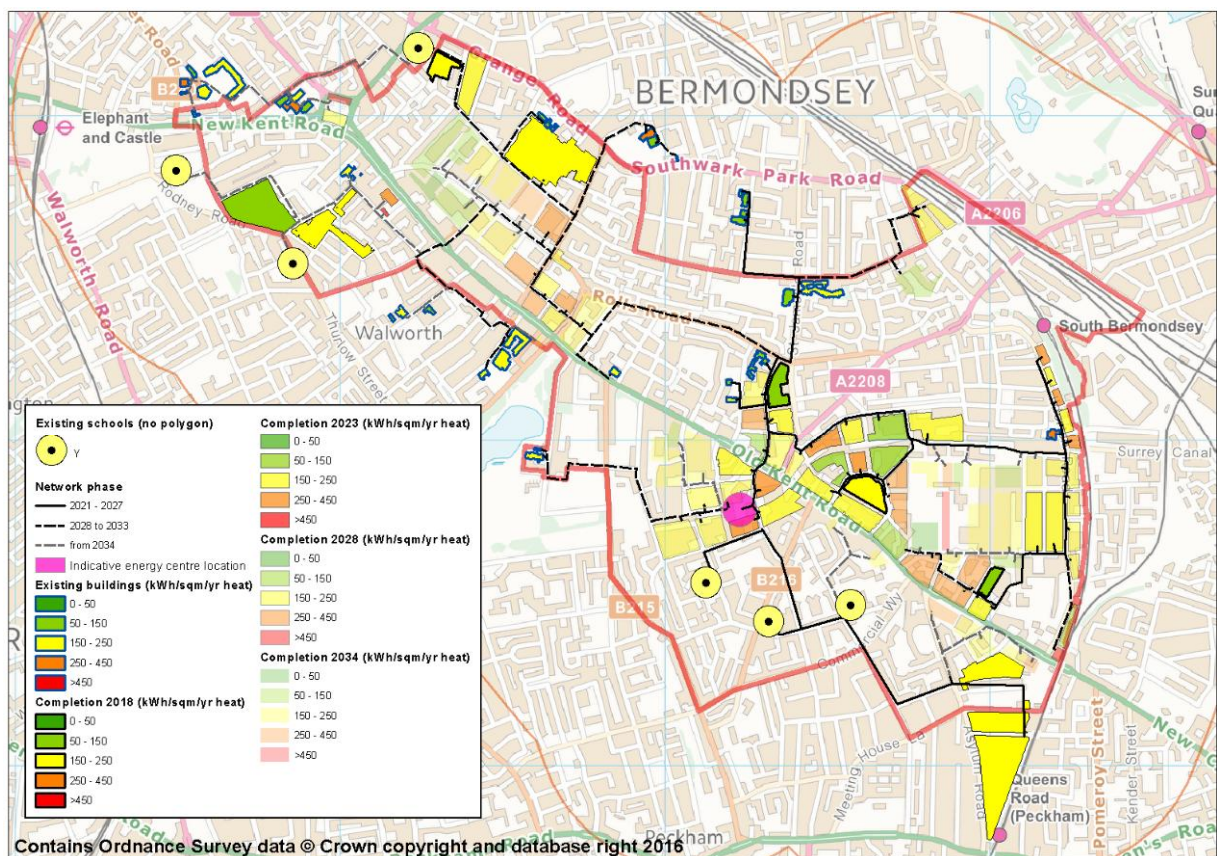


Figure 3: Map showing indicative energy centre location and network routes

## Network Option 1

A phased heat distribution network with a single energy centre (EC) located within the opportunity area and run on gas-CHP.

## Network Option 2

Option 2: A variant of Option 1 above with smaller inter-connected ECs, modelled as a variation on projected energy centre costs and timeline of when these costs will be incurred assuming three separate ECs.

### Key results

	Phase 1	Phase 2	Phase 3	Whole scheme
<b>CHP system size, MW<sub>e</sub></b>	2 x 3.7 1 x 1.2	4 x 3.7 1 x 1.2	6 x 3.7 1 x 1.2	6 x 3.7 1 x 1.2
<b>Top-up/ back-up boilers size, MW<sub>t</sub></b>	3.6	6.7	12.7	12.7
<b>Capital costs by phase (£m)</b>	£23.7m	£16.0	£22.9	£62.6
<b>Cumulative NPV@ 6% over 40 years (£m)</b>	-£4.6m	£9.8m	£11.4m	£11.4m
<b>Cumulative IRR</b>	3.4%	8.6%	8.7%	8.7%
<b>Payback period (from start of phase)</b>	17 years	7 years	3 years	16 years
<b>Cumulative average annual CO<sub>2e</sub> savings, tonnes/yr</b>	4215	7361	11,020	11,020
<b>Cumulative NPV per tonne CO<sub>2e</sub>, £/tonne</b>	-£27	£35	£27	£27

### Key results

	Phase 1	Phase 2	Phase 3	Whole scheme
<b>CHP system size, MW<sub>e</sub></b>	2 x 3.7 1 x 1.2	4 x 3.7 1 x 1.2	6 x 3.7 1 x 1.2	6 x 3.7 1 x 1.2
<b>Top-up/ back-up boilers size, MW<sub>t</sub></b>	3.6	6.7	12.7	12.7
<b>Capital costs by phase (£m)</b>	£20.5	£18.1	£25.0	£63.6
<b>Cumulative NPV@ 6% over 40 years (£m)</b>	-£2.1	£11.0	£11.5	£11.5
<b>Cumulative IRR</b>	4.7%	9.1%	8.9%	8.9%
<b>Payback period (from start of phase)</b>	14 years	3 years	2 years	15 years
<b>Cumulative average annual CO<sub>2e</sub> savings, tonnes/yr</b>	4215	7361	11,020	11,020
<b>Cumulative NPV per tonne CO<sub>2e</sub>, £/tonne</b>	-£12	£37	£28	£28

## Network Option 3

Option 3: A variant of Option 1 with a single EC located within the opportunity area, which in turn is connected SELCHP to meet part of the heat demand.

### Key results

	Phase 1	Phase 2	Phase 3	Whole scheme
<b>CHP system size, MW<sub>e</sub></b>	0	2 x 3.7	4 x 3.7	14.8
<b>Waste heat from SELCHP, MW</b>	10	10	10	10
<b>Top-up/ back-up boilers size, MW<sub>t</sub></b>	2.6	6.0	11.8	11.8
<b>Capital costs by phase (£m)</b>	£18.8	£15.8	£22.9	£57.5
<b>Cumulative NPV@ 6% over 40 years (£m)</b>	-£3.7	£2.6	£3.4	£3.4
<b>Cumulative IRR</b>	3.7%	7.0%	7.1%	7.1%
<b>Payback period (from start of phase)</b>	18 years	8 years	5 years	17 years
<b>Cumulative average annual CO<sub>2e</sub> savings, tonnes/yr</b>	7,025	10,138	16,908	16,908
<b>Cumulative NPV per tonne CO<sub>2e</sub>, £/tonne</b>	-£19	£7	£6	£6

### Conclusions

The high-level feasibility analysis shows that a DH network run on gas-CHP is viable for the opportunity area offering positive rates of return on investment.

The analysis shows that both Option 1 and Option 2 offer a comparable rate of return on investment in the region of ~9% when fully built out and operational, with a net present value of

circa £11.5m. Option 3 has a relatively lower rate of return compared to the other two options, though still exceeding the 6% threshold with a positive NPV of about £3.4m. The lower return can be attributed to the unit cost of waste heat and the lost revenues from electricity generation (relative to an all gas-CHP scenario). Option 3 however delivers the highest carbon savings over the 40 year analysis period due to low carbon factor for waste heat relative to heat from gas-CHP.

Under all options the investment does not break even in terms of cashflow until late 2030s. Also, Phase 1 in isolation does not deliver a healthy return on investment under all three options. The overall viability of all options can be improved where opportunities to sell electricity locally can be maximized, and additionally for Option 3 where a lower heat tariff for waste heat can be negotiated to reflect the lower management costs of selling heat to a single large consumer.

While the high level feasibility suggests a financial case for investing in DH network in the area, deliverability will be a challenge given the development phasing, multiple ownerships and local constraints, such as air quality. From a strategic viewpoint, Option 1 may be a preferred solution as it offers scale (which may be an attractive proposition for investors, project developers and operators) as well as better flexibility to integrate new technologies in the future, such as the opportunity to harness waste heat from the London transport network. Option 2 on the other hand is a more practical proposition from a deliverability viewpoint. It allows energy centre costs to be phased but equally minimises the likely impact of siting a large energy centre on the viability of an individual development plot/ site. There would inevitably be challenges associated with integrating both a single large energy centre and three separate energy centres within a dense urban context in terms of air quality, noise and visual impact, which would need to be fully taken into consideration when further assessing energy centre locations and during detailed design.

The results of this high-level feasibility study provide reasonable evidence for local planning policy to support the delivery of decentralised energy networks in the OKROA. There are, however, a number of technical, financial, and environmental risks associated with the delivery of the DH network. The rate of return is also highly sensitive to a range of variables, in particular projected heat demand and capital costs. Further detailed investigations as well as engagement with key stakeholders is recommended to inform a full business plan.

### Policy recommendations

1. **Support for a DH network in the OKROA** – This study provides the evidence base in support of a targeted policy to facilitate the delivery of a district heating scheme within the OKROA. It is recommended that Southwark Council use its planning powers to require major developments in the OKROA to connect to, or be futureproofed to connect to, a local district heating network, where viable. Figure 32 shows the extent of the proposed ‘strategic district heating area’ (SDHA) within which development plots are recommended to be connected (or designed to allow connection) to a DH network. This indicative area is based on data available to date on current and future energy demand within the OKROA, and should be reviewed in light of changes to projected development capacities or where significant developments are proposed outside this indicative boundary.
2. **Design requirements for developments** – The policy should include reference to the CIBSE Heat Networks Code of Practice and the technical standards set out in the London Heat Network Manual, in particular for secondary system design to ensure effective operation of the DH network.
3. **Futureproofing requirements for developments** – Developments coming forward prior to the DH network being installed should be required to include physical

safeguarding measures for pipe routes and should adopt the design requirements referred to above.

4. **Safeguarding of pipework routes** - Proposals for major infrastructure crossings and bridges should be required to demonstrate that provision is included to accommodate utilities networks, including heating and cooling network pipes where appropriate.
5. **Harnessing opportunities for waste heat** – Developments with significant surplus of waste heat should be required to assess the potential to supply this to an area-wide heat network and to make suitable provision, where viable.

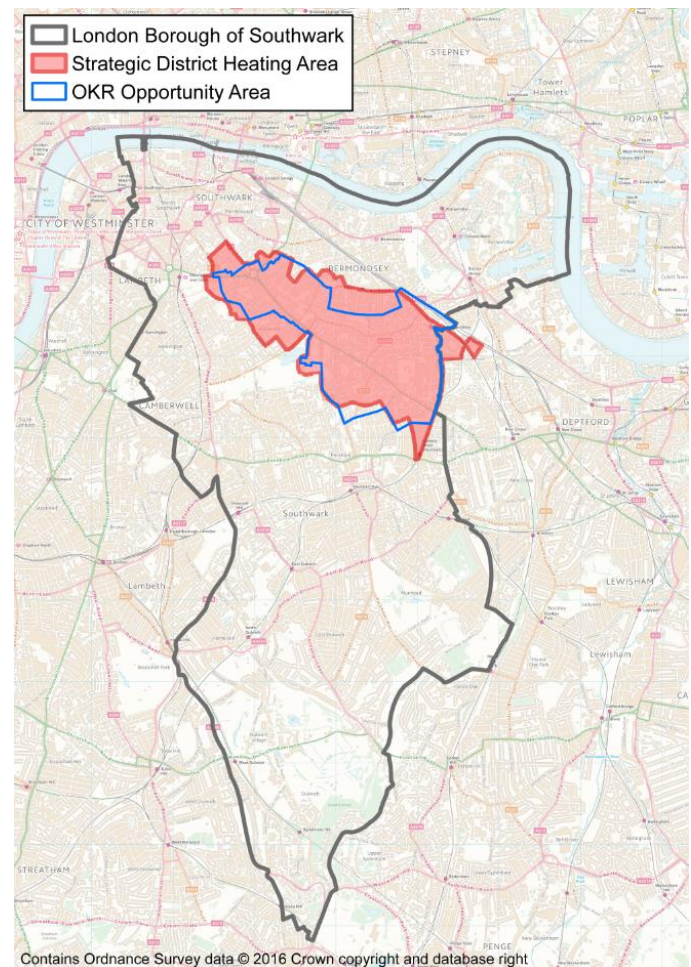


Figure 4: Proposed Strategic District Heating Area

## Delivery and Implementation

**The role of planning:** Using the outcomes from this study as an evidence base, planning policy could be put in place requiring new developments to either connect to, or design for connection to, a future network in these locations. The Area Action Plan (AAP) being developed by Southwark Council could, for instance, designate a strategic district heating area (SDHA) that extends to include major development plots and large existing loads within the OKROA. S106 obligations could be used to require connection to DH networks or to futureproof development to enable them to be connected once the system is operational. Planning policy should also be used to help safeguard possible network routes and energy centre locations. In addition, new developments should be required to be designed to specified technical standards to enable connection and to ensure effective operation of the DH system. This includes encouraging the effective design of secondary systems in buildings both to minimise heat losses and to provide low return temperatures to the network.

**Delivery models:** Consideration should be given to a suitable delivery and business model at an early stage. Delivery models for district heating networks, and other low carbon investments, range from fully public sector led to fully private sector led, and a variety of partnership or 'hybrid' arrangements between public, private and non-governmental sectors. The type of delivery model determines the balance of risk and reward along with the level of control for the participating entities.

A review of delivery structures on heat networks<sup>4</sup> identified the following delivery models that have been typically adopted in the UK to date.

- **Public sector led, public sector ownership.** Typically the public sector leads the development of the project and takes full financial risk, with some elements of the

construction and/or operation outsourced to specialist companies in the private sector.

- **Public sector led, private sector ownership.** Public sector procures a private sector partner / ESCo under a long-term service concession agreement and the private sector in this instance builds, owns and operates the scheme for the duration of the agreement. This was the model used to deliver the Queen Elizabeth Olympic Park heat network.
- **Private led, private sector ownership.** A developer procures a long-term private sector ESCo partner to develop, own and operate the scheme under a long-term concession, with ESCO retaining ownership of the assets.

Even in the case of a private sector led and owned model, the role of local authorities as a facilitator should not be underestimated. It is imperative that the local authority sets a clear long term vision and a plan for the delivery (and expansion of heat networks) supported by the right policy instruments both to give confidence to the private sector and to retain a degree of control on outcomes.

**Funding streams and sources of finance:** A range of funding and financing options may be available for district heating schemes including:

- Conventional project financing (e.g. via a private sector partner or ESCo);
- Prudential borrowing<sup>5</sup> (e.g. in case of a public- sector led delivery model or where public sector provides initial seed funding);
- Non-recourse project finance<sup>6</sup> (typically through creation of a 'Special Purpose Vehicle' involving public and/or private

<sup>5</sup> Please refer Appendix F for a brief description

<sup>6</sup> This is a loan where the lender is only entitled to repayment from the profits of the project the loan is funding, not from other assets of the borrower

<sup>4</sup> Scottish Futures Trust, 2015

sector entities with a combination of bank debt and/or prudential borrowing).

These can be supplemented / coupled with the following sources of funding:

- Developer contributions, including both S106 and Community Infrastructure Levy (although the availability of both mechanisms to fund district heating infrastructure will be limited by other local priorities);
- European Structural funding, e.g. via instruments such as JESSICA / London Energy Efficiency Fund (LEEF);
- National government capital support for heat networks.

In addition, development funding and technical assistance grants may be available from European funds and/ or DECC's Heat Networks Delivery Unit (HNDU).

**Delivery roadmap:** The following table sets out a broad roadmap for the delivery of a district heating network in OKROA.

Delivery roadmap for DH network in OKROA	
1	<p><b>Develop local planning policy framework</b> This is currently underway and the findings from this high-level feasibility assessment will be used to inform the AAP / OAPF that is currently being developed for the OKROA.</p>
2	<p><b>Commission detailed technical &amp; financial feasibility studies</b> A full feasibility assessment should be commissioned to assess the technical aspects in more detail, appraise energy centre location/s and associated constraints, provide more certainty of capital and operational costs, and to develop a comprehensive future strategy for scheme operation.</p>
3	<p><b>Stakeholder engagement</b> This is an on-going exercise that will effectively run in parallel with the detailed feasibility studies, and will also help inform the next step on identification of suitable delivery models.</p>
4	<p><b>Identify suitable delivery model and financing route</b> The appropriate delivery and financing model will depend on a number of factors but the most significant will be the scale of financial investment and the allocation of risk. The alternative options should be appraised within the overall context of delivering the Council's key environmental and/or social objectives and targets.</p>
5	<p><b>Set up delivery and governance structures</b> The scope of this exercise will be dependent on the type of delivery model identified. Appropriate governance arrangements should be defined for the delivery entity that will set out the overall framework and processes for operation, management and decision-making.</p>
6	<p><b>Select delivery partners/ specialist contractors and agree terms</b> The scope of this exercise will again be dependent on the delivery model, which will determine the type of partners and/or range of specialist services required. The contractual arrangements will to a large extent determine the level of control that the local authority will have over tangible outcomes.</p>

## **Introduction, background and context to this study**



# 1 Introduction, background and context to this study

This study has been commissioned by Southwark Council to appraise the potential for district heating networks to provide low carbon heat for new and existing development in the Old Kent Road Opportunity Area.

## 1.1 The need for a decentralised energy study

The London Borough of Southwark, in collaboration with GLA, is preparing an Area Action Plan (AAP) for Old Kent Road (OKR) Opportunity Area (OA) that will provide the overall framework to manage growth in the area over the next 15 years and ensure that opportunities for sustainable growth are maximised.

This decentralised energy (DE) strategy, along with a suite of other documents being commissioned separately, is intended to be a key evidence base to underpin the development of

planning policies and project plans for the area. The primary aim of the study is to carry out a high-level feasibility assessment for ‘market-competitive’ district heating networks for the opportunity area and recommend preferred solution/s that can be taken forward.

## 1.2 Planning context for the OKR Opportunity Area

The Further Alterations to the London Plan, incorporated into the London Plan in March 2015, identifies Old Kent Road as a new Opportunity Area (OA) with significant potential for residential-led development. Following this, Southwark Council, together with the Greater London Authority is preparing a new plan for Old Kent Road and the surrounding area. The plan will identify the land uses, site density and capacities, and set out the design guidance and infrastructure requirements for the area.



Figure 5: Old Kent road AAP indicative area

The Area Action Plan (AAP) will form part of the statutory development plan and the council expects to publish a preferred options report in spring 2016. The AAP, once agreed, will be used to make decisions on planning applications in the OA. The plan will also be an Opportunity Area Planning Framework (OAPF) and will be endorsed by the Mayor of London.

In the meantime, the council and GLA are engaged in preparing evidence to support the plan and consulting with stakeholders.

The boundary for the OA is yet to be formally agreed, which will be done at the preferred option stage of the AAP. For the purpose of this study and other studies being prepared to inform the AAP, an indicative area has been identified by Southwark Council. This is shown in Figure 5 above.

### 1.3 Existing uses and heat densities in OKROA

The existing land-use pattern in the area is shown in Figure 6. This broadly falls into four broad categories:

- Large areas of low density residential
- Large patches of industry and warehousing
- Series of small retail parks; and
- Fragments of high street retail

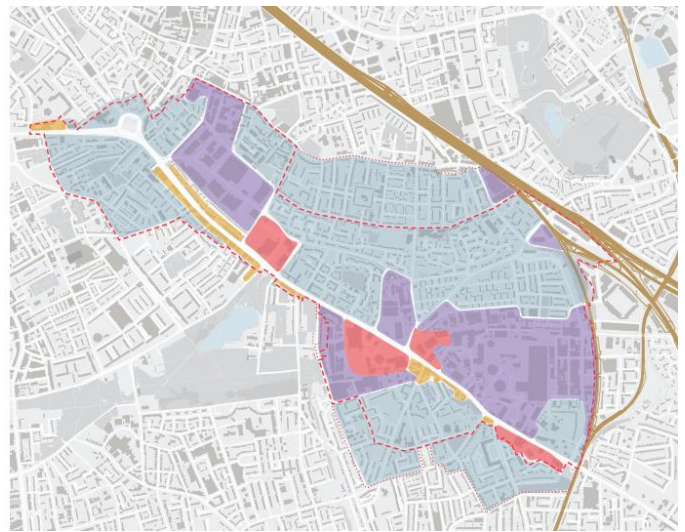


Figure 6: Schematic land use plan (Source: Old Kent Road Place-making Study, 2016)

As part of the Mayor's Decentralised Energy Master Planning (DEMaP) programme, Ramboll were commissioned in 2010 to collect heat data for priority buildings in the London Borough of Southwark. This information was used to update the London Heat Map<sup>7</sup> and to identify clusters of high heat demand in the borough which could be suitable for the implementation of a decentralised energy network.

<sup>7</sup> London Heat Map available at: <http://www.londonheatmap.org.uk>

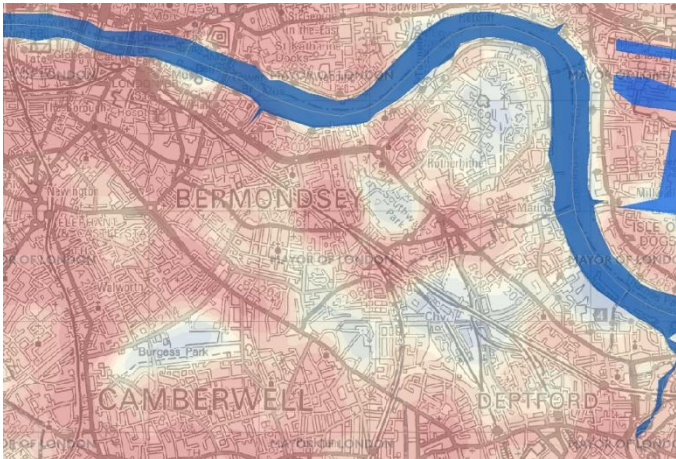


Figure 7: Extract from the London Heat Map showing the existing heat demands within the OKROA

An extract from the London Heat Map is shown in Figure 7. The heat demand densities in the OKROA reflect the existing land use pattern, with predominantly low demand density (blue to yellow colour tones) across the residential and industrial uses. The highest heat demands (orange to red colour tones) are located around Old Kent Road and towards the northern western edge of the OA.

Figure 8 shows the clusters of high heat demand identified in Southwark as part of the DEMaP study that could potentially be suited for DH networks. Given the existing heat densities, the area covered by the proposed OKROA was not considered suitable for DH in the DEMaP study. The expectation is that the OKROA will change this, resulting in substantial increases in heat density as new developments come forward.

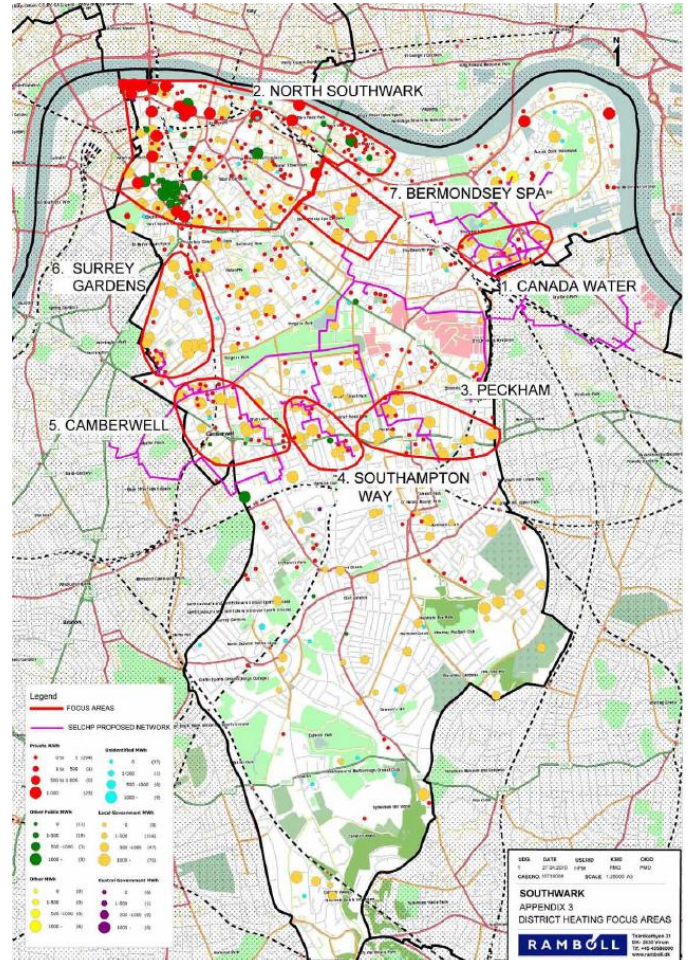


Figure 8: Map showing District Heating Focus Areas in Southwark (circled in red) suggested as part of the DEMaP study undertaken by Ramboll (2010)

### 1.4 Future growth and development scenarios

Southwark Council have commissioned a place-making study for the opportunity area that is identifying the framework for change, the principles that should guide intervention and the quantum of development that would be appropriate. As part of this study, an assessment and rigorous testing of development capacity has been carried out taking into account the emerging place-making principles.

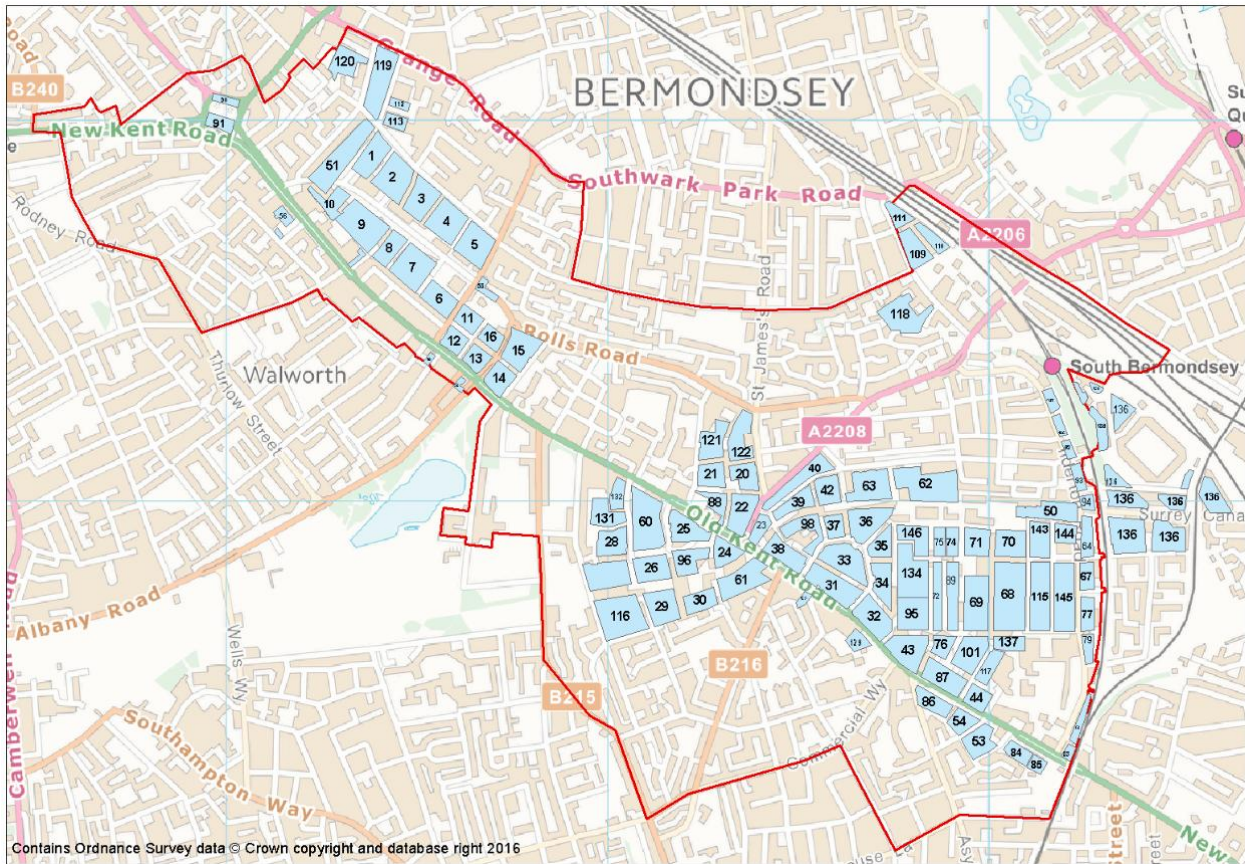


Figure 9: Map of development plots in OKROA

Three alternative development scenarios have been produced; a low development scenario (with no Bakerloo line extension), a medium scenario and a high scenario (both with the Bakerloo line extension). The development scenarios provide projected floorspace for residential, employment, retail, education and cultural uses along with indicative phasing of individual development plots for each five year period from 2015 onwards to 2036.

The high development scenario is the preferred option, and is used as the primary basis for the decentralised energy options analysis<sup>8</sup>. Figure 9 shows the development plots in the

<sup>8</sup> The likely impact of low and medium development scenarios on the viability of district heating networks has been assessed as a sensitivity analysis on the total projected heat demand in future years. See section 4.5.

opportunity area by land use. The indicative capacities of development plots under the high development scenario are set out in Appendix B.

## 1.5 Old Kent Road (and surroundings) in context

The following sections briefly discuss the key constraints within the OKROA which could impact on the technology options and ability to deliver decentralised energy infrastructure.

### 1.5.1 Air Quality

The map in Figure 10 shows the Air Quality Management Area (AQMA) declared in Southwark for both NO<sub>2</sub> and PM<sub>10</sub>, which extends across most of the borough. All of the OKROA falls within the AQMA.

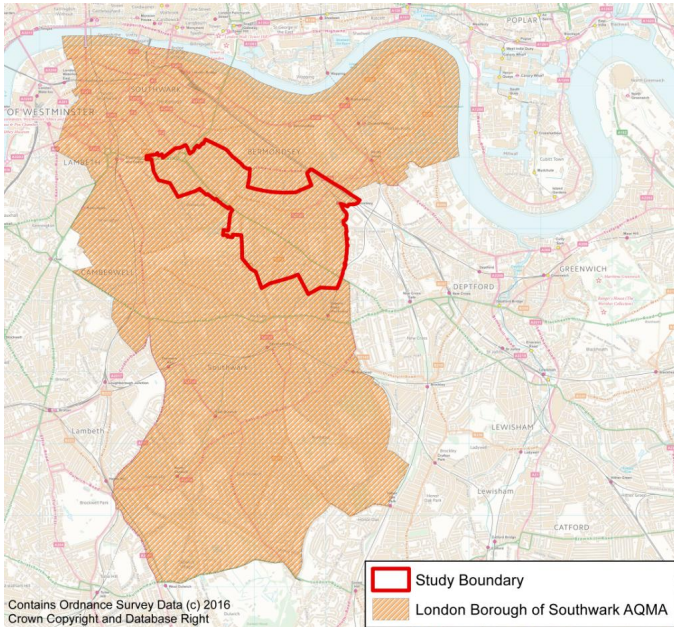


Figure 10 Map showing the extent of the AQMA declared for NO<sub>2</sub> and PM<sub>10</sub> in the London Borough of Southwark (DEFRA 2003)

This represents a potential constraint on the use of biomass. Combustion of biomass results in greater emissions of NO<sub>x</sub> and PM<sub>10</sub> compared to natural gas. Therefore, the use of biomass-based heating and CHP systems could potentially have a detrimental effect on air quality relative to gas-based systems. The problem is further aggravated by transport related emissions for delivery of fuel. This will be particularly important in areas where these pollutants are already at critical levels.

The Mayor’s Air Quality Strategy (December 2010) sets out a number of requirements and limitations on the use of biomass and CHP plant in AQMAs. Policy 7 states that the mayor will use his planning powers to ensure that new developments in London shall as a minimum be ‘air quality neutral’ through the adoption of best practice in the management and mitigation of emissions, and that increased exposure to existing poor air quality, particularly within AQMAs will be minimised.

The London Plan requires development proposals to minimise increased exposure to existing poor air quality and make provision to address local problems of air quality (particularly within AQMAs) and be at least ‘air quality neutral’. Air quality assessments are required for major developments that meet certain predefined criteria including those that are located within an AQMA, those that result in new air pollution exceedance or exacerbate an existing air pollution exceedance, and those that include biomass boilers or combined heat and power. Minimum emission standards are set for heating plant including solid biomass and CHP.

1.5.2 Flood Risk

Areas with high flood risk will have significant requirements for mitigation and adaptation measures which may impact upon the viability and delivery of local infrastructure.

Figure 11 shows that the majority of the OKROA is located in Flood Zone 3. This relates to the risk of flooding from the Thames. The flood risk is however mitigated by the Thames flood protection measures, and therefore is unlikely to be a key concern for the provision of decentralised energy infrastructure within the OA.

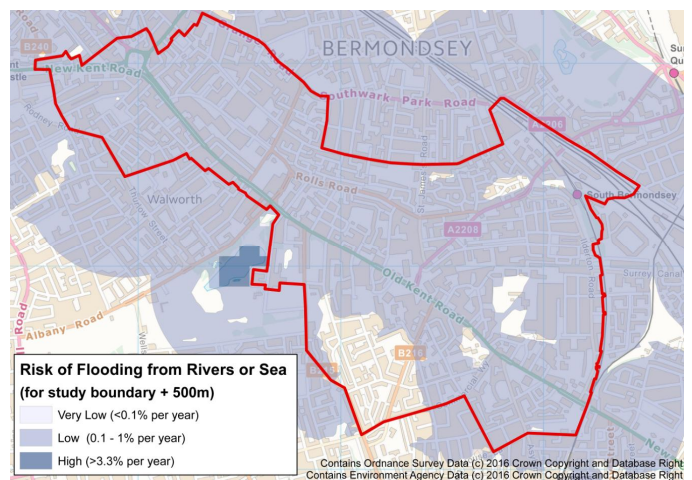


Figure 11: Map showing the extent of the flood risk in the area. (Source: Environment Agency website)

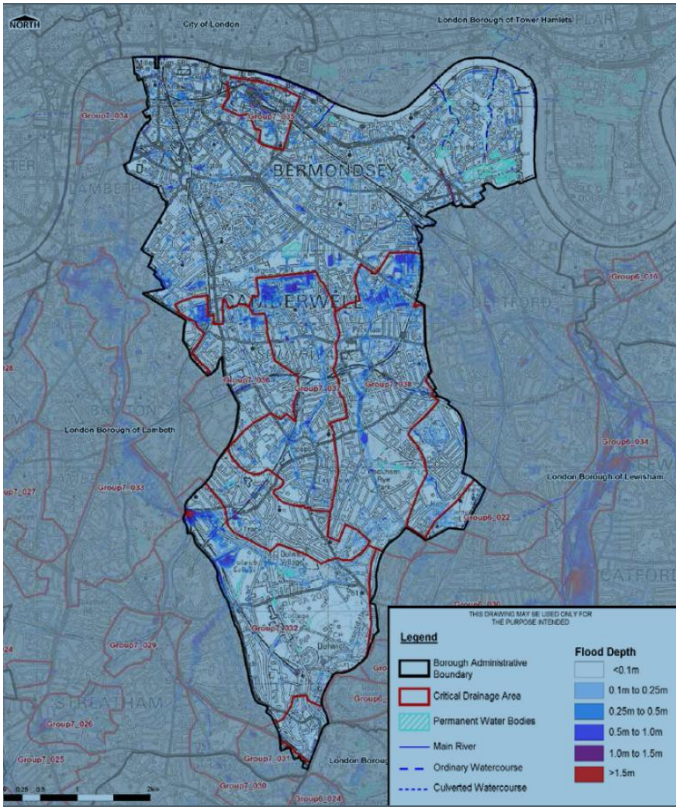


Figure 12: Critical Drainage Areas (CDAs) in Southwark (outlined in red)

Southwark’s Local Flood Risk Management Strategy (LFRMS, 2015) identifies Local Flood Risk Zones (LFRZs) and delineates those areas identified to be at more significant risk from surface water flooding into Critical Drainage Areas (CDAs), as shown in Figure 12. The LFRMS states that “...the most extensive areas of surface water flooding in the borough are located along the central belt of the borough north of the A202 (e.g. Camberwell and Old Kent Road).” The East Southwark CDA overlaps with the southern end of Old Kent Road, indicating that this is the part of the OA currently at most risk of surface water flooding. This will need to be taken into consideration when siting decentralised energy infrastructure.

1.5.3 Conservation Areas

Nearly all of the OA lies within an archaeological priority zone as shown in Figure 14. A number of conservation areas are also located south of Old Kent Road and at the north-western edge of the OA although their extent is fairly limited.

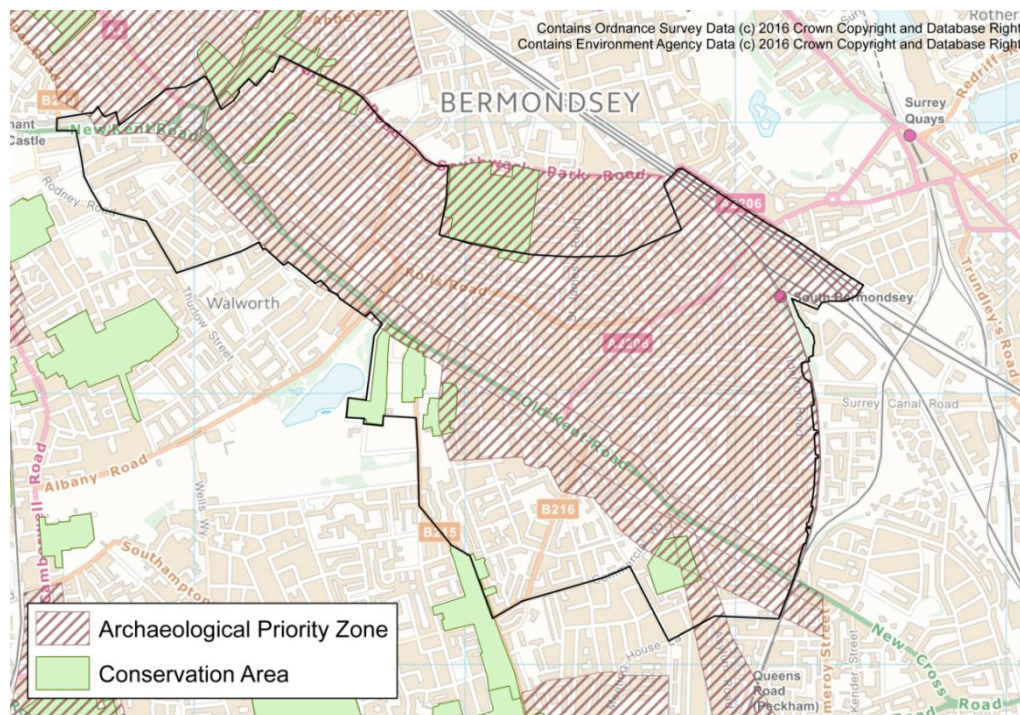


Figure 13: Conservation areas and archaeological priority zones in the OKROA

The archaeological priority zone could impact upon the deliverability of low carbon energy infrastructure within the OKROA and should be factored in as a potential risk.

#### 1.5.4 SELCHP Energy Recovery Facility

SELCHP is an advanced Energy Recovery Facility built through a partnership between Veolia, Lewisham Council, Royal Borough of Greenwich, and a number of other private sector companies. The facility is located in the London Borough of Lewisham outside the eastern edge of the indicative OKROA boundary.

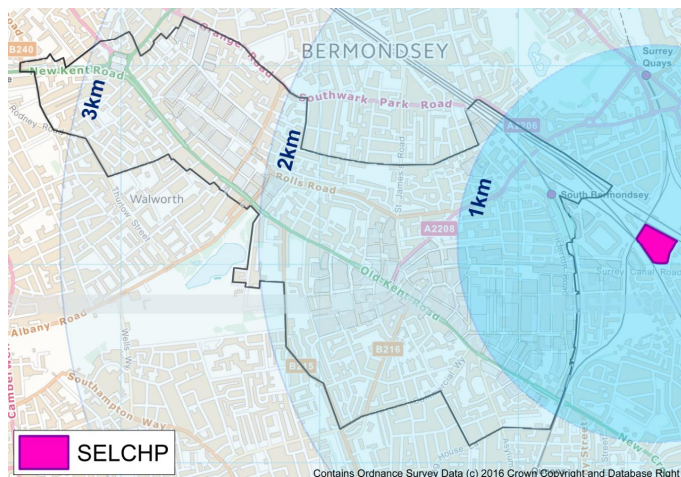


Figure 14: Map of OKROA and surroundings showing location of SELCHP

The facility is capable of handling up to 464,000 tonnes of household waste per year. This is incinerated and the heat used to produce steam that drives a 35MW steam turbine generator to produce electricity.

Plans are progressing to make use of the waste heat produced as part of the process, and the first 5km of heat network was installed in 2014 to supply 2,500 properties in Southwark with heat and hot water. A number of major new developments in the vicinity of the facility are also considering connecting to SELCHP for their heat supply, which limits the waste heat

capacity that may potentially be available for developments in the OKROA.

#### 1.6 Background to District Heating

District Heating (DH) networks supply heat via hot water through a network of insulated pipes, and are sometimes referred to as District Energy Networks since they can also involve the delivery of electricity and/or cooling across separate networks of pipes and wires.

The network of hot water pipes is linked to one or more energy centres, typically containing a combination of heat generating technologies. Heat from the network is transferred to a heat exchange substation at the plot or building level and then in turn to individual properties through a heat exchanger, or Heat Interface Unit (HIU), for use in a conventional wet heating system that can be controlled from within the property. Heat meters are used to measure the amount of energy that is taken from the network for billing purposes.

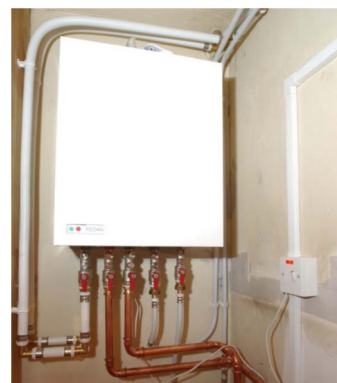


Figure 15: A heat exchanger inside one of the flats connected to the Aberdeen district heating network (Source: Aberdeen City Council: a case study of community heating CE65, Energy Saving Trust, 2003)

District heating networks can be applied at a variety of scales from a few buildings to whole cities. In the UK there are numerous examples of schemes across council-owned housing estates, university campuses, hospitals as well as area-wide schemes such as those in Birmingham,

Southampton, Pimlico, Sheffield and Nottingham. Even larger schemes exist outside the UK. For example, the Copenhagen district heating network is one of the world's largest and oldest, and now supplies 98% of the city's heating demand.

District heating generally helps to deliver energy more efficiently because the system can run at relatively constant levels, smoothing out the peaks and troughs in heat demands in individual buildings. Similarly the ability to consolidate heat supply, together with the ability to bulk buy fuel, means that district heating can often provide cheaper energy. The efficiencies are to some extent offset by heat losses across the distribution network, and the fuel cost savings partly offset by higher maintenance costs for the distribution network. To provide overall benefits to the end user there needs to be a significant focus on improving the overall efficiency of the network through the design, construction and operation. One way of achieving this would be to follow the Heat Networks Code of Practice, produced by The Chartered Institution of Buildings Services Engineers (CIBSE) and the Association for Decentralised Energy (ADE)<sup>9</sup>.

Reduction in CO<sub>2</sub> emissions can be achieved more easily with district heating schemes because of the ability to incorporate low or zero carbon technologies which are often not efficient or effective at smaller scales. It also enables strategic connection to low carbon sources of heat, such as waste heat from industrial and/or other sources, and provides flexibility to switch to more carbon efficient technologies in the future. For instance, the Copenhagen DH network referred to earlier has continued to evolve in recent years with phased introduction of low carbon technologies including biomass, waste heat from incinerators and multi-fuel CHP plants.

Most DH schemes in the UK use either gas-fired Combined Heat and Power (CHP) or biomass-fuelled boilers. However, there are other schemes that use waste heat from power

stations or incinerators (Nottingham), geothermal energy (Southampton) or innovative technologies such as fuel cell CHP (e.g. Woking).

The actual CO<sub>2</sub> and cost savings from using a DH network compared to individual systems are dependent on the type of system, the fuel used and the scale of energy generation. To maximise both the CO<sub>2</sub> reductions and cost savings the system needs to be efficient and designed to minimise the extent of the network (and thereby distribution losses) while delivering as much energy as possible. This therefore favours a location where the density of heat demand is high.

There are a number of ownership and management structures for the generation, distribution and supply of the heat. More information is provided in Section 5.

## 1.7 The benefits of district heating

District heating can potentially offer a number of environmental and financial benefits, which are briefly discussed below. The benefits will however vary depending on the generation technology (not only with regard to cost but also CO<sub>2</sub> savings and operational risks), the chosen delivery model for investment in DH infrastructure, as well as the timing of when connection to the DH system becomes available to individual plots.

### 1.7.1 Delivering reductions in CO<sub>2</sub> emissions

District heating systems can help realise reductions in CO<sub>2</sub> emissions compared to individual heating systems. As mentioned previously, the scale of the CO<sub>2</sub> savings will depend on a number of factors, primarily the technology used on the network and the systems that it replaces. For certain technologies (e.g. gas CHP), larger system sizes can offer better efficiencies, and therefore CO<sub>2</sub> savings, relative to a number of smaller systems.

For electricity generation and/or electricity consuming technologies, the savings will also be dependent on how the

<sup>9</sup> CIBSE/ADE CP1 Heat Networks: Code of Practice for the UK, 2015



carbon intensity of the electricity grid changes over time. The inherent flexibility of a district heating network allows additional technologies to be added, either as additional plant within the energy centre(s) or in new energy centres connected to the network in the future.

There are a number of policy drivers for both public and private sector organisations to mitigate CO<sub>2</sub> emissions from their own operations and/or from new developments. These are discussed in more detail in Section 2. In particular, where considered technically and financially viable, connection to district heating networks could currently provide developers with a more straightforward and potentially cheaper solution for meeting the increasingly stringent energy performance standards of the current (and forthcoming revisions) of the London Plan as well as higher standards of BREEAM and other environmental ratings. It is worth highlighting that inevitably there will be trade-offs between upfront savings for developers and energy savings/ costs for end consumers.

The CO<sub>2</sub> savings in this study are calculated using Marginal Emission Factor (MEF) for grid electricity, which represents the CO<sub>2</sub> intensity of the marginal unit of generation displaced by electricity generated locally (e.g. from gas-CHP). This is in line with guidance provided by the Department of Energy and Climate Change (DECC). It should however be recognised that these will differ from CO<sub>2</sub> savings calculated using the Standard Assessment Procedure (SAP) in Building Regulations which uses average grid carbon intensity figures for a 3-year projection. Also, if in future SAP is updated to reflect projected reductions in grid electricity emission factors, the calculated CO<sub>2</sub> emissions savings from heat delivered by certain technologies (such as gas CHP engines) may fall from their current level. The impact of this will be dependent on if and how future calculation methods for regulatory compliance are updated to reflect an increasingly dynamic electricity market (see Section 4.7 on future energy system).

### 1.7.2 *Reduced operational and management risks*

The district heating network operator would take most of the risks associated with the day-to-day operation and management of plant away from the end user/manager of the building, with the costs for this service typically being recovered from the end consumer via service charge. Schemes are usually designed with full back-up plant. The resilience is further enhanced with additional energy generation systems being added to the network as it expands.

A decentralised energy system can also potentially provide greater security over both the price and supply of energy. The increased buying power of an ESCo purchasing energy for multiple customers affords better protection against price fluctuations in the marketplace. An ESCo should also be better placed to get better deals on energy prices. It should, however, be recognised that after sudden reductions in energy prices there may be a delay before these are passed onto consumers, for example, where consumer heat prices are adjusted on an annual basis.

The flexibility of a decentralised energy network enables additional and different energy generating technologies to be added and the proportion of heat delivered by each to be varied. This offers the potential to alternate between different fuels, such as gas, off-peak electricity or biomass (though air quality concerns may rule out the latter in the OKROA), to get the best fuel prices and financial returns as prices and financial incentives change over time.

In a similar vein, the flexibility of the system and the ability to switch between fuels can provide an element of security of supply going forward.

### 1.7.3 *Delivering practical benefits*

District heating systems can offer a number of practical benefits to buildings that are connected. By offsetting the need for plot-level / building-level plant rooms they can potentially free up space (assuming all top-up and back-up generation is

located in the DH energy centre), thereby increasing the potential lettable/usable floorspace. This would also negate the need for exhaust flues at individual building and/or plot level. The level of benefit will vary depending on the level and degree of resilience desired on site, which means that some developers may still opt to have plot-level back-up generation plant. Also, depending on the timing of when connection of the DH system becomes available, individual plots may still require temporary plant on site.

### 1.8 Outputs and objectives of the study

The outputs of this study are as follows:

- a) Set out an area-based strategy for developing district heating networks in the OKROA.
- b) Identify key 'anchor' sites/ loads with significant heat demand (including both current and planned development), either in or immediate vicinity of the opportunity area.
- c) Appraise the suitability of alternative low carbon heat generation technologies, and in particular the viability to use waste heat from SELCHP.
- d) Set out the potential phasing of a network taking account of growth areas.
- e) Provide indicative capital costs for delivery for both initial and subsequent phases.
- f) Outline delivery options available to the Council taking into account technical, financial and legal considerations.

These outputs have three major objectives:

1. Enable Southwark Council and other stakeholders to recognise the potential for district heating networks to provide low carbon heat for new and existing development in the area.

2. Provide an evidence base for related planning policy and project plans within the AAP, subject to investment in decentralised energy infrastructure being considered viable.
3. Identify the basis for a heat network project that can be investigated in further detail.

### 1.9 Structure of the report

The remainder of the report is structured as follows:

Chapter 2 covers the policy context to the study, providing a summary of the key national, regional and local policy drivers.

Chapter 3 provides an assessment of the suitability of the various heat supply technology options taking into account local opportunities and constraints, technical performance, likely CO<sub>2</sub> savings and potential risks.

Chapter 4 provides details of the work undertaken to assess the potential to deliver a district heating network in the OKROA, and summarises the results of the technical and financial viability assessment.

Chapter 5 outlines the delivery options and strategic actions required to implement the decentralised energy strategy.

The appendices contain details of the input data and assumptions that underpin the analysis, a risk register that outlines the key technical, financial and environmental risks associated with delivery of district heating networks in OKROA, and other background data.

## Policy Context

## 2 Policy Context

This chapter sets out the key national, regional and local policies relating to energy use and CO<sub>2</sub> emissions that are relevant to the development of decentralised energy networks in the OKROA.

### 2.1 National Policy

The key national policies that encourage use of low carbon technologies and decentralised energy networks are summarised below:

- **Climate Change Act (2008)** sets a legally binding target to reduce UK carbon dioxide (CO<sub>2</sub>) emissions by at least 80% by 2050. To deliver this act, the first four carbon budgets, leading to 2027, have been set in law. These require a 35% reduction by 2020 and a 50% reduction by 2025 over 1990 levels.
- **Energy Act (2013)** updates energy legislation to reform the electricity market, encourage low carbon electricity generation and in turn ensure security of supply.
- **UK Renewable Energy Strategy (2009)** describes how the UK will meet its legally binding target to supply 15% of all of the energy it uses from renewable sources by 2020. This target is anticipated to be achieved by using renewable energy technologies to supply over 30% of electricity, 12% of the heat and 10% of energy for transport.
- **UK Renewable Energy Roadmap (2011)** sets out a targeted programme of action that Government is taking to increase renewables deployment.
- **Feed In Tariff** was launched in April 2010 and provides a financial incentive for the uptake for small scale renewable electricity generating technologies. More details are provided in Appendix F.
- **Renewable Heat Incentive** was launched in July 2011 and provides a financial incentive for the uptake of renewable heat generating technologies. More details are provided in Appendix F.
- **Contracts for Difference (CfD)** mechanism was introduced in 2014 as part of the Government's Electricity Market Reform programme to provide a financial incentive for new investment in all forms of low-carbon generation. Under CfD, generators receive a variable top-up from the market price to a pre-agreed 'strike price'. The strike price for each contract is determined via a competitive auction process.

### 2.2 Building Regulations

The Building Regulations set the minimum standards for building performance and must be met for a building to be approved for construction. Part L of the Building Regulations focuses on the conservation of heat and power and sets specific requirements for the fabric performance, building services efficiency, overheating and the CO<sub>2</sub> emissions.

The 2013 edition of Part L, which is the current version, introduced a Target Fabric Energy Efficiency standard (TFEE) that sets the minimum energy performance for new dwellings expressed in terms of energy demand (for heating and cooling) per unit floor area per annum. The implication of this is that heating demands in new dwellings have been further reduced making higher levels of density even more important when assessing the viability of heat networks for new development.

In July 2015, the government announced its decision to postpone the proposed 2016 update to Part L of the Building Regulations. Therefore there is considerable uncertainty around the timing for future revision/s to Part L and the expected trajectory for further tightening of energy and carbon performance standards.

**2.3 Regional Policy**

**• London Climate Change Mitigation and Energy Strategy (2011)**

The policy document sets out the following targets for the reduction in CO<sub>2</sub> emissions in London.

Target year	Target CO <sub>2</sub> emissions reduction on 1990 levels
2015 (interim target)	20%
2020 (interim target)	40%
2025	60%
2050	At least 80%

Additionally, the Mayor has set a target to supply 25% of London’s energy from secure, low carbon local sources. The decentralised energy programme, one of the key activities planned to deliver against these targets, aims to support the commercialisation of large-scale decentralised energy projects that can heat and power London’s existing and new buildings more carbon-efficiently.

**• The London Plan (2015) (Consolidated with Minor Alterations since 2011)**

The London Plan is the overall strategic plan for London. The key policies relating to building energy consumption and CO<sub>2</sub> emissions are outlined below:

- **Policy 5.1 – Climate Change Mitigation:** Sets a target for a 60% reduction in CO<sub>2</sub> emissions (on 1990 levels) by 2025.
- **Policy 5.2 – Minimising CO<sub>2</sub> emissions:** Requires all developments to contribute to reducing CO<sub>2</sub> emissions by meeting the energy hierarchy: use less (by

incorporating passive design and energy efficiency measure); supply efficiently (through the use of combined heat and power systems and/or connection to district heating systems); and use renewable energy sources (by incorporating low and zero carbon energy technologies). The targets are expressed as percentage improvement over building regulations as set out in the table below.

Improvement on Building Regulations Part L 2010		
	Domestic	Non-domestic
2010	25%	25%
2013	40%	40%
2016	Zero Carbon	As building regulations
2019		Zero Carbon

Minor alterations to the London Plan (MALP) 2015 have been prepared in response to the housing standards review and are expected to be published (adopted) in late March 2016. The CO<sub>2</sub> targets in the MALP remain unchanged though they will be set relative to the 2013 Building Regulations baseline. In light of the government’s decision to postpone the proposed 2016 update to Part L of the Building Regulations, the CO<sub>2</sub> reduction targets outlined under Policy 5.2 may be revised in future reviews of the London Plan.

- **Policy 5.4 – Retrofitting:** Requires the environmental impact of existing buildings to be addressed through policies and programmes.
- **Policy 5.5 – Decentralised Energy Networks:** Requires local authorities to identify opportunities to implement large scale district heating networks in their areas.

- **Policy 5.6 – Decentralised Energy in Developments:** Requires developments to implement systems that are compatible with the roll out of large scale district heating systems by incorporating communal or district heating networks on development sites, where appropriate, and using combined heat and power systems.
- **Policy 5.7 – Renewable Energy:** Includes targets for the generation of heat and power from renewable energy sources. Section 5.42 of the supporting text states that: “There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20% through the use of on-site renewable energy generation wherever feasible”.

- **Sustainable Design and Construction SPG (April 2014)**

The Sustainable Design and Construction SPG (Supplementary Planning Guidance) provides guidance on minimum and best practice sustainable design and construction practices that will help London meet its sustainability aspirations. This document does not set new policy, but explains how policies in the London Plan should be carried through into action. It is also intended to assist boroughs when preparing their Local Plans and will be a material planning consideration when determining planning applications.

- **The Mayor’s Air Quality Strategy (December 2010)**

The strategy sets out a framework for improving London’s air quality and outlines measures aimed at reducing emissions from transport, homes, offices and new developments. In particular it set out proposals to work with boroughs to make better use of the planning process so that new developments are ‘air quality neutral or better’. The proposed package of policy measures include, among others, introducing emission

standards for new biomass boilers and combined heat and power systems.

## 2.4 Regional Initiatives

- **Decentralised Energy Project Delivery Unit (DEPDU)**

The Greater London Authority (GLA) set up a dedicated Decentralised Energy (DE) Project Delivery Unit (PDU), with funding from European Investment Bank’s ELENA (European Local Energy Assistance), to provide technical, commercial and commercial advisory support to develop DE projects. To date, support has been provided to over 40 projects over the 4-year programme with 10 projects progressing to procurement and delivery stage to date, and many more in the pipeline.

DEPDU is to be followed by a successor programme, Energy for London (EfL) subject to ERDF (European Regional Development Fund) match funding.

## 2.5 Local Policy

- **Southwark Core Strategy (2011)**

The Council adopted the Core Strategy in April 2011. This sets out the approach for new development and strategic policies in the borough, covering the period up to 2026.

The key policy promoting low carbon development is Strategic Policy 13: High Environmental Standards. It sets out an energy hierarchy as indicated in the Figure 16, which prioritises energy efficiency measures, followed by energy efficient supply infrastructure and renewable energy technologies. The policy sets out the following requirements:

### Strategic Policy 13 – High environmental standards

1. New development to meet the highest possible environmental standards
2. All new development to be designed and built to minimise greenhouse gas emissions across its lifetime, including

- Designing all developments so that they require as little energy as possible to build and use.
  - Expecting all major developments to set up and/or connect to local energy generation networks where possible.
  - Requiring developments to use low and zero carbon sources of energy.
3. Enabling existing buildings to become more energy efficient and make use of low and zero carbon sources of energy.

*“We will work with energy service providers and developers to deliver further possible networks, such as at Canada Water, Aylesbury and Peckham. These networks will allow new and existing buildings to make large savings of CO<sub>2</sub> emissions in the most cost effective way”*

The map shown in Figure 17, reproduced from the Core Strategy, indicates the locations within the borough that are considered to have the potential for district energy schemes.

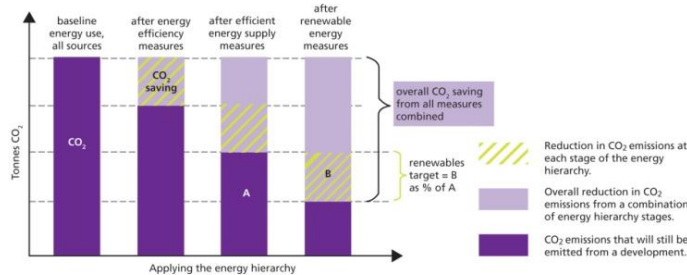


Figure 16: Approach to Meeting energy targets (Figure 35 from the Core Strategy p.115)

The policy includes the following targets (which it states will be “updated to reflect changes in national, regional and local policy”):

- Major development should achieve a 44% saving in carbon dioxide emissions above the building regulations from energy efficiency, efficient energy supply and renewable energy generation.
- Major development must achieve a reduction in carbon dioxide of 20% from using on-site or local low and zero carbon sources of energy.

In regards to district heating, the Core Strategy refers to the local energy network being created at Elephant & Castle and states that:

• **The New Southwark Plan**

Southwark Council is reviewing the Core Strategy and the Southwark Plan to prepare a new local plan. This will set out the regeneration strategy from 2017 -2033 and will also be used to make decisions on planning applications. The preparation of the New Southwark Plan has now reached the ‘Preferred Option’ stage.

Policy DM56 of the New Southwark Plan refers to the Mayor’s energy hierarchy as a means to demonstrate compliance with CO<sub>2</sub> reduction targets. It requires major developments to connect to existing or planned decentralised energy networks. Where connection to an existing or planned network is demonstrated not to be feasible, it requires major development to prioritise use of a site-wide combined heat and power (CHP) communal heating system. Additionally, the policy requires major developments to evaluate and enact, where feasible, the opportunity to oversize the CHP system and extend the network to supply nearby buildings beyond the site boundary.

• **Southwark Sustainable Design and Construction SPD (2009)**

The Sustainable Design and Construction SPD sets out the minimum and preferred standards for all new development against a range of sustainability criteria. The energy and climate change related minimum standards are:

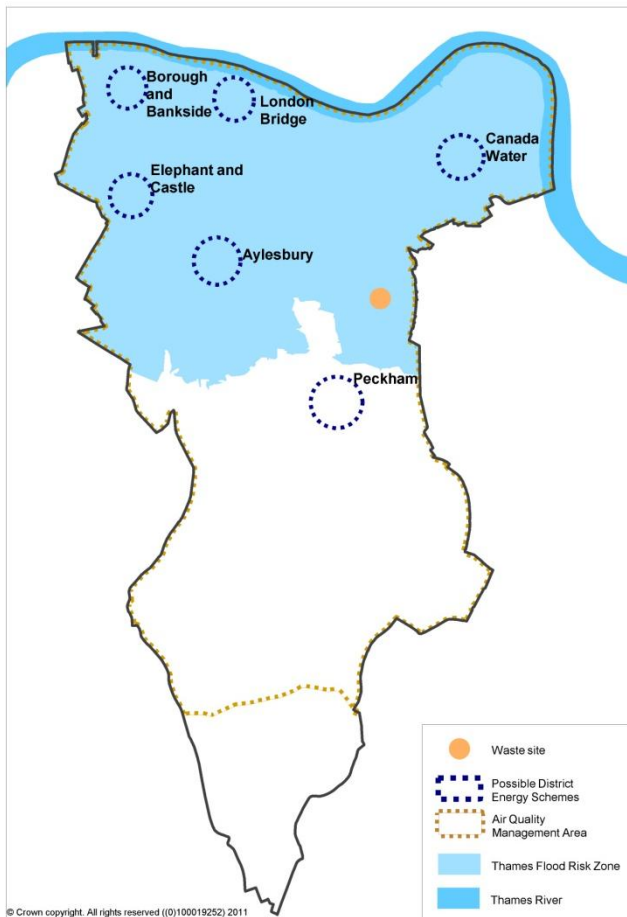


Figure 17: Location of potential district energy schemes (Figure 28 from the Core Strategy p.109)

- 25% improvement over Building Regulations (although this is now superseded by targets outlined in the Core Strategy);
- An assessment of energy use and CO<sub>2</sub> emissions and evidence of the application of the energy hierarchy;
- Connect to CHP/CCHP where possible;
- 20% reduction in CO<sub>2</sub> emissions from the use of renewable energy;
- Offset, where targets cannot be met, by payment for other energy saving projects in Southwark.

In addition a set of preferred standards are set out, which include:

- Exceed 20% target for renewables;
- Energy systems to be provided with the capacity for future expansion for other developments to connect at a later date.

#### • Southwark Climate Change Strategy (2006)

The Climate Change Strategy looks at ways in which Southwark Council can address the impact of climate change and achieve the ambition of reducing CO<sub>2</sub> emissions by 80% by 2050. The report recommends a number of possible policies and projects that could be taken forward, including the creation of district heating networks and improving the energy efficiency of existing buildings.

#### • Southwark Energy and Carbon Reduction Strategy (2011)

This policy document sets out interim targets for reduction of CO<sub>2</sub> emissions from both the council estate and across the borough, which include a:

- 26.6% reduction in CO<sub>2</sub> emissions from council estate and schools by 2016 relative to a 2009 baseline;
- 15% reduction in emissions from council housing by 2022 relative to 2005 baseline; and
- 22.4% reduction in borough-wide emissions by 2020 relative to 2003 baseline.

The strategy additionally recommends that the Council work with the GLA to identify and develop district heating networks in the borough.

#### • Old Kent Road Area Action plan

Area Action Plans (AAPs) form part of the development plan and set out planning policies, masterplans and/or maps to show how places will be regenerated and what planning



applications in the area will need to deliver. Southwark Council, in partnership with GLA, is preparing a new plan for the Old Kent Road and surrounding area. The plan will guide and manage new development and growth in the area over the next 15 years. The plan will also be an Opportunity Area Planning Framework (OAPF) and will be endorsed by the Mayor of London.

The AAP will be prepared in stages. Consultation on the preferred option version is planned to start in May 2016. The outcomes of consultation will inform the submission version of the AAP, which is intended to be prepared for consultation in late 2016.

**‘Low and Zero Carbon’  
energy supply  
technologies**

### 3 'Low and Zero Carbon' energy supply technologies

A number of Low and Zero Carbon (LZC) heat supply technologies may be considered as part of a decentralised energy strategy for the OKROA. This section discusses the suitability of the different technology options taking into account local opportunities and constraints, technical performance, likely CO<sub>2</sub> savings and potential risks.

The findings from the technology options appraisal are summarised in Section 3.7.5 at the end of this chapter.

#### 3.1 Opportunities for the use of LZC technologies

A range of LZC technologies can be deployed at the community scale with heat networks linking energy generation technologies to multiple buildings within the opportunity area.

The following technologies are discussed in this chapter and their applicability for providing low carbon heat to new and existing buildings within the OKROA is assessed.

- Gas -fired Combined Heat and Power (CHP)
- Fuel cell CHP
- Biomass heating
- Biomass CHP
- Heat Pumps linked to a range of potential secondary heat sources
- Energy from Waste

#### 3.2 Gas- fired Combined Heat and Power (CHP)

CHP systems running on gas are an efficient way to deliver both heat and power at the point of use. They are normally classified as a 'low carbon technology' rather than a 'renewable technology' because they use fossil fuels.

Gas is used to generate electricity but the heat from the process is also captured to generate hot water that can be

used for space heating and domestic hot water use. Electricity that is produced and used locally is typically much more energy and carbon efficient than electricity supplied from power stations, which do not normally utilise the waste heat generated and have high losses associated with transmission of power over the national grid.

Generating electricity and heat from a standard, gas-fired CHP typically achieves a 30% reduction in energy usage compared with electricity from conventional power stations and heat from individual gas boilers based on current grid carbon intensity. The following diagram demonstrates the energy benefits of CHP:

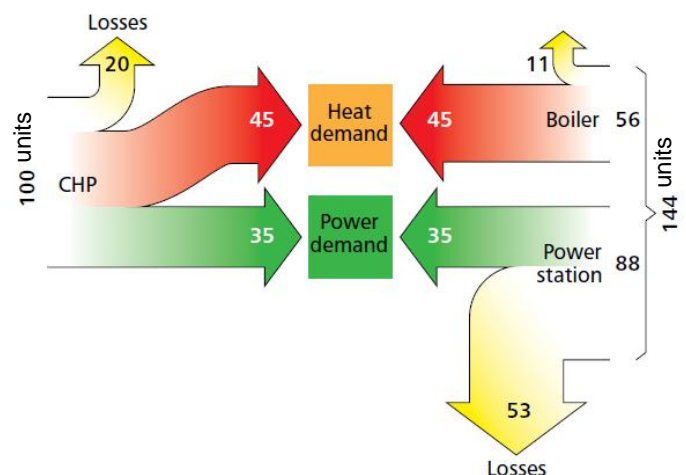


Figure 18: The efficiency benefits of CHP over conventional power generation and gas boilers (Source: CIBSE AM1210)

The electrical efficiency<sup>11</sup> of gas-engine CHP varies with the size and type of system. At the smaller scale (in the low 100s of kW), the electrical efficiency may be circa 30%, but it can approach 40% for larger engines (typically greater than 5MW).

With CHP systems, the CO<sub>2</sub> savings and financial benefits are primarily derived from the production of electricity. However,

<sup>10</sup> Combined Heat and Power for Buildings, CIBSE AM12 (2012)

<sup>11</sup> This is the efficiency of conversion of the energy in the fuel gas into useful power.

the production of electricity is linked to the production of heat and the limiting factor for most systems will be the level of heat demand on the network.

CHP systems can adjust their output to follow the heat demand, but it is preferable for them to operate against a relatively stable demand. This is achieved by both sizing the CHP correctly and ensuring it has a sufficient base heat load to operate. In the case of district heating networks, the mix of uses and varying energy demand profiles across a range of buildings combine to create a good base heat load for system operation, making gas-CHP a viable technology option. Ideally a system would have at least 4,500 run hours per year for a reasonable return on investment. Additional ways of using heat (such as absorptive cooling) and ways of storing the heat (using thermal storage vessels) can all help to increase and stabilise the heat demand thus increasing the electricity generation and therefore the CO<sub>2</sub> savings and financial benefits.

Savings from gas-CHP systems are further enhanced by the ability to bulk buy fuel, although there are additional costs for management, operation and billing which offset a proportion of these savings.

Another contributory factor to the economic viability of CHP is the difference between the cost of electricity and gas, referred to as the “spark gap”. The greater the cost of electricity over gas is, the more likely a CHP installation is to be viable.

It is worth noting that the CO<sub>2</sub> benefits of gas-fired CHP will reduce over time if, as the Government is proposing, the CO<sub>2</sub> emissions associated with grid electricity fall. The Department for Energy and Climate Change (DECC) have set out the projected emissions from different fuel sources including electricity from the national grid up to 2050<sup>12</sup>. This shows a substantial drop in the predicted CO<sub>2</sub> emissions from grid

<sup>12</sup> Valuation of energy use and greenhouse gas emissions for appraisal and evaluation (DECC, June 2010)

electricity over the next 40 years, as power generation changes to cleaner and greener forms of electricity generation.

DECC also provide guidance on the type of electricity generation that would be displaced if additional gas CHP was brought forward, and the resulting time series for the average carbon intensity of electricity displaced by gas CHP<sup>13</sup>. Figure 19 shows that the emissions factor for displaced electricity is forecasted to be approximately 350-400 g/kWh from 2012 through to 2025, reducing to 250-300 g/kWh from the late 2020s onwards as the penetration of low-carbon technologies increases.

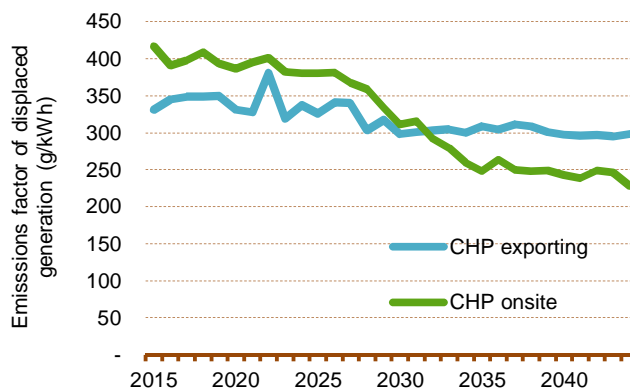


Figure 19 Graph showing the marginal emissions factor<sup>14</sup> for electricity displaced by gas CHP (g/kWh) (DECC, 2014)

CHP systems also typically have higher NO<sub>x</sub> emissions than individual gas boilers. Emissions are capable of being reduced through the ‘lean burn process’ and post combustion treatments such as catalytic and non-catalytic converters, although their applicability varies according to the engine technology and size. Typically larger system sizes are able to incorporate abatement technologies much more cost effectively, although the cost for abatement technologies will

<sup>13</sup> Modelling the impacts of additional Gas CHP capacity in the GB electricity market (LCP, Dec 2014)

<sup>14</sup> The Marginal Emission Factor (MEF) represents the CO<sub>2</sub> intensity of the marginal unit of generation displaced by additional gas CHP generation. The graph shows separate MEFs for CHP generation supplying on-site power demand and where exporting to the grid.

also vary depending on the local context (such as background pollution levels and distance to sensitive receptors).

The potential advantages and disadvantages of gas CHP systems are summarised below.

#### Advantages:

- mature technology with reliable, working applications throughout the world including in the UK
- scale of the technology allows for a phased modular build-out, which means the installation can be optimised to incrementally meet the needs of the different development phases
- although a fossil fuel based technology, it is expected to continue to offer CO<sub>2</sub> savings for at least the life of the first installed engines

#### Risks and disadvantages:

- relies on a finite fossil fuel resource (gas) and therefore not the long term energy solution

### 3.3 Fuel cell CHP

A fuel cell is an electrochemical device that converts the chemical energy contained in fuels, such as natural gas or hydrogen, into electrical energy and heat. It is typically composed of a fuel electrode (anode) and an oxidant electrode (cathode) separated by an ion-conducting membrane. Oxygen passes over one electrode and hydrogen over the other, generating electricity, water and heat.

There are five main types of fuel cell classified by the electrolyte used in the cells. Three of these five types, the Phosphoric Acid Fuel Cell PAFC (150-200°C), the Molten Carbonate Fuel Cell MCFC (600-700°C), and the Solid Oxide Fuel Cell SOFC (700-1000°C) are suitable for district heating applications due to their operating temperature range.

As there is no combustion, the pollutants arising from fuel cells are relatively low compared with a gas-engine or gas turbine. Fuel cells can operate continuously as long as the necessary

reactant and oxidant flows are maintained. High temperature systems cannot modulate and therefore need a constant baseload heat demand.

Fuel cell CHP systems may offer wider benefits when combined with a hydrogen system. Where excess renewable electricity is used to generate and store energy in the form of hydrogen fuel, this can help with addressing some of the intermittency issues with renewable electricity generation technologies. Hydrogen fuel can also be used as flexible energy storage to manage peaks or as inter-seasonal storage.

Although fuel cells are commercially available, they are generally considered to be an immature technology and significantly more expensive than conventional gas CHP engine alternatives. In general at present, the efficiency advantages of fuel cells do not justify the additional costs over gas engine CHP. If the cost of fuel cells reduces significantly, then they may become more viable in the future, although due to the expected reduction in the CO<sub>2</sub> intensity of the electricity grid, this maturity may not happen in a timeframe which allows natural gas fuel cells to remain effective at saving CO<sub>2</sub> emissions.

### 3.4 Biomass heating

Biomass heating is based on the use of a boiler just as standard heating technologies; however it uses wood fuel instead of fossil fuel as the source of energy. Wood fuel comes in a number of different forms, each with different characteristics. Chips can be obtained from arboriculture waste or other wood waste streams and are often cheap and locally available but can often be of variable size, shape and moisture content. This can affect the efficiency of the heat produced. Pellets made from compressed saw dust usually have much lower moisture contents and higher calorific value than chips but tend to have higher processing and transportation requirements. Logs can also be used but are very rarely used

for systems larger than stoves serving individual domestic dwellings.

Wood fuels have a CO<sub>2</sub> emission factor ranging from 0.016 - 0.039kgCO<sub>2</sub>/kWh depending on the type of fuel<sup>15</sup>. The use of biomass can therefore result in considerable CO<sub>2</sub> savings relative to gas as a fuel. Fuel costs can often be higher than for a gas system depending on the type of biomass fuel used, although this can be partially offset through Renewable Heat Incentive (RHI) payments. It is however worth noting that there is considerable policy uncertainty around the medium to long term availability of RHI payments.

There is also significant risk associated with future availability and cost of fuel, whilst also ensuring sustainability of fuel source. The price that energy schemes will pay for biomass fuel in the future is dependent on demand, which is predicted to continue to grow in the medium to long term as existing policies are made stringent and new policies are introduced to deliver against national medium to long term CO<sub>2</sub> reduction targets. A report published by the Forestry Commission (2010) indicates that even sources of waste food are increasingly becoming exhausted. By 2017 potential demand for recovered (waste) wood is forecast to be almost 36% greater than potential availability, resulting in UK becoming a net importer of biomass fuel<sup>16</sup>. Imported biomass may have low embodied carbon content due to the relative efficiency of transportation by ship. However, once the biomass begins to be transported inland the embodied carbon can increase considerably. In addition there are questions about the long term sustainability of imported biomass owing to concerns around deforestation, loss of habitat and/or diverting resources away from food production.

Biomass boilers come in a variety of capacities (rated in kW). The main difference between biomass boilers and conventional

gas boilers is their considerably larger physical size and thermal inertia. Because of this they are normally designed to meet the base heat load for space and hot water with gas back-up to cover the peak loads.

The use of biomass can have air quality implications due to higher nitrogen oxides (NO<sub>x</sub>) and particulate matter (PM<sub>10</sub>) in flue gases compared to conventional gas boilers. This is another key consideration, in particular as all of the OKROA falls within an Air Quality Management Area (AQMA).

The Mayor's Air Quality Strategy (Dec 2010) and the London Plan 2015 set out a number of requirements and limitations on the use of biomass in areas with an AQMA. These require development proposals to minimise increased exposure to existing poor air quality and make provision to address local problems of air quality (particularly within AQMAs) and be at least 'air quality neutral' through the adoption of best practice in the management and mitigation of emissions.

The use of biomass fuels is therefore subject to a screening assessment and dispersion modelling to demonstrate that detrimental impacts on local receptors are within acceptable limits. Research has shown that biomass boilers can be effectively fitted with abatement equipment (such as ceramic or fabric filters) for PM, though for smaller biomass boilers, the cost of retrofitting can be as high as 30 per cent of the installation costs. At present there is no viable abatement equipment to reduce NO<sub>x</sub> emissions from all but the larger biomass boilers, and none for the scale of biomass boilers that typically get proposed in inner city/ urban locations<sup>17</sup>.

The significant space requirement for plant and fuel storage is another key consideration with biomass fuelled systems. Access is needed for fuel delivery. A significant fuel demand will inevitably require regular HGV deliveries, with impacts on traffic congestion, noise and air quality nearby.

<sup>15</sup> Based on carbon factors published in Building Regulations 2013

<sup>16</sup> Wood Fibre Availability and Demand in Britain 2007 to 2025, John Clegg Consulting Ltd, 2010

<sup>17</sup> Mayor's Air Quality Strategy, Dec 2010, Section 4.7.4

**Potential advantages:**

- established and mature technology, with widespread use both in the UK and Europe
- can provide large CO<sub>2</sub> reductions through the provision of low carbon heat for space heating and hot water
- renewable technology that can potentially form part of a long-term energy strategy for the site, though this is subject to sustainable fuel source being available locally

**Potential risks and disadvantages:**

- impact on local air quality, particularly in case of AQMAs
- fuel supply is a considerable risk with uncertainties as to the future availability and cost, in particular, sustainably sourced fuel
- space needed for fuel storage and access for delivery vehicles is a potential downside; this would be a particular concern with multiple energy centres on site or with fuels having low calorific value
- biomass heating not an efficient use of finite biomass resource, and provides lower CO<sub>2</sub> savings compared to using the fuel in an alternative technology such as biomass CHP

**3.5 Biomass CHP**

The term “biomass CHP” covers an array of technologies and processes which may be used to convert biomass or biofuel to renewable heat and power. These primarily fall into two types:

**Steam turbine systems:** The fuel is combusted to generate steam and drive a turbine that in turn operates a generator. In general, larger biomass CHP schemes are based on steam turbine electricity generation. In a system designed for CHP operation, heat can be extracted with a small loss in electrical efficiency and used in the DH network. Biomass steam turbine CHP systems generally have a relatively low electrical efficiency of between 15% and 28%, with smaller systems typically at the lower end of that scale. At a larger-scale, typically over 10MWe, the steam turbine technology and biomass combustion processes are well understood and

commercially mature. These are usually fuelled by straw, forest residues (e.g. wood-chips), or waste wood (which is usually classed as a waste product and therefore is required to comply with the Waste Incineration Directive). Smaller turbine systems are also currently being developed in the sub MWe range. These are based on a hot air process, where biomass combustion is used to drive high pressure air through a turbine or an alternative two-phase fluid for use in the Organic Rankine cycle.

**Gasification systems:** The biomass fuel is gasified and then burnt in a gas CHP system. The efficiency of the gasification process is typically around 80% or less due to heat used in the process. The syngas produced in the process is scrubbed using a number of procedures before being combusted in the modified gas engine. This scrubbing process is one area where development is still required to ensure that the engine is fed with a suitably high quality of gas to prevent tars and other residues being fed into the engine. Gasification technology brings higher electrical efficiencies compared to steam based systems, although gas engines designed to operate on syngas (or biogas) have a slightly lower electrical efficiency than natural gas engines, typically around 30%. Combined with the gasification losses, the overall efficiency of gasification systems can be much lower than for a natural gas equivalent engine.

Biomass gasification has been trialled at a number of sites in the UK for smaller scale CHP (in the low 100s of kW). In the UK, there have been some instances of poor performance, with a number of installations experiencing problems with operation, and it is generally considered that the technology is pre-commercial and immature. In Europe there are wood gasifiers of less than 1 MW capacity that have been running successfully for some years, and it is expected this technology would start to become more widely available in the UK.

Biomass CHP systems have similar challenges as with biomass boilers with regard to air quality, security of fuel supply

and on site space requirements for equipment, storage and handling of fuel.

#### Potential advantages:

- relatively efficient means of using biomass fuel to save CO<sub>2</sub> emissions, with greater savings being achieved than in a heat only application

#### Potential risks and disadvantages:

- impact on local air quality, particularly in case of AQMAs
- fuel supply is a considerable risk with uncertainties as to the future availability and cost, in particular, sustainably sourced fuel
- space needed for fuel storage and access for delivery vehicles is a potential downside; this would be a particular concern with multiple energy centres on site or with fuels having low calorific value
- biomass CHP technologies at the small scale are immature and risky at present; there are few commercial installations operating at small scale and many are experiencing operational difficulties; many systems are still considered prototype and in development
- technology not as modular as gas-CHP, and will result in significant heat dumping in the initial years as the development is built out

### 3.6 Heat Pumps

Heat pumps take thermal energy from a low temperature heat source (such as ground, air, water, or waste heat from industrial processes/ other sources) and deliver this at higher temperature by using electrical energy to drive a compression cycle<sup>18</sup>.

The ratio of heat produced to input electricity required is known as the Coefficient of Performance (CoP), which provides an indication of the system efficiency. The “coefficient of performance” is governed by the “energy in” and “energy out” temperatures, with higher efficiencies achieved when there is a lower temperature gradient across them. It is therefore

<sup>18</sup> Heat pumps can also be gas driven

important to optimise the building space heating systems to operate on as low a temperature as possible, through the use of underfloor heating or large radiators. However, this does not necessarily preclude the use of heat pumps as part of high temperature DH networks, with heat pumps potentially deployed as part of a 2-step process to bring the output temperatures to the desired level.

As they require electricity to operate, heat pumps are often considered to be low carbon rather than renewable energy systems. The relatively high CO<sub>2</sub> intensity and cost of grid electricity in comparison to other heating fuels such as gas and oil mean that the CoPs of heat pump systems need to be sufficiently high to allow the system to compare favourably. At present, the average CO<sub>2</sub> intensity of grid electricity is about 2.5 times higher than that of boilers running on natural gas (after accounting for boiler efficiency). This means that a CoP of at least 2.5 is required for the heat pump to give a positive CO<sub>2</sub> benefit. However, as the grid reduces in CO<sub>2</sub> intensity with increasing share of renewable and low carbon generation, heat pumps will progressively become more favourable on a CO<sub>2</sub> emissions basis.

Heat pumps can utilise a range of low grade heat sources. The GLA's secondary heat study<sup>19</sup> provides further detail on the range of potential heat sources that could be utilised in London. A summary of the heat sources reviewed is provided in Table 3.

<sup>19</sup> London's Zero Carbon Energy Resource – Secondary Heat. Summary Report, Buro Happold, July 2013



Source	Examples	Typical Temp Range
Environmental Sources	Ground	13-14°C
	Air	2-19°C
	River	5-20°C
Process Sources	Power Station	35°C+
	Building cooling heat rejection	28°C
	Industrial	35-70°C
	Commercial buildings non-HVAC	32-40°C
	Water Treatment works	14-22°C
Infrastructure Sources	Metro Tunnels	12-29°C
	UKPN/NG Electrical Gear	50°C
	Sewer Heat Recovery	14-22°C

Table 3: Summary of Secondary Heat Sources (Source: GLA Secondary Heat Study<sup>19</sup>)

Of the potential heat sources, air is a diffuse source and so is less suitable for DH systems. In order to absorb enough energy from the air the collector coil will need to be very large. This size can be reduced somewhat by blowing air across the collector with a fan. If noise is to be minimised then this fan speed will be limited and the size of the collector increases. However, sources of waste heat (such as the higher ambient temperatures within London Underground) can offer opportunities for more efficient operation.

London Borough of Islington has recently received 1.2 million Euros in funding from the EU Celsius project to be a demonstrator of urban heat reclamation. An extension to Islington's Bunhill District Heating Network will be supplied with waste heat from a ventilation shaft on the Northern line and from substation transformers operated by UK Power Networks. It is important to note that the potential capacity that is likely to be available from such sources is relatively modest (in the range of low 100s of kW) in proportion to the total energy demands predicted for the OKROA. Also, the technologies are

partly grant funded and not deemed to be cost effective currently.

Closed loop ground source systems are similarly limited in capacity as a large ground area is required. A closed loop system extracts heat through the use of a secondary medium. A glycol mix is circulated around the borehole array, and this is connected to the evaporator side of the heat pump. In general, closed loop, borehole ground energy systems are best suited to individual building systems, rather than wide area heat networks as the energy source is diffuse. Each borehole provides around 5-8kW of heat output (3.7-6.4MWh/yr).

In the case of open loop ground source heat pumps, water is extracted from the ground, passed through a heat exchanger and returned to a separate borehole. The heat extracted is available through a water to water heat exchanger. Boreholes are typically located 100m apart. Open loop ground water systems could produce water at higher temperatures than typically achieved by closed loop systems. The flow rate from a single well is still limited though, and therefore a number of such installations would be needed to deliver the heat demand for the OA. A typical open loop borehole pairing can only provide around 380kW of heat energy. To avoid long term cooling of the ground, preference is given to balanced schemes which both extract and reject heat to aquifers on an annual cycle. The amount of energy available from open loop schemes is subject to regulatory constraints imposed by the Environment Agency (EA). These issues limit the applicability of the technology for the study area. Additionally, the high cost of ground-source systems is a significant barrier. Although ground-source systems are more efficient than air-source systems, the installed costs are nearly double that of air source heat pumps.

With water source heat pumps (e.g. a river source), heat is extracted by passing a proportion of the water flow through a water to water heat exchanger system. The water is then returned to the source, with no net abstraction and no changes

in chemical composition but at a lower temperature. Robust water intake arrangements are required, along with measures to deal with biological fouling and to protect fish from being entrained within the intake pump suction. There are no viable heat sources for such systems within or in vicinity of the OKROA.

A recent study investigating the ways in which heat pumps can be integrated into heat networks (DECC, 2016<sup>20</sup>) concluded that although the technology offers large CO<sub>2</sub> reduction potential alongside a decarbonising electricity grid, the price premium for heat from district heating schemes incorporating heat pumps is in the range of 35% -74% at current costs (relative to a counterfactual of DH schemes operating on gas CHP or gas boilers). This is attributed to a combination of factors including high capital costs, high electricity price compared to gas price, lost revenue from electricity sales compared to schemes with gas-CHP and higher network costs for low temperature distribution. The ability to provide cooling as well as heating can however bring additional financial benefits.

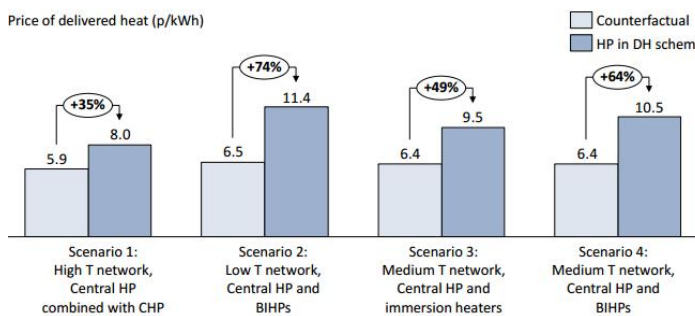


Figure 20: Comparison of the price of heat for DH schemes incorporating heat pumps and the counterfactual (DECC, 2016)

The study also concludes that there exist certain scheme types whose cost is comparable to conventional networks without heat pumps. These include schemes in which there is CHP installed as part of the heating strategy, and

<sup>20</sup> Heat Pumps in District Heating, DECC, 2016

- high-COP heat pumps are powered by CHP electricity, or
- heat pumps are used to recover waste heat from CHP operation

The potential advantages and disadvantages of heat pumps are summarised below.

**Potential advantages:**

- relatively mature technology
- with progressive grid decarbonisation, can provide large CO<sub>2</sub> reductions compared with fossil based systems
- ability to provide cooling as well as heating, which will also improve efficiencies for ground-source systems
- reduced air-quality implications in inner city areas compared with combustion technologies

**Potential risks and disadvantages:**

- high cost of delivered heat largely due to a combination of high capital costs and electricity prices; price premium for heat from district heating schemes incorporating heat pumps is in the range of 35% -74% at current costs
- Heat pumps are more efficient at lower temperatures; individual building heat systems will need to be designed to operate at lower temperatures to maximise efficiency
- High DHW demand (relative to space heating demand) in new residential buildings limits efficient operation
- existing buildings will require retrofitting to operate on a low temperature system or alternatively will need local boiler plant for top-up

### 3.7 Energy from Waste

The energy from waste options are briefly outlined below. These are included for completeness, as it is unlikely that they will prove appropriate as an “on-site” generation technology for OA, because of the significant scale and associated impacts associated with them. The one exception to this is the potential for a future connection to the SELCHP energy-from waste facility, which is located outside the eastern edge of the indicative OKROA boundary. This technology option is

discussed below and a potential connection to SELCHP has been considered as part of the network and energy centre options presented in Section 4.

**3.7.1 Waste Incineration**

Incineration is a means of releasing the energy in waste through combustion at high temperatures. This can reduce the amount of municipal solid waste sent to landfill by 90% and generates useful amounts of heat and electricity. With current technology, typically around 100,000 tonnes of municipal solid waste can provide 7MW of electricity. The waste heat produced as part of the incineration process can be a resource when it is exported to nearby buildings/consumers.

Incineration plants typically operate on large scales and require large plant resulting in significant land take. Incinerators are also normally accompanied by tall stacks which may constitute a significant impact on both landscape character and visual amenity. Incineration plants are regulated by the EU Waste Incineration Directive which sets emissions limits for many substances. Air quality is a material planning consideration and can be an issue of great public concern. Detailed emissions studies are required along with careful stack design and management. Incineration plants handle large amounts of waste requiring regular delivery access.

<b>Potential advantages:</b>
- Synergies with solid waste management strategies
<b>Potential risks and disadvantages:</b>
- typically operate at large scales
- has a large footprint associated with fuel storage and processes
- requires a significant volume of waste as feedstock, with associated concerns around vehicle movements
- potential for odours from waste handling

**3.7.2 Waste heat from SELCHP**

The SELCHP energy-from waste facility, located outside the eastern edge of the indicative OKROA boundary is capable of handling and incinerating up to 464,000 tonnes of household waste per year. SELCHP currently has a total installed heat capacity of 30MW with potential to increase this by another 10MW.

Work was undertaken by PB Power in 2006 to assess the potential to supply heat from SELCHP to areas of Southwark and Lewisham. Figure 21 shows the areas of Southwark considered for connection as part of this study, with a potential route running across the OKROA. Since this study, the first 5km of heat network was installed in 2014 to supply 2,500 properties in Southwark with heat and hot water. This network, located outside the north-eastern boundary of the OKROA, is estimated to have a peak demand of circa 10MW. The contractual arrangement with Southwark Council is for the supply of circa 17MW of heat.

A number of major new developments and existing buildings in the vicinity of the facility are also considering connecting to SELCHP for their heat supply, including the Biscuit Factory to the north of the OKROA, new developments being proposed on and around the existing Surrey Quays shopping centre site (within the Canada Water AAP) and the proposed New Bermondsey Housing zone on the eastern edge of the OA. Should contractual arrangements for these be in place in the near future, these could well absorb nearly all of the currently installed heat capacity.

It is assumed that an additional 10MW of heat capacity may be available for a future connection to the OKROA, although this will be dependent on a number of commercial considerations, including; the availability of other significant heat loads in the vicinity of the existing network / network extensions currently under consideration; the timing of when significant clusters of

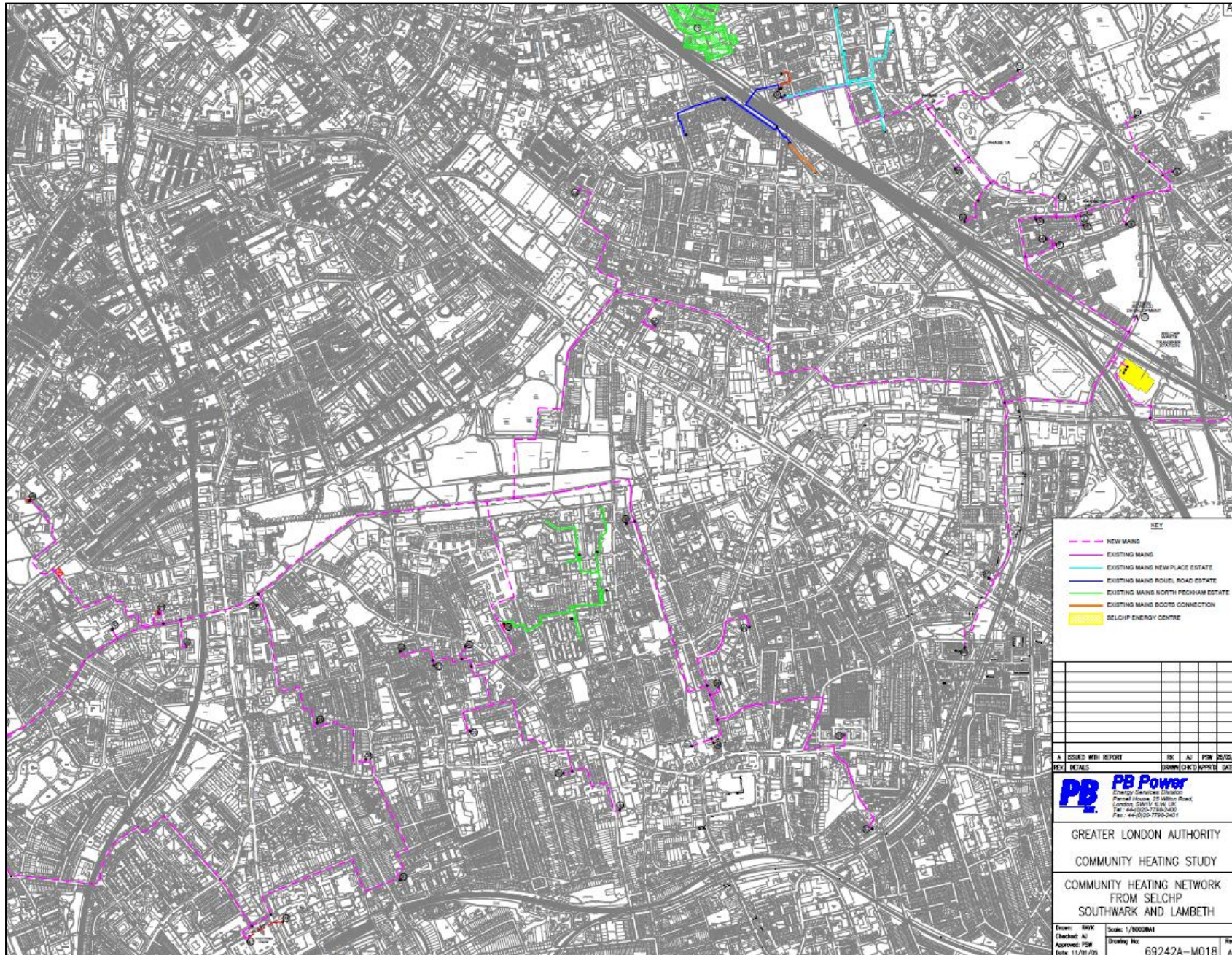


Figure 21: Map showing the possible district heating networks from SELCHP to areas of Southwark (PB Power, 2006)

developments are available for connection within OKROA; and the relative costs of connecting to such heat loads.

Key system and technology attributes are tabulated below.

System losses on primary network (based on monitoring of currently operational DH network)	4% -8%
Flow temperatures	110/70 degC
Planned downtime	2 weeks/yr
CO <sub>2</sub> emissions from waste heat	Approx. half of mains gas (may change in future)

The SELCHP facility was developed through a partnership between Veolia, Lewisham Council, Royal Borough of Greenwich, and a number of other private sector companies. As a business, Veolia offer a range of services including end-to-end services that include billing to residents. The delivery and financing approach typically varies on a case-by-case basis; from 100% developer funding for upfront infrastructure costs (in lieu of on-site solution) to 100% funded by SELCHP with these funds being recovered from end consumers through standing charges. The latter will be dependent on the balance of risk and reward on the investment, and will typically require guarantees for when loads will come on-line.

Tariffs for waste heat are subject to commercial negotiations. Typically these will be indexed to gas tariffs with a 10% discount on average tariffs offered by energy companies.

**Potential advantages:**

- Local resource in close proximity to OKROA
- Relatively low carbon intensity of waste heat
- No additional air quality implications
- Synergies with solid waste management strategies makes it a viable option for the medium to long term

**Potential risks and disadvantages:**

- Limited resource with other competing demands in the area

**3.7.3 Pyrolysis and gasification**

Pyrolysis and gasification are novel methods for extracting energy from municipal solid waste. Both operate at high temperature in a reduced oxygen environment turning waste into useful resources.

Pyrolysis produces syngas which can be used to generate electricity while other chemical compounds are bound in a char. The binding of these chemicals helps reduce emissions and leaching to the environment and the char can be used as a fertiliser. Gasification operates at higher temperatures with some oxygen. It produces a gas along with an ash residue with little calorific value.

These thermal treatments currently have a small market penetration but are becoming increasingly common, partly due to the EU landfill tax. Costs remain high but are expected to reduce as their development continues. Pyrolysis and gasification have similar site constraints to waste incineration but may be able to run at slightly smaller scale, meaning land take may not be as great.

**Potential advantages:**

- Higher conversion efficiencies for waste to energy compared to incineration

**Potential risks and disadvantages:**

- relatively new technology with limited market penetration
- high capital costs
- has a large footprint associated with fuel storage and processes
- requires a significant volume of waste as feedstock, with associated concerns around vehicle movements
- potential for odours from waste handling

**3.7.4 Anaerobic Digestion**

Anaerobic digestion (AD) is a biological process for the treatment of organic waste. It requires separation of the

biodegradable (or putrescible) waste stream. The process produces a gas which is methane rich and can be used for energy production. It also has a liquid by-product that can be used as a fertilizer and the solid, fibrous fragment can be used as a soil conditioner.

A wet AD system typically processes feedstock using shredding and pulping systems before digesting in an air-tight reactor (usually batch processed). The biogas produced is taken off for energy generation (usually in a gas CHP engine, but also potentially for export), with some of the CHP heat used within the process. The resultant digestate is removed for use as a fertiliser. An alternative dry-batch system is also used for green waste where the feedstock is digested in air tight bunkers using a watering system to aid the process.

Anaerobic digestion has been applied on a small scale in the UK, processing sludge, agricultural and industrial waste. Larger scale facilities are active across Europe and North America accepting a greater range of organic feedstocks including parks waste. A few of these types of facilities are now operational in the UK (e.g. Greenfinch, Shropshire) and others are being planned. Many existing Waste Plans refer to anaerobic digestion as a future waste treatment option.

Anaerobic digestion is thought to be generally viable at smaller scales than some of the thermal waste treatment processes but would still result in significant land take due to requirements for waste storage, vehicle turning etc. Odours from decomposing waste can become a nuisance, and so typically there would be a requirement for enclosed waste storage as part of an AD facility. The digestion process itself is also enclosed and emissions to the atmosphere are controlled.

#### Potential advantages:

- relatively clean technology with little impact on air quality
- whilst there are only a few AD installations in the UK, it is a relatively mature and simple technology that has a high uptake in other European countries

#### Potential risks and disadvantages:

- has a large footprint associated with fuel storage and processes
- requires a significant volume of waste as feedstock, with associated concerns around vehicle movements
- generates significant volumes of digestate (both solids and liquids), which would necessitate identifying a suitable disposal route locally
- potential for odours from waste handling

### 3.7.5 Summary of technology options appraisal

Technology	Suitability for primary heat supply	Future applicability	Comments
<b>Gas-fired CHP</b>	Potentially suitable	Diminishes with progressive decarbonisation of the electricity grid	Gas CHP is a mature technology that can deliver significant CO <sub>2</sub> reductions over the medium term when connected to a district heating network compared to individual gas boilers.
<b>Fuel cell CHP</b>	Not suitable	Increases with technology maturity; hydrogen fuel cells potentially applicable in the medium to long term	This is currently considered an immature technology, and uneconomic compared with gas CHP engines. Whilst the electrical efficiency can be higher than for engines, the significant additional capital and operation costs outweigh this benefit. In the longer term, hydrogen fuel cells can be relevant where hydrogen generated from renewable electricity were to become part of the energy system.
<b>Communal biomass boilers</b>	Not suitable	Not suitable	Whilst technically suitable, air quality concerns are a key constraining factor. This will be further exacerbated by transport movements associated with delivery of fuel in a relatively inner London location. The space requirement for storage of fuel is another constraining factor. There is also significant risk associated with future availability and cost of fuel, whilst also ensuring sustainability of fuel source.
<b>Biomass-fired CHP</b>	Not suitable	Not suitable	Biomass CHP systems have similar challenges as with biomass boilers with regard to air quality, security of fuel supply and on site space requirements for equipment, storage and handling of fuel. Also, the technology is not as modular as gas-CHP, and will result in significant heat dumping in the initial years as new development is built out
<b>Heat pumps</b>	Not suitable at present	Potential future option as electricity grid decarbonises	Heat pumps are a relatively mature technology although, at current energy prices, there is a significant price premium for heat from district heating schemes incorporating heat pumps. A key advantage in the context of OKROA is the reduced air-quality implications compared with combustion technologies. Careful consideration is needed to avoid unintended impacts on the heat sink for example through changes in temperature (in case of aquifers, etc.). Heat pumps also do not offer a CO <sub>2</sub> benefit over counterfactual technologies with the current mix of grid electricity, but will become more CO <sub>2</sub> effective as the grid decarbonises. In the medium term, heat pumps could complement gas-CHP systems and operate in times of excess low carbon electricity available from the grid. Systems connected to a heat network also offer opportunities to cost effectively capture sources of waste heat (e.g. proposed London Underground extension) thereby further improving system efficiencies. They are therefore viewed as a future potential technology.

Technology	Suitability for primary heat supply	Future applicability	Comments
<b>“On-site” energy from waste technologies</b>	Not suitable	Not suitable	These typically operate at large scales and have a large footprint associated with fuel storage and processes
<b>Waste heat from SELCHP</b>	Potentially suitable	Potentially suitable	The proximity of OKROA to the SELCHP Energy Recovery Facility makes waste heat a viable option. However, the waste heat capacity that may be available for a future connection to the OKROA is limited and will be dependent on a number of commercial and financial considerations.

**3.8 Conclusions and Recommendations**

The findings from the technology options review are summarised in Section 3.7.5. The review concludes that the following would be most suited as the first wave of heat supply technologies for district heating networks in the OKROA:

- Gas-fired CHP
- Waste heat from SELCHP

Heat pumps (using waste heat from transport networks or other sources) are better suited as the second wave of technology that either complements or replaces gas-CHP at the end of its life. The complementarity stems from the fact that while average grid carbon intensity is expected to drop (due to a shift from high carbon fossil generation to a mix of nuclear, increased renewables, and carbon capture and storage (CCS) fossil-fuel generation) it will have different levels of CO<sub>2</sub> emissions at different periods depending on the electricity demands, and the amount of renewable electricity on the system. There will be periods when fossil fuel generation (high carbon) will be the operating marginal plant<sup>21</sup>, and also periods where there is excess renewable or low carbon electricity (low carbon). Gas CHP will still save CO<sub>2</sub> against the former, whilst

electricity consuming systems (for example heat pumps) could make use of the low carbon electricity in times of excess.

By potentially operating a combination of heat pumps and gas CHP on a district heating network in the future, it may be possible to optimise the generation source under certain grid conditions so that CO<sub>2</sub> savings and financial returns are maximised (also see Section 4.7 that briefly discusses the expected transition in energy systems in the future and associated uncertainties).

<sup>21</sup> The marginal plant(s) refers to the generation plant(s) and/or energy source(s) that are expected to increase or decrease when there are marginal but sustained changes to energy demand or supply.





**Heat network  
development and analysis  
of network options**

## 4 Heat network development and analysis of network options

### 4.1 Introduction

This section provides a summary of the assessment of the potential to deliver district heating infrastructure within the OKROA to support the following policy:

- **Southwark Core Strategy** sets out a vision to create low carbon energy networks across the borough and expects all major developments to set up and/or connect to these networks where possible.
- **London Plan Policy 5.5 Decentralised Energy Networks** requires boroughs to develop policies and proposals to identify and establish decentralised energy network opportunities.
- **London Plan Policy 5.6 Decentralised Energy in Development Proposals** requires development proposals to evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine the opportunities to extend the system beyond the site boundary to adjacent sites.

### 4.2 Heat data and mapping

A heat map for the study area was produced using GIS (Geographic Information System) showing heating demand density from significant existing loads and proposed new developments in the area. Heat demand provides an indication of the potential environmental and financial benefits that could be derived from the creation of a heat network served by a low carbon energy technology.

Existing heat demand density within the opportunity area was mapped as part of the London Heat Map study (Ramboll, 2010) and is shown in Section 1.3 above. This along with data from the local employment study carried out by Southwark Council, the Local Land and Property Gazetteer, and data provided by Southwark Council on council-owned housing estates has been used to identify significant existing loads and/or 'anchor

loads' within or in the immediate vicinity of the OA. 'Anchor' loads are individual loads that can justify the start of development of a network owing to them being particularly large consumers (e.g. hospitals are one type of load often considered as an anchor).

The existing and/or 'anchor loads' have been selected for one or more of the following reasons:

- They have, or are considered likely to have, a high, stable, constant and predictable level of year round heat demand.
- They have existing communal systems in place (e.g. existing housing estates).
- They are buildings over which the Council has a high level of control or influence to support the connection to a heat network (e.g. council-owned buildings and other public sector buildings).

Heat demand from future development within the OKROA has been estimated using the data on development capacity and phasing produced as part of the place-making study commissioned by Southwark Council. The high development scenario is the preferred option, and is used as the basis for the analysis.

Figure 22 below shows the heating demand density from significant existing loads and proposed new developments in OKROA. Figure 23 shows the heat densities by development phasing. The energy benchmarks along with data sources used and any underlying assumptions made to calculate the baseline energy demand are outlined in Appendix C.

### 4.3 Assessing the potential for district heating

The heat mapping exercise concluded that in the absence of existing buildings that could serve as 'anchor loads' as well as the absence of clusters of existing buildings with significant heat demand density, the development of heat networks in the OA would have to be largely new development led.

Being new development led, the network would be phased in line with the anticipated timeline of the development in the area. The network could then be expanded to connect to significant existing heat loads in the vicinity of the new development plots. Given the lack of existing high heat demand clusters in the area and taking into account the new build development projections, the network has been modelled as being operational in the early 2020s<sup>22</sup>.

It was considered prudent to exclude any existing floorspace that is planned to be redeveloped in future years as such time limited heat supply contracts would not justify the initial investment required to connect and/or upgrade existing systems.

The list of existing buildings and development plots modelled as being connected to an OA-wide district heating network along with their estimated annual heat loads are tabulated in Appendix D.

#### 4.3.1 DH network options

Three network options have been considered to test the viability of decentralised energy for the OKROA. These have been informed by available and projected heat densities as well as early discussions with Southwark Council and other stakeholders.

**Option 1:** A phased heat distribution network with a single energy centre (EC) located within the opportunity area and run on gas-CHP.

**Option 2:** A variant of Option 1 above with smaller inter-connected ECs.

**Option 3:** A variant of Option 1 with a single EC located within the opportunity area (albeit smaller than the first option), which

in turn is connected to SELCHP to meet part of the heat demand<sup>23</sup>.

The options investigate the viability of a new energy centre/s run on gas-CHP. Gas CHP is a mature, low-risk technology, which is readily scalable. Option 2 investigates a multiple energy centre option to help mitigate the impact of infrastructure provision on the viability of individual development plots/ sites. This option has been modelled as a variant of Option 1 with phased energy centre costs to reflect the development timeline, albeit with an overall larger energy centre footprint compared to a single energy centre option. It assumes a network of three interconnected ECs (one located in each cluster of new development plots, rather than standalone energy centres) with a view to balance heat loads and maximise operational efficiencies. Option 3 assesses the viability to connect to a local heat resource, SELCHP. Between them these represent the range of possible approaches and practical considerations to delivering a decentralised energy solution for the OA given the air quality concerns, current grid carbon intensity and technology maturity.

A standalone network operating on gas-CHP could be supplemented/ replaced by other energy sources and technologies in the future as they become available (such as waste heat from transport network), should a gas-CHP operated standalone system be proven to be inherently viable.

For the options analysis, three network phases have been modelled to reflect the development phasing.

- Phase 1: This will include new floorspace added between 2015 and 2025 (assuming floor space build in early years is futureproofed to be connected to the DH network), plus major existing loads in close proximity.

<sup>22</sup> Modelled as being operational from 2023 for the financial analysis

<sup>23</sup> Refer to section 0 for likely limitations on available waste heat capacity from SELCHP.

- Phase 2: This will model an extended network to include new floorspace added between 2025 -2030 plus major existing loads in close proximity.
- Phase 3: This will model an extended network to include new floorspace added between 2030 and 2036 plus major existing loads in close proximity.

Based on the buildings selected for inclusion and development phasing, a high level network design has been produced for the DH network with indicative infrastructure routes, as shown in Figure 24 -Figure 26.

The network options have been assessed using an in-house toolkit which allows the heat loads to be quantified across all the branches, size the pipework and attribute indicative costs to the network.

#### 4.3.2 Energy Centre

In locating the energy centre, an assumption has been made on the potential location taking into consideration the following parameters:

- Proximity to pockets of high heat/ electricity demand and to existing heat sources such as SELCHP.
- Development phasing, with the energy centre located close to pockets of land that will be developed early on.
- Expected building heights and therefore ability to accommodate a tall flue.

Determining a suitable location for an energy centre is a complex task involving a considerable number of variables not listed above. On the basis of a simplistic assessment, a potential location (shown in Figure 24) was identified for Option 1 to enable the network assessment to be undertaken. The location identified should be treated as indicative only, and whilst it makes use of the limited information available at this stage, further analysis of this and other potential locations against a number of additional variables would be required as

part of any further development work. Indicative energy centre locations for Option 2 are shown in Figure 25.

Based on initial estimates, a single energy centre containing CHP engines, top-up/ back-up gas boilers, thermal store and associated plant and equipment is anticipated to have a footprint in the order of 4,000 - 5,000m<sup>2</sup>. Under option 2, the total footprint of the three energy centres is estimated to be in the range of 5,000 – 6,000m<sup>2</sup>, decreasing to around 3,500-4,500 m<sup>2</sup> under Option 3. Please note that these assume that all top-up/ back-up plant is located in the energy centre and not on the individual plots. The area needed for the energy centre/s will however depend on a number of variables, in particular, how modular the generation and top-up/ back-up plant needs to be (i.e. to ensure efficient operation as heat loads come online), building geometry and/or other physical constraints (e.g. access for maintenance) , as well as other technical requirements (such as acoustic restrictions).

#### 4.3.3 Modelling of plant

Based on the heat demand data, plant options have been tested to ascertain the size of plant that would be required to supply the required heat to the buildings connected to the network.

The CHP sizing has been heat-led and optimised to maximise financial returns over its life. In practice, depending on the priorities and delivery routes, the system size could be optimised for maximising CO<sub>2</sub> emissions savings.

Figure 22: Heat demand density from significant existing loads and proposed new developments in OKROA

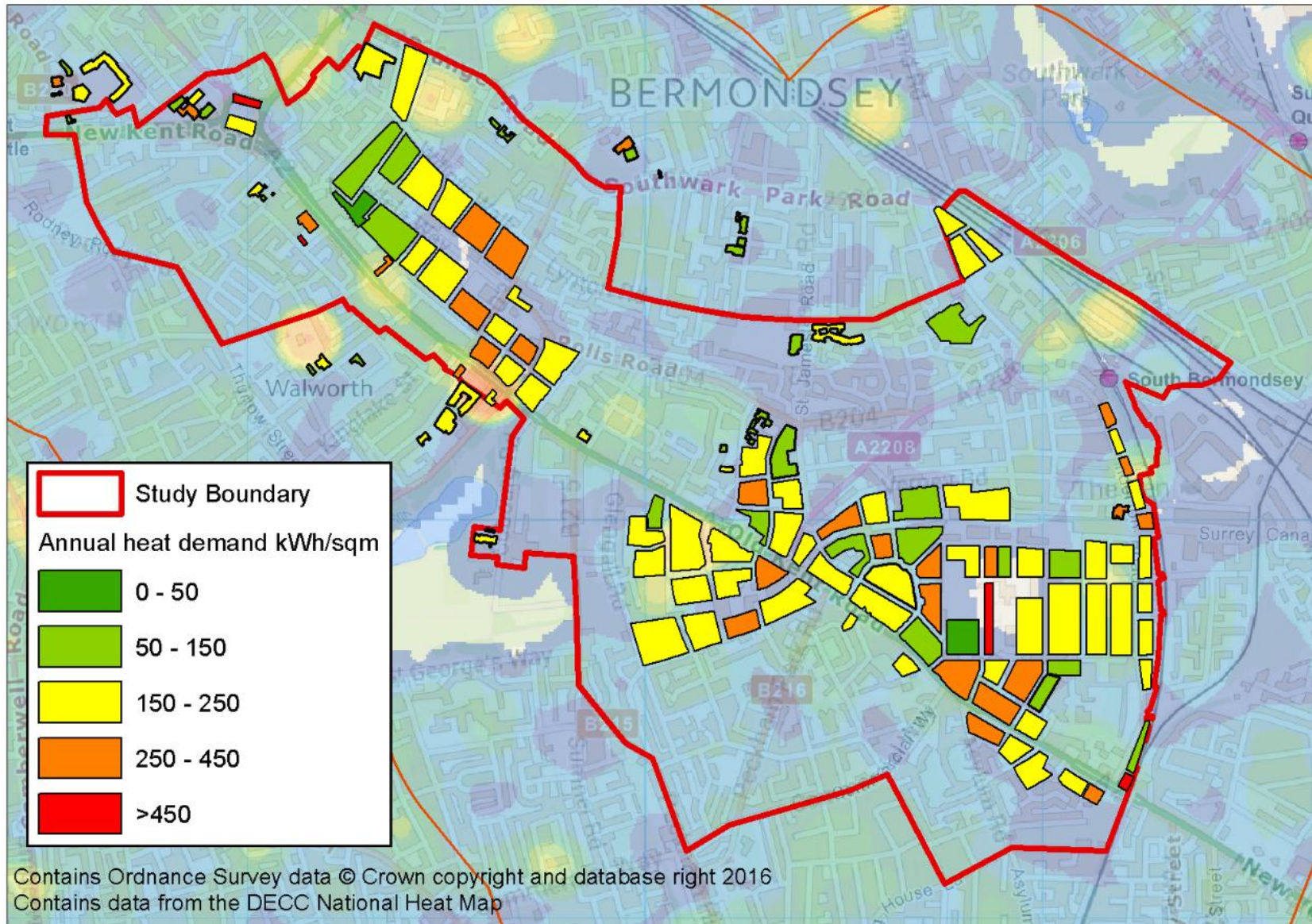


Figure 23: Heat demand density by development phasing

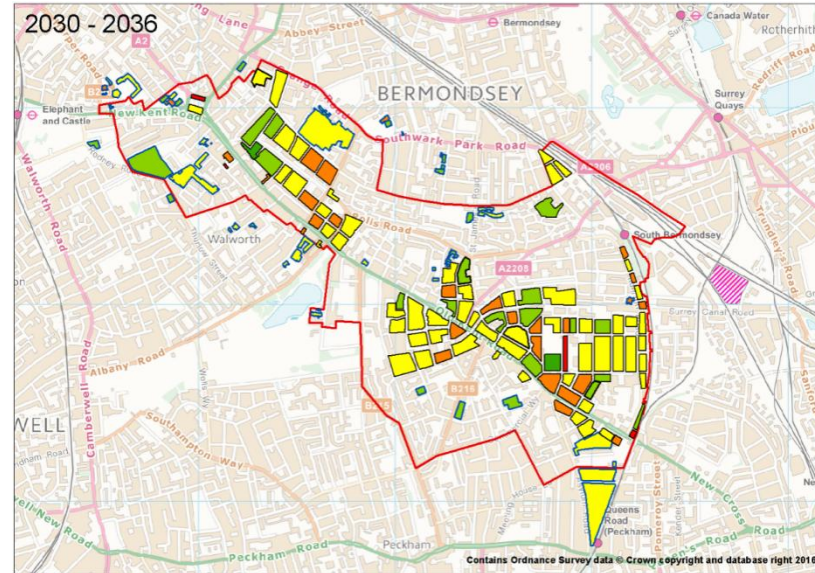
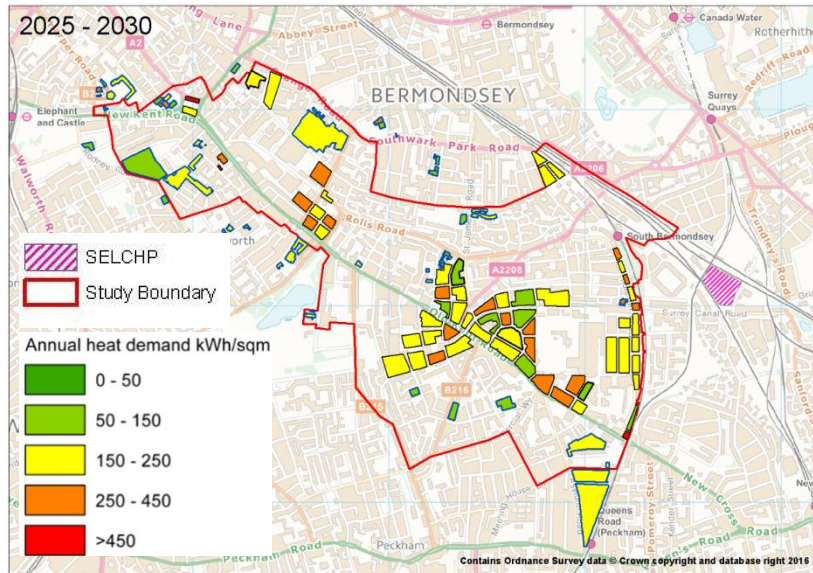
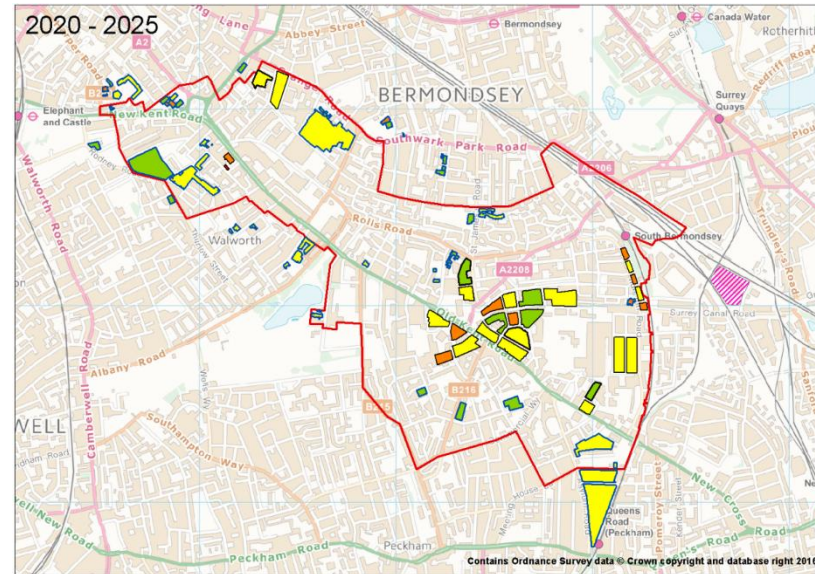
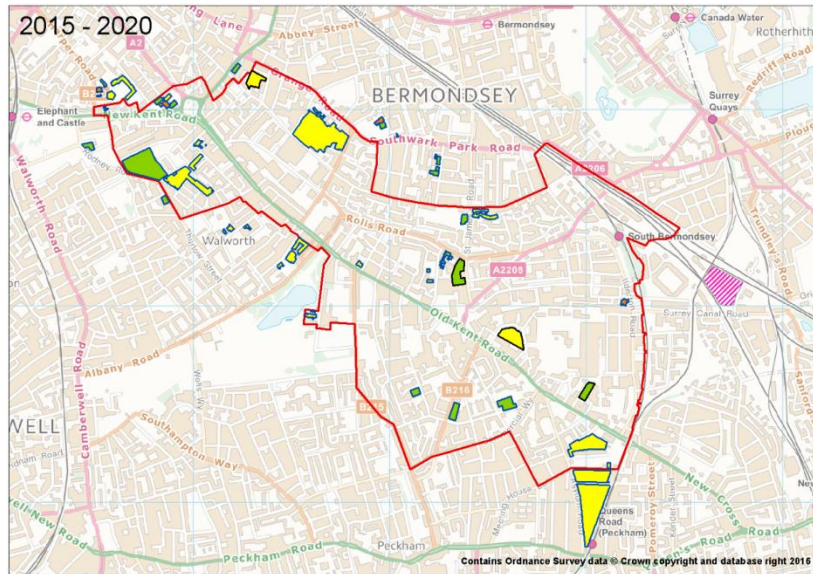


Figure 24: Map showing indicative heat network routes for Option 1

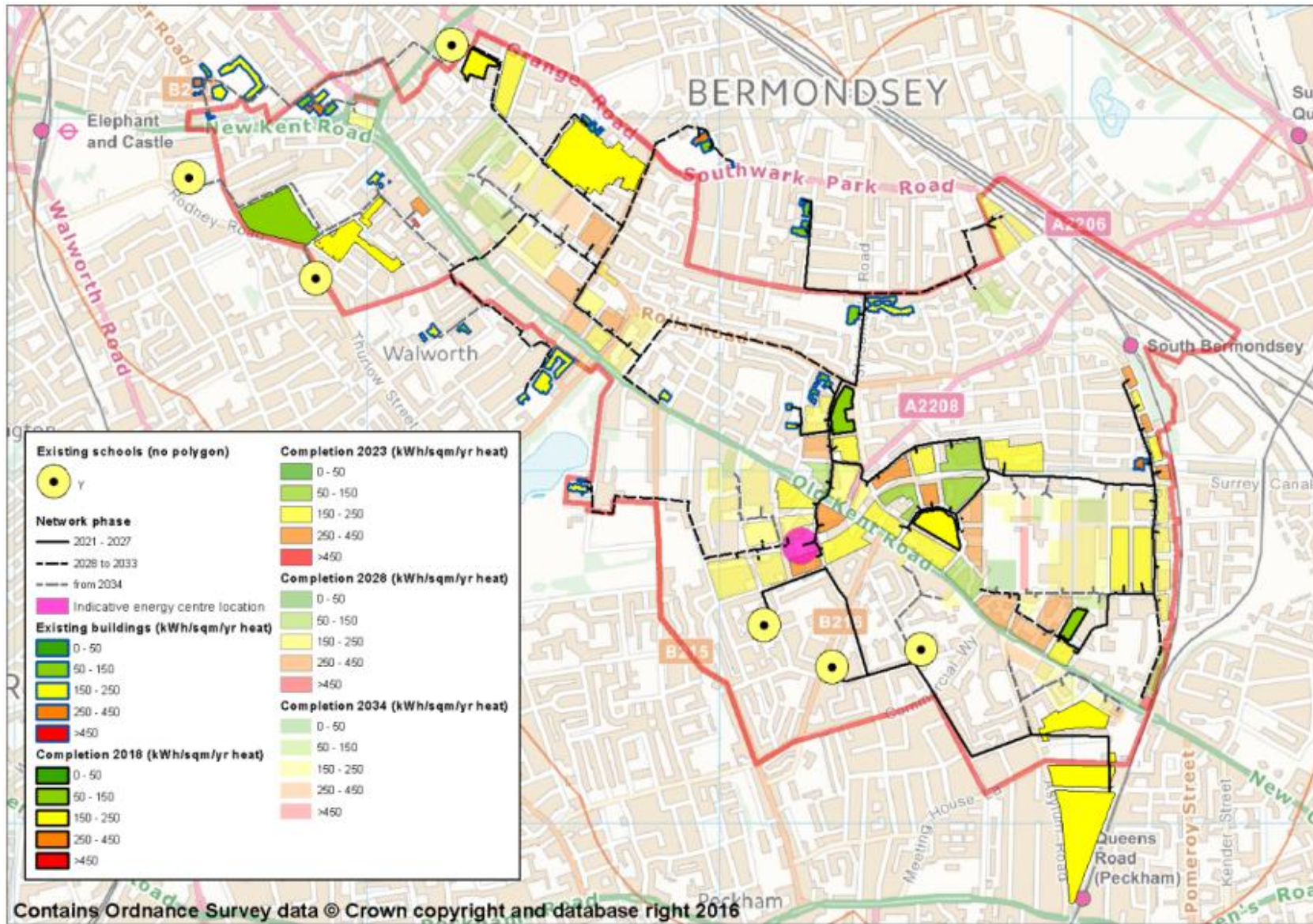


Figure 25: Map showing indicative heat network routes and energy centre locations for Option 2

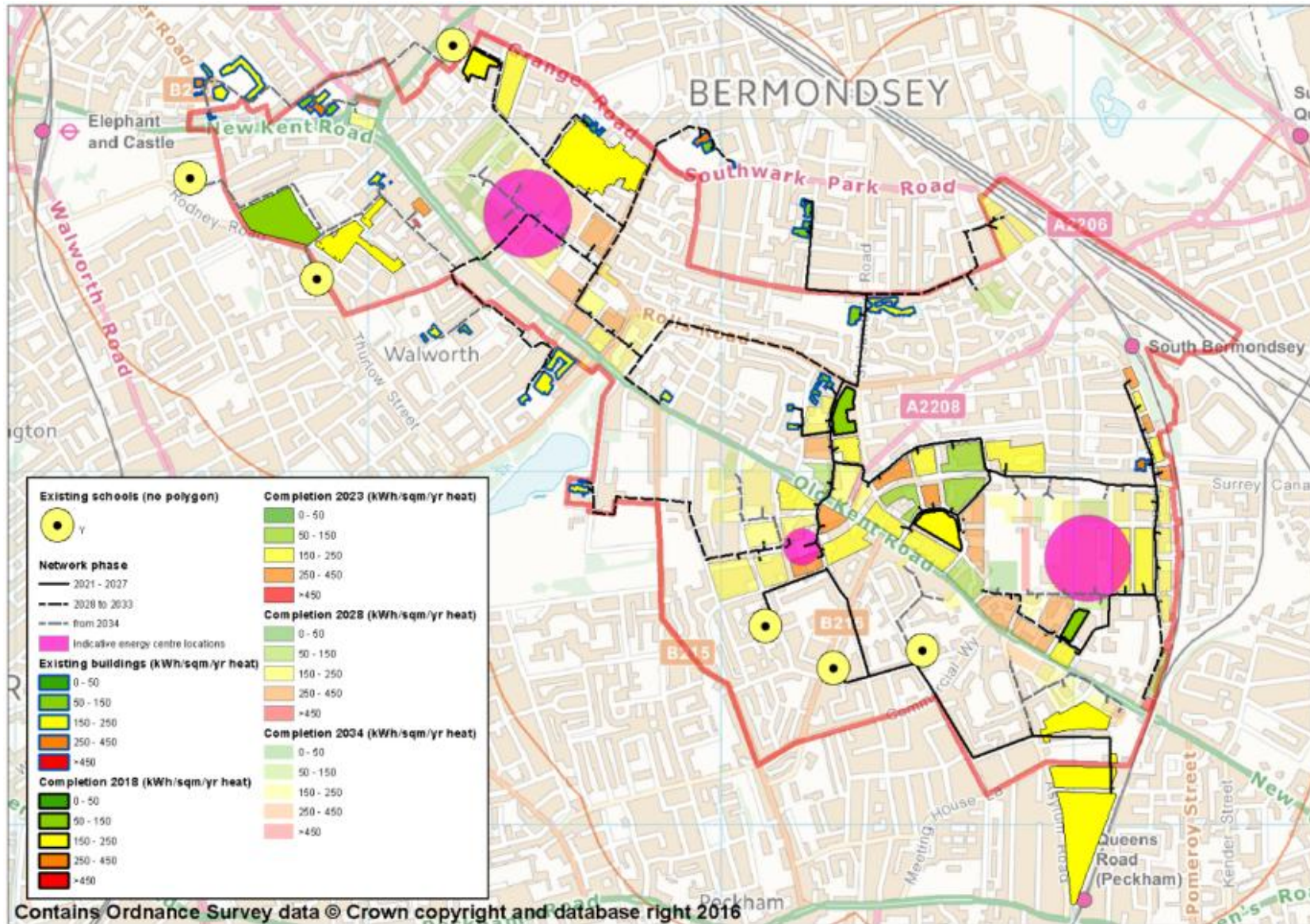
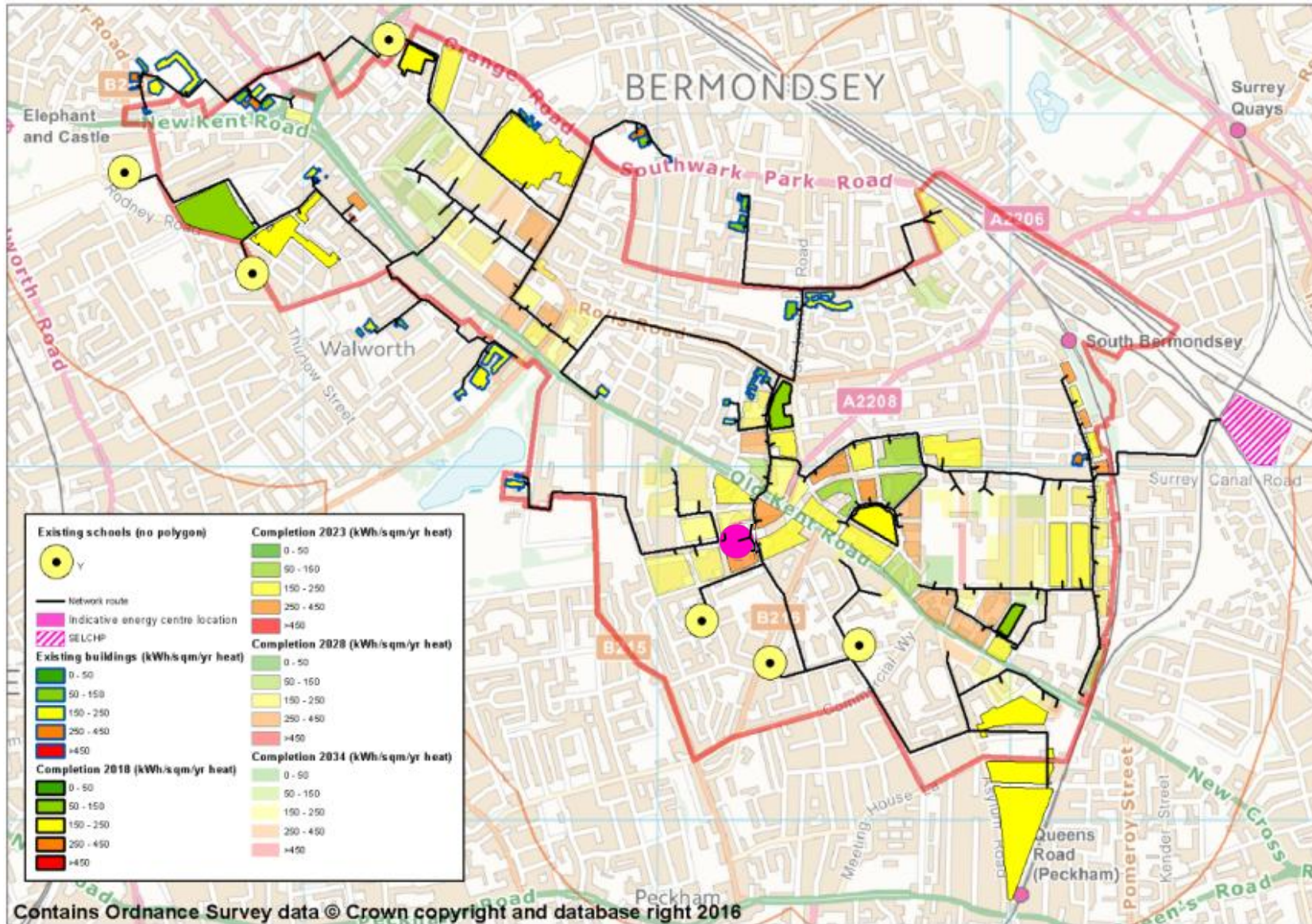




Figure 26: Map showing indicative heat network routes for Option 3



#### 4.3.4 CO<sub>2</sub> savings

Once the plant size is ascertained, the potential CO<sub>2</sub> savings from the use of either gas-fired CHP or waste heat have been calculated relative to the baseline scenario. The baseline CO<sub>2</sub> emissions have been set as a weighted average of buildings proposed to be connected to the network based on the following assumptions:

- Existing buildings (with the exception of existing estates with communal heating systems) and new build development plots with less than 100 residential units or <1,000 m<sup>2</sup> of non-domestic floorspace have individual gas boilers.
- New development plots with between 100 and 500 residential units or >1,000 m<sup>2</sup> of non-domestic floorspace have gas-fired communal systems.
- Development plots with more than 500 residential units have communal systems with gas-CHP.

The baseline CO<sub>2</sub> emission calculations include an allowance for distribution losses in case of existing communal systems and where plot-level communal systems are assumed for new build. Where any existing buildings are using electric heating or another fossil fuel then the savings would be greater than currently estimated.

The data sources used for fuel emission factors are outlined in Appendix C.

#### 4.3.5 Commercial viability

To assess the commercial viability of the district heating networks, the total capital costs associated with each system presented, the costs associated with operation and maintenance and the revenue from the sales of heat and electricity have been estimated.

It is assumed that a financial contribution is made by developers connecting to the proposed network (referred to as 'Developer Contribution' in the results tables that follow in the subsequent sections). This contribution reflects the costs of meeting planning policy and Building Regulations requirements compared to the counterfactual baseline scenario (refer Appendix C). The level of developer contribution could potentially be set slightly below the costs of the alternative option in order to provide an incentive to connect.

The financial analysis has been run over a 40 year period to determine the cash flows and calculate the following:

- Capital and replacement costs - These include costs associated with delivery of heat network infrastructure to plot boundary, costs for energy centre/s and associated equipment. All costs are presented as 2016 figures.
- Annual operating costs – These are based on the fuel costs and annual maintenance costs. The year 1 data is presented but these figures change each year in line with the fuel price changes.
- Annual revenue – This is based on the heat and electricity sales in the case of CHP and heat sales in the case of waste heat from SELCHP. The year 1 data is presented but these figures change each year in line with the fuel price changes. The heat tariffs assume a 10% discount relative to counterfactual/ baseline cost of heat for end consumers to incentivise connection to DH network (for details refer Appendix C).
- Simple payback period – The time taken to return the initial capital expenditure.
- Net Present Value (NPV) – This is the yield of the investment based on the capital investment and returns over time together with the discount factor. The NPV has been calculated using a discount rate of 6%. This reflects the rate required for some level of private sector involvement. In reality commercial organisations may well seek to apply a higher discount factor but this value gives

an indication of viability. The NPV is a useful indicator as it shows, for any given discount factor and length of contract, how much gap funding may be required (if any) in order to make a project viable.

- Internal Rate of Return (IRR) – This shows the return on the investment and is a measure of the profitability of potential investments.

The range of input data and assumptions used for the financial analysis is outlined in Appendix C.

The results of the technical and financial analysis of alternative district heating network options are presented in the next section. A high-level sensitivity analysis has been carried out to test the impact of variance in key variables such as heat demand, developer contributions and heat tariffs on the viability of alternative options. The results of this exercise are discussed in Section 4.5.

#### **4.4 Results**

The key results for the three district heating network options are tabulated below. The results are broken down by phasing in line with development projections.

## Network Option 1

A phased heat distribution network with a single energy centre (EC) located within the opportunity area and run on gas-CHP.

### Technical details

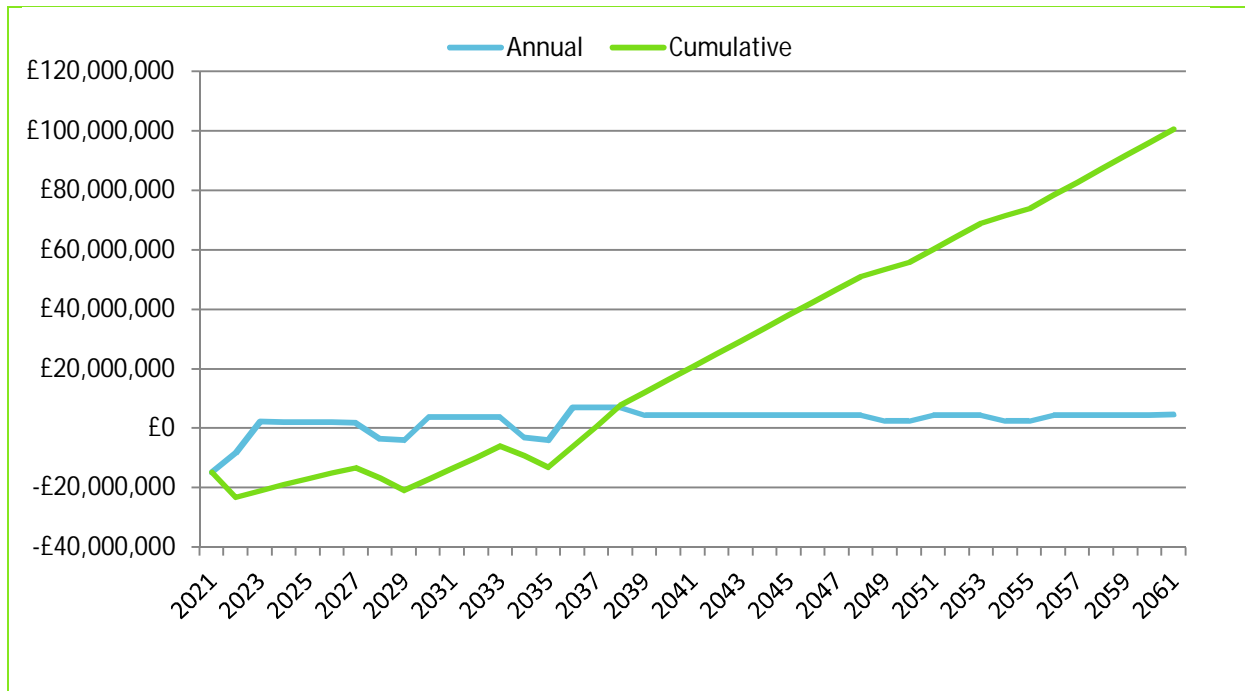
Phasing	Phase 1	Phase 2	Phase 3	Whole scheme
Annual heating & hot water demand (MWh)	41,604	39,539	45,881	127,024
Total trench length (m) <sup>24</sup>	7,112	2,067	7,274	16,453
Indicative energy centre footprint (m <sup>2</sup> )	4,000 – 5,000			

### Key results

Phasing	Phase 1	Phase 2	Phase 3	Whole scheme
CHP system size, MWe	2 x 3.7	4 x 3.7	6 x 3.7	6 x 3.7
	1 x 1.2	1 x 1.2	1 x 1.2	1 x 1.2
Top-up/ back-up boilers size, MWth	3.6	6.7	12.7	12.7
Capital costs by phase (£m)	£23.7m	£16.0	£22.9	£62.6
Cumulative NPV@ 6% over 40 years (£m)	-£4.6m	£9.8m	£11.4m	£11.4m
Cumulative IRR	3.4%	8.6%	8.7%	8.7%
Payback period (from start of phase)	17 years	7 years	3 years	16 years
Cumulative average annual CO <sub>2e</sub> savings, tonnes/yr	4215	7361	11,020	11,020
Cumulative NPV per tonne CO <sub>2e</sub> , £/tonne	--£27	£35	£27	£27

### Cashflow

<sup>24</sup> Please refer to



## Network Option 2

Option 2: A variant of Option 1 above with smaller inter-connected ECs, modelled as a variation on projected energy centre costs and timeline of when these costs will be incurred assuming three separate ECs.

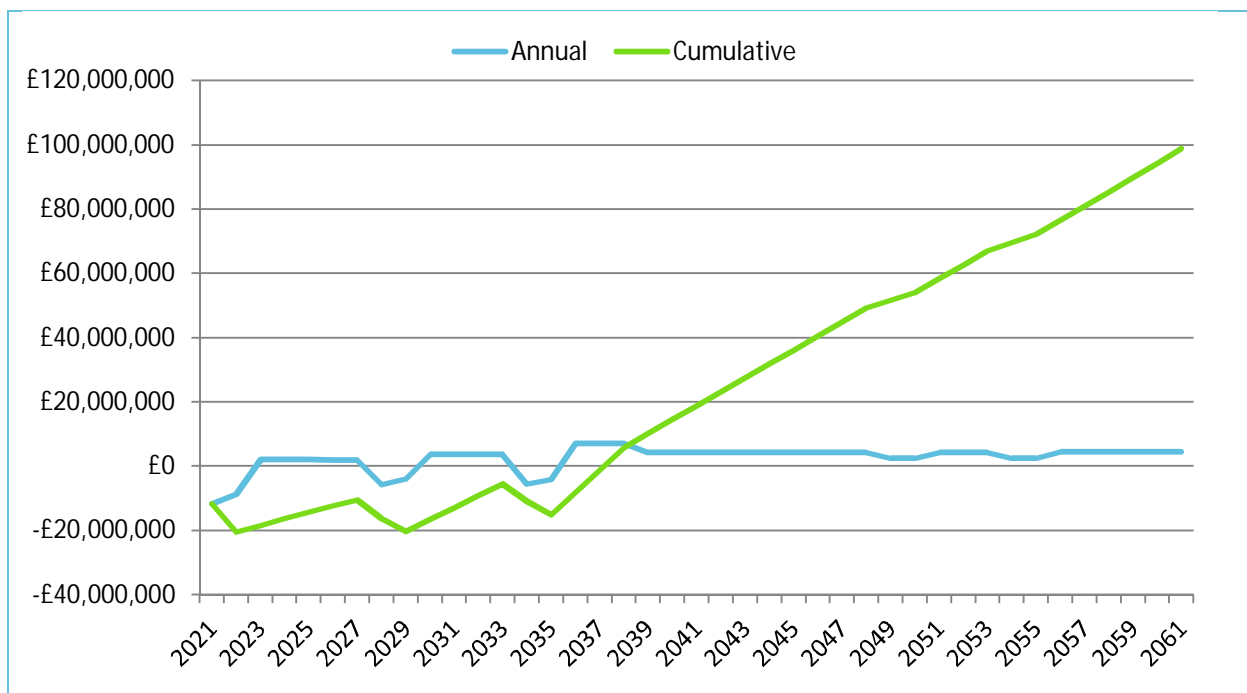
### Technical details

Phasing	Phase 1	Phase 2	Phase 3	Whole scheme
Annual heating & hot water demand (MWh)	41,604	39,539	45,881	127,024
Total trench length (m)	7,112	2,067	7,274	16,453
Indicative energy centre footprint (m <sup>2</sup> )	1,600 – 2,000	1,600 – 2,000	1,600 – 2,000	5,000 – 6,000

### Key results

Phasing	Phase 1	Phase 2	Phase 3	Whole scheme
CHP system size, MWe	2 x 3.7 1 x 1.2	4 x 3.7 1 x 1.2	6 x 3.7 1 x 1.2	6 x 3.7 1 x 1.2
Top-up/ back-up boilers size, MWth	3.6	6.7	12.7	12.7
Capital costs by phase (£m)	£20.5	£18.1	£25.0	£63.6
Cumulative NPV@ 6% over 40 years (£m)	-£2.1	£11.0	£11.5	£11.5
Cumulative IRR	4.7%	9.1%	8.9%	8.9%
Payback period (from start of phase)	14 years	3 years	2 years	15 years
Cumulative average annual CO <sub>2e</sub> savings, tonnes/yr	4215	7361	11,020	11,020
Cumulative NPV per tonne CO <sub>2e</sub> , £/tonne	-£12	£37	£28	£28

### Cashflow



### Network Option 3

Option 3: A variant of Option 1 with a single EC located within the opportunity area, which in turn is connected SELCHP to meet part of the heat demand.

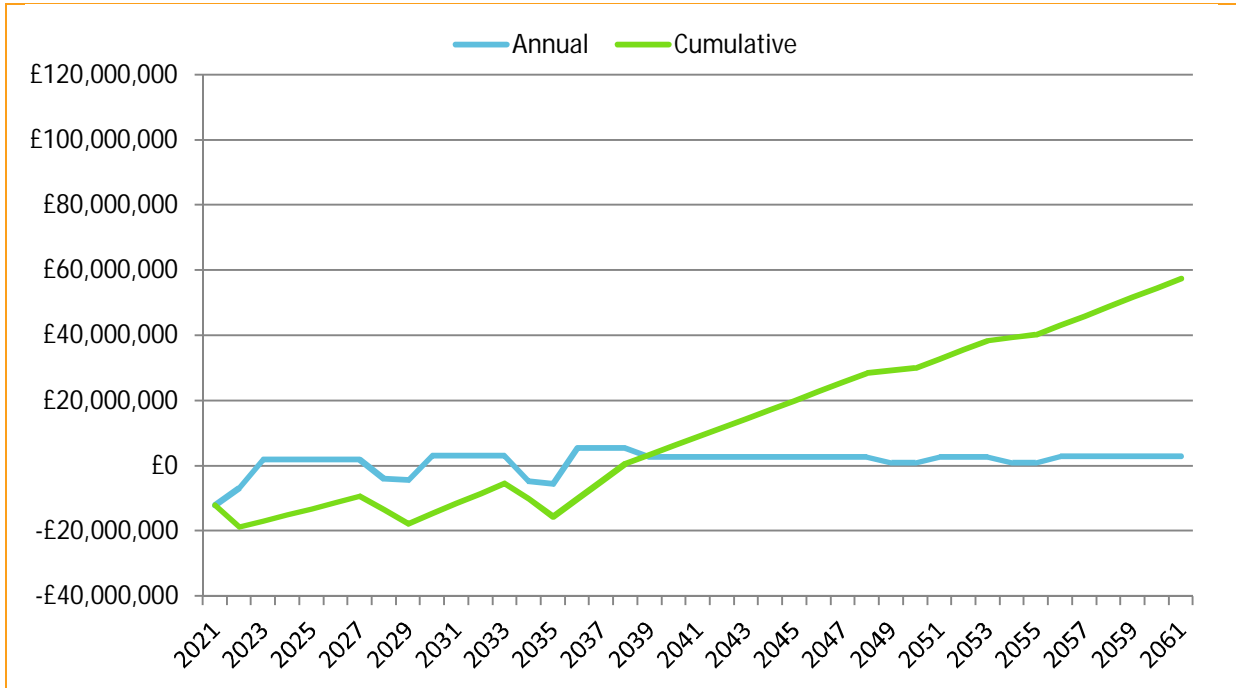
#### Technical details

Phasing	Phase 1	Phase 2	Phase 3	Whole scheme
Annual heating & hot water demand (MWh)	41,604	39,539	45,881	127,024
Total trench length (m)	7,612	2,067	7,174	16,953
Indicative energy centre footprint (m <sup>2</sup> )	3,500 – 4,500			

#### Key results

Phasing	Phase 1	Phase 2	Phase 3	Whole scheme
CHP system size, MWe	0	2 x 3.7	4 x 3.7	14.8
Waste heat from SELCHP, MW	10	10	10	10
Top-up/ back-up boilers size, MWth	2.6	6.0	11.8	11.8
Capital costs by phase (£m)	£18.8	£15.8	£22.9	£57.5
Cumulative NPV@ 6% over 40 years (£m)	--£3.7m	£2.6m	£3.4m	£3.4m
Cumulative IRR	3.7%	7.0%	7.1%	7.1%
Payback period (from start of phase)	18 years	8 years	5 years	17 years
Cumulative average annual CO <sub>2e</sub> savings, tonnes/yr	7,025	10,138	16,908	16,908
Cumulative NPV per tonne CO <sub>2e</sub> , £/tonne	-£19	£7	£6	£6

#### Cashflow



**4.5 Sensitivity Analysis**

The impact of key variables on the financial viability of a DH scheme in the OKROA has been assessed. The sensitivity analysis has been carried out on Option 1, with the exception of sensitivity on waste heat tariffs which is specific to Option 3.

**4.5.1 Heat loads**

The heat demand from new and existing buildings connected to the network has a direct bearing on the revenues from the sale of heat, and therefore the financial viability of a scheme. A number of factors are likely to influence the projected heat demand. Of these, the two critical factors are development capacity projections and expected improvements to Building Regulations/ London Plan requirements over time.

Figure 27 shows the impact of variation in projected heat demand on project IRRs.

The place-making study commissioned by Southwark puts forward three alternative development capacity scenarios. The high development scenario is the preferred option, and is used as the basis for the core analysis. Proportionately, the connected heat loads are estimated to drop by about 15% under the medium scenario and by about 40% under the low development scenario<sup>25</sup>. The analysis suggests that while the development densities under the medium development scenario would support an area-wide DH network, a DH

scheme is unlikely to be viable under the low development scenario, with IRRs dropping below 6%.

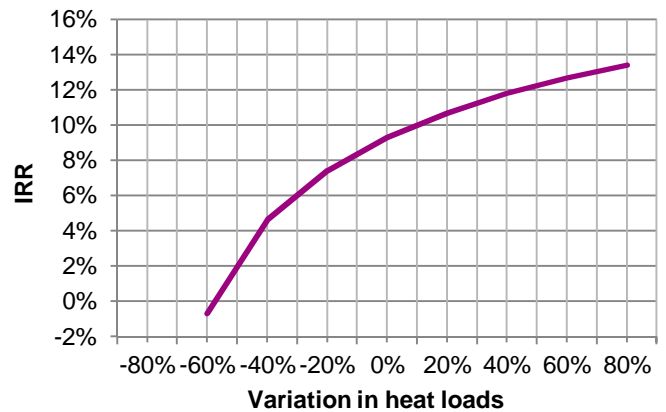


Figure 27: Sensitivity of project IRRs to heat loads

As briefly discussed in Section 2, there is significant uncertainty around the timing and the level of improvements to Part L of the Building Regulations in the future, which govern the minimum energy performance standards in buildings. The sensitivity analysis suggests that every 10% improvement in energy efficiency performance standards over Part L 2013 on average over the build out phase would roughly mean a 1% drop in IRR, though the impact on IRR starts to be more significant where the improvements in energy efficiency standards lead to a 40% or more decrease in connected heat

<sup>25</sup> Estimated based on total projected floorspace under the various scenarios

loads. It is worth noting that in case of high density developments such as high rise flats (and with progressive tightening of fabric standards) the domestic hot water (DHW) related heat loads are increasingly becoming much more significant relative to space heating loads, and substantial reductions in DHW related loads are not expected without changes in user behaviour.

The combined impact of reduction in development capacity and improved energy efficiency standards may mean a marginal financial case for DH networks under the medium scenario.

On the other hand, where the DH network can be extended to connect to large schemes that are underway or planned in the vicinity of the OA, such as the Aylesbury and the New Bermondsey schemes, this could see a significant uplift in connected heat loads at marginal investment costs, thereby improving the overall financial viability. In such instances, plot-level energy centres could be managed by the entity operating the DH scheme and would work as part of a larger integrated DH network.

4.5.2 Capital costs

The impact of capital costs for the DH network (including plant) and energy centre on project viability is shown in Figure 28 and Figure 29. A 40% increase in DH costs would result in a drop in IRR to around 6%. On the plus side a 20% decrease in costs will improve the IRR to over 11%. The rate of return is overall less sensitive to energy centre costs, with a 40% increase reducing the IRR by half a percent.

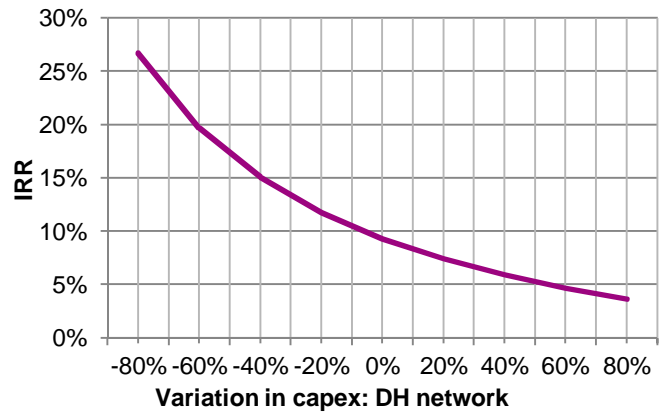


Figure 28: Sensitivity of project IRRs to capital costs of DH network

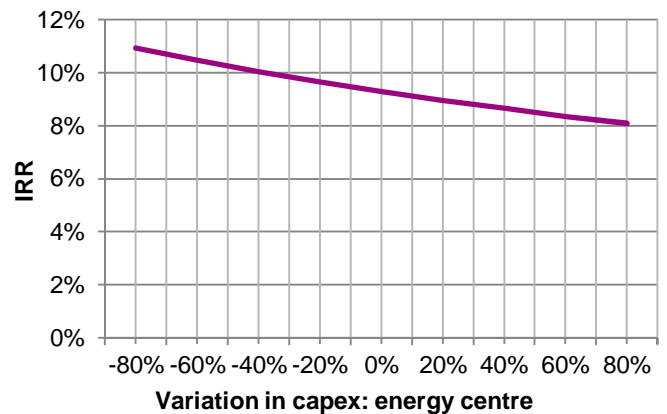


Figure 29: Sensitivity of project IRRs to energy centre capital costs

4.5.3 Developer contributions

As noted in Section 4.3.5, the financial analysis assumes developer contributions that broadly reflect the avoided costs for developers of meeting planning policy and Building Regulations requirements. The impact of variation in developer contributions on project viability is akin to that of a decrease or increase in net capital costs. A 10% decrease in developer contributions would reduce the IRR to about 8%, bringing it close to 6% with a 40% reduction.



4.5.4 Electricity sales revenue

The electricity sales revenue has a significant impact on the commercial viability of the scheme. This is impacted by the electricity tariff which in turn can vary depending on whether the generated electricity is directly exported to the grid or a proportion is sold locally<sup>26</sup>. The latter will typically attract higher tariffs relative to exporting to the grid<sup>27</sup>.

Figure 30 shows that a 20% drop in electricity revenues (which would equate to a reduced electricity export tariff of ~3.2p/kWh) would bring the IRR down to around 6% and the NPV of the investment close to zero. This assumes 100% of the generated electricity is exported to the grid. A 20% increase in revenues through a higher export tariff, on the other hand, would increase the IRR to over 11%. Equally, where 10% of the electricity is sold locally at a higher tariff of ~8p/kWh, this would give a similar outcome. A 60-40 split of exported to local sold electricity would increase the IRR close to 17%.

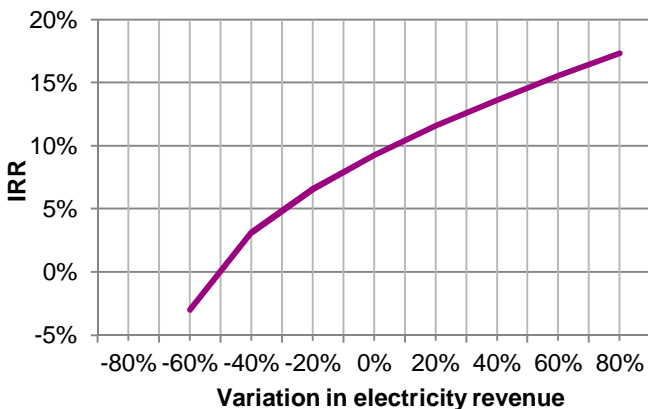


Figure 30: Sensitivity of project IRRs to electricity revenue

A licence for the supply of electricity would be required where selling electricity directly to end consumers via the public

<sup>26</sup> Via the electricity grid or a private wire arrangement  
<sup>27</sup> The core model assumes an export electricity tariff of 4p/kWh

network. This often requires substantial up-front investment and on-going resourcing. Licence Lite offers an option to reduce some of the financial and technical barriers to being a licensed supplier by allowing a new supplier to enter into a commercial arrangement with a third party licensed supplier (TPLS). The TPLS carries out compliance for certain part of the supply licence on behalf of the Licence Lite supplier.

The GLA is in the process of becoming a Licence Lite supplier that will allow it to buy electricity produced by London boroughs and other public sector decentralised energy generators and sell the electricity at market rates.

4.5.5 Waste heat price

The price of waste heat is a key variable for the commercial viability of a DH network under Option 3. Figure 31 shows that a 40% decrease in the price of heat would bring the IRR comparable to other options.

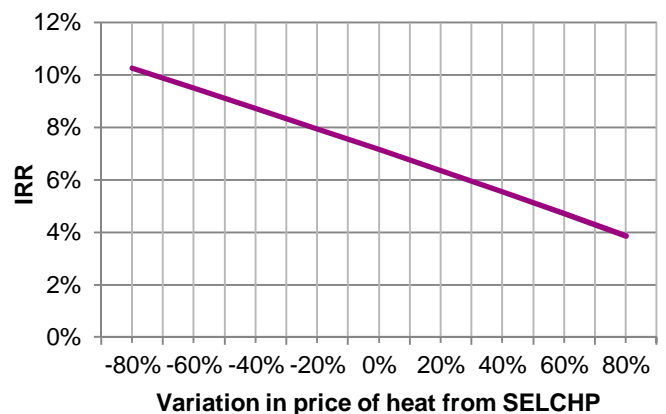


Figure 31: Sensitivity of project IRRs to SELCHP waste heat tariffs

4.6 Conclusions

The high-level feasibility analysis shows that a district heating network run on gas-CHP is viable for the opportunity area offering positive rates of return on investment.

The rate of return is highly sensitive to a range of variables, in particular projected heat demand, capital costs and revenues from electricity sales. There are also a number of technical, financial, and environmental risks associated with the delivery of the DH network. Therefore further detailed studies should be carried out to assess the technical aspects in more detail, appraise energy centre location/s and associated constraints, provide more certainty of capital and operational costs, and to develop a comprehensive future strategy for scheme operation. Consideration should also be given to the appropriate delivery route as that will also have a bearing on cost of finance and the desired level of return on investment.

The indicative capital costs for the modelled district heating options range from £58million to £64million, and are somewhat evenly spread across the three phases.

The analysis shows that both Option 1 and Option 2 offer a comparable rate of return on investment in the region of ~9% when fully built out and operational, with a net present value of circa £11.5m. Although Option 2 has a higher overall capex, some of the investment is deferred to later years translating into a marginally higher return. This does not however factor in the operational inefficiencies of managing three separate energy centres, which may or may not be significant depending on the management structure and whether these are under a single or separate ownership. As would be expected both options also offer similar CO<sub>2</sub> savings over the 40 year period.

Option 3 has a relatively lower rate of return compared to the other two options, though still exceeding the 6% threshold with a positive NPV of about £3.4m. The lower return can be attributed to the unit cost of waste heat and the lost revenues from electricity generation (relative to an all gas-CHP scenario). Option 3 however delivers the highest carbon savings over the 40 year analysis period due to the lower carbon factor for waste heat relative to heat from gas-CHP. It is however worth mentioning that the option has a high degree of

uncertainty attached with regard to the volume of waste heat that may potentially be available.

Under all options the investment does not break even in terms of cashflow until late 2030s. Also, Phase 1 in isolation does not deliver a healthy return on investment under all three options. The overall viability of all options can be improved where opportunities to sell electricity locally can be maximized, and additionally for Option 3 where a lower heat tariff for waste heat can be negotiated to reflect the lower management costs of selling heat to a single large consumer .

While the high level feasibility suggests an overall financial case for investing in DH network in the area, deliverability will be a challenge given the development phasing, multiple ownerships and local constraints such as air quality. From a strategic viewpoint, Option 1 may be a preferred solution as it offers scale (which may be an attractive proposition for investors, project developers and operators) as well as better flexibility to integrate new technologies in the future, such as the opportunity to harness waste heat from the London transport network. Option 2 on the other hand is a more practical proposition from a deliverability viewpoint. It allows energy centre costs to be phased but equally minimises the likely impact of siting a large energy centre on the viability of individual development plots/ sites. There would inevitably be challenges associated with integrating both a single large energy centre and three separate energy centres within a dense urban context in term of air quality, noise and visual impact, which would need to be fully taken into consideration when further assessing energy centre locations and during detailed design.

The results of this high-level feasibility study provide reasonable evidence for local planning policy to support the delivery of decentralised energy networks in the OKROA. Further detailed investigations as well as engagement with key stakeholders is recommended to inform a full business plan. A risk register outlining the key technical, financial and

environmental risks associated with delivery of district heating networks in the OKROA is included in Appendix E. A broad roadmap outlining next steps is set out in Section 5.4.

#### 4.7 Future Energy Systems

In order to meet the UK's target to reduce CO<sub>2</sub> emissions by 80% by 2050, it is recognised that the electricity grid will need to have substantially decarbonised through greater use of renewable energy and nuclear power. Transport energy use will need to have been substantially decarbonised through the use of measures such as electric vehicles, fuel cells operating on renewable derived hydrogen, or the use of biofuels. Heat will need to be delivered from low or nearly zero carbon sources of energy.

There are considerable uncertainties as to how quickly these transformations will take place and the precise mix of technologies which will come into play which in turn will be dictated by policy and market forces. However, one of the generally accepted outcomes is that there will be an increase in electricity demand from increased use of electric vehicles and increasingly for space heating as the grid decarbonises. There will also be increased use of intermittent renewable energy sources such as wind and solar power. This will mean substantial reinforcement of local and national electricity distribution networks and greater need for dynamic management of supply and demand to help reduce these reinforcement costs and to make the most effective use of renewable resources. This in particular is likely to include greater focus on storage mechanisms for helping to balance supply and demand, these could take many forms, examples including: large scale battery storage on electricity networks; use of heat networks to provide storage of surplus wind power through use of heat pumps or direct electric boilers at times of peak renewable generation; or inter-seasonal storage using electrolyzers to create hydrogen from surplus wind energy which could in turn supply fuel cells in cars, homes or heat

networks. It is beyond the scope of this study to resolve what are likely to be the most economically attractive and hence plausible future energy system outcomes, however, the GLA's " 'Smart City' - Intelligent energy integration for London's decentralised energy projects " (2012) study explored some of the potential ways in which London's energy system might evolve in the longer term.

One of the consequences of rapid decarbonisation of the electricity grid is that this will impact the carbon savings that are calculated for different heat generating technologies. The expectation is that over time, the carbon savings for gas CHP will reduce. This is because gas CHP currently derives much of its carbon benefit by generating electricity which offsets the need to import relatively high carbon energy from the grid. At the same time there is an expectation that heat pumps which at present have relatively high carbon emissions will become increasingly attractive as a heat generation technology as the grid decarbonises. In reality the situation may be more complex than this and there may be benefits in operating different technologies at different times of day to address changing supply and demand profiles. For example when there is a surplus of wind and solar energy it is likely electricity will be cheap and it could be expected that there will be an incentive to operate heat pumps to utilise this low carbon resource. By contrast at times when there are limited available renewable resources and peaks in electricity demand, operating gas CHP engines on heat networks where the waste heat can be utilised may offer a lower carbon alternative than the marginal generation plant that might otherwise be brought in to address the peak.

This implies that in future there will be benefits of energy centres being served by a number of heat generating options which the network operators will utilise according to the incentives and pricing signals available, which if policy has been effective will be driving the lowest carbon plant to operate at any given time. It is not currently possible to reflect this kind

of complexity in heat network carbon saving and revenue forecasts, but it implies the need to maintain flexibility for a range of future energy sources. At present heat network operators are likely to favour gas CHP engines as these will offer the greatest revenue and CO<sub>2</sub> savings at the current time.

#### 4.8 Policy Recommendations

1. **Support for a DH network in the OKROA** – This study provides the evidence base in support of a targeted policy to facilitate the delivery of a district heating scheme within the OKROA. It is recommended that Southwark Council use its planning powers to require major developments in the OKROA to connect to, or be futureproofed to connect to, a local district heating network, where viable. This will provide the necessary planning framework against which individual planning applications can be assessed. It will also provide confidence of connection from new developments that will be required to attract investment and delivery partners.

Figure 32 shows the extent of the proposed 'strategic district heating area' (SDHA) within which development plots are recommended to be connected (or designed to allow connection) to a DH network. This indicative area is based on the data available to date on current and future energy demand within the OKROA, and should be reviewed in light of changes to projected development capacities or where significant developments are proposed outside this indicative boundary.

2. **Design requirements for developments** – The policy should include reference to the CIBSE Heat Networks Code of Practice and the technical standards set out in the London Heat Network Manual, in particular for secondary system design to ensure effective operation of the DH network.

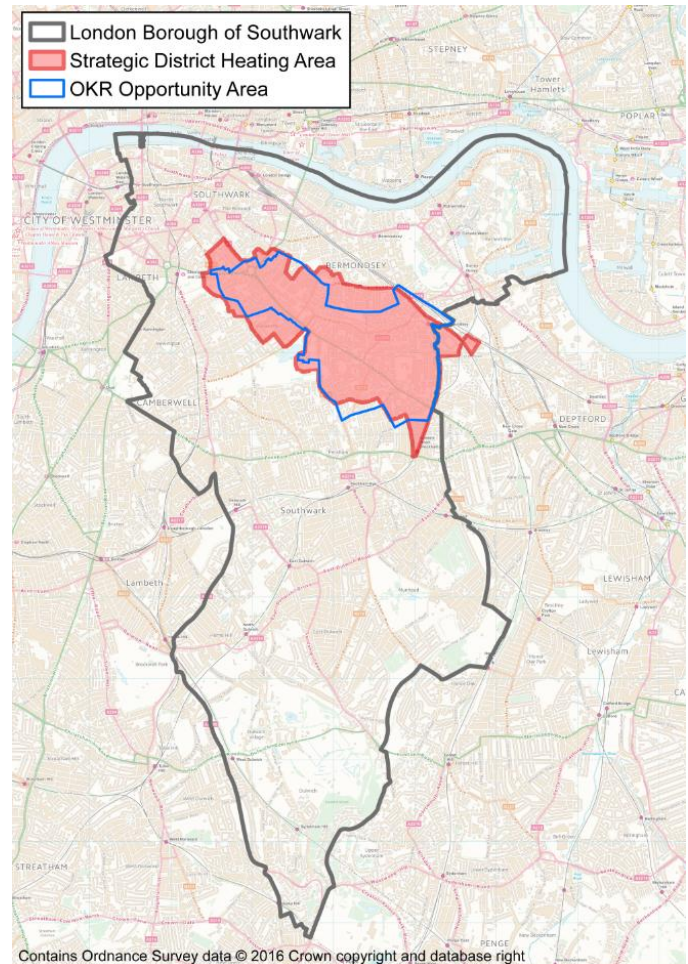


Figure 32: Proposed Strategic District Heating Area

3. **Futureproofing requirements for developments** – Developments coming forward prior to the DH network being installed should be required to include physical safeguarding measures for pipe routes and adopt the design requirements referred to above.
4. **Safeguarding of pipework routes** - Proposals for major infrastructure crossings and bridges should be required to demonstrate that provision is included to accommodate utilities networks, including heating and cooling network pipes where appropriate.
5. **Harnessing opportunities for waste heat** – Developments with significant surplus of waste heat should be required to

assess the potential to supply this to an area-wide heat network and to make suitable provision, where viable.

# Implementation and Delivery

## 5 Implementation and Delivery

This chapter focusses on the role of planning in facilitating the delivery of DH networks, the range of delivery models that could be considered, as well as alternative funding streams and sources of finance that may be available. It goes on to outline the broad delivery roadmap and strategic actions required to bring forward investment in required infrastructure and assets.

### 5.1 The role of planning

Under the National Planning Policy Framework, local authorities have a responsibility to contribute to the UK's emissions reduction targets set out in the 2008 Climate Change Act by using local planning policy and guidance, and by encouraging and facilitating co-ordinated local action. Southwark Council's Climate Change strategy aims to reduce carbon emissions by 80% by 2050 and promotes the use of CHP and district heating networks as one of the main means of tackling CO<sub>2</sub> emissions from buildings.

The techno-economic assessment undertaken as part of this study has demonstrated the potential viability of heat networks for OKROA. In particular, in the case of the OKROA it has been concluded that in the absence of existing buildings that could serve as 'anchor loads' as well as the absence of clusters of existing buildings with significant heat demand density, the development of heat networks in the OA would have to be largely new development led. Using the outcomes from this study as evidence base, planning policy could therefore be put in place to support development of decentralised energy networks requiring new developments to either connect to, or design for future connection to, a DE network with the OKROA.

The Area Action Plan (AAP) being developed by Southwark Council could, for instance, designate a strategic district heating area (SDHA) that extends to include major development plots and large existing loads within the OKROA. S106 obligations could be used to require connection to DH networks or to futureproof development to enable them to be connected once the system is operational. There are a number of precedents for using planning policy to achieve similar outcomes in recent years, such as in the case of the Canada Water AAP and the Olympic Park.

Planning policy should also be used to help safeguard possible network routes and energy centre locations. In addition, new developments should be required to be designed in line with the CIBSE Heat Networks Code of Practice and the technical standards outlined in the London Heat Network Manual to enable connection and effective operation of the DH system. A key issue for efficient network operation is ensuring secondary systems within buildings are designed to reduce heat losses and to return low water temperatures to the network. The standards referenced above aim to address this issue along with other important design considerations.

Beyond planning policy, a collaborative approach with developers and other key stakeholders should be explored to bring forward investment in DH and other strategic infrastructure. The Embassy Quarter in Nine Elms is one example where the local authorities have worked closely with development partners.

The Vauxhall Nine Elms Opportunity Area Planning Framework (along with the Vauxhall Area Supplementary Planning document) is another example of a strong local planning policy in support of district heating. With engagement and leadership from Lambeth and Wandsworth Council, and the GLA, the Nine Elms Vauxhall Partnership (NEVP) was set up for delivering the strategic vision for the area and the required investment in infrastructure. The NEVP includes the area's main developers and landowners, the Mayor of London, Transport for London, and the GLA. The Embassy Quarter in Nine Elms is an example of a coordinated approach among developers and key stakeholders to facilitate the delivery of a district heating network by assembling the heat loads across individual plots and taking these to the market. Energy Service Companies (ESCO) were invited to present proposals to develop and invest in an area-wide DH solution. The commercial and contractual negotiations are currently underway.

participating entities. The choice of delivery model will be informed by a range of considerations, and in particular:

- Project-specific technical, construction, operational, performance and regulatory risks;
- Appetite for risk for the lead organisation and other participating organisations and/or stakeholders;
- The degree of control on desired outcomes (e.g. environmental and/or other co-benefits) that the lead organisation would ideally like to retain;
- The commercial viability and expected return on investment;
- Internal capacity and resources available to the lead organisation, including availability and access to finance.

**5.2 Delivery models**

Consideration should be given to a suitable delivery and business model at an early stage. Delivery models for district heating networks, and other low carbon investments, range from fully public sector led to fully private sector led, and a variety of partnership or 'hybrid' arrangements between public, private and non-governmental sectors. The hybrid arrangements include community ownership models wherein for instance the local community provides overall governance with the operation and maintenance outsourced to the private sector.

The type of delivery model determines the balance of risk and reward along with the level of control for the

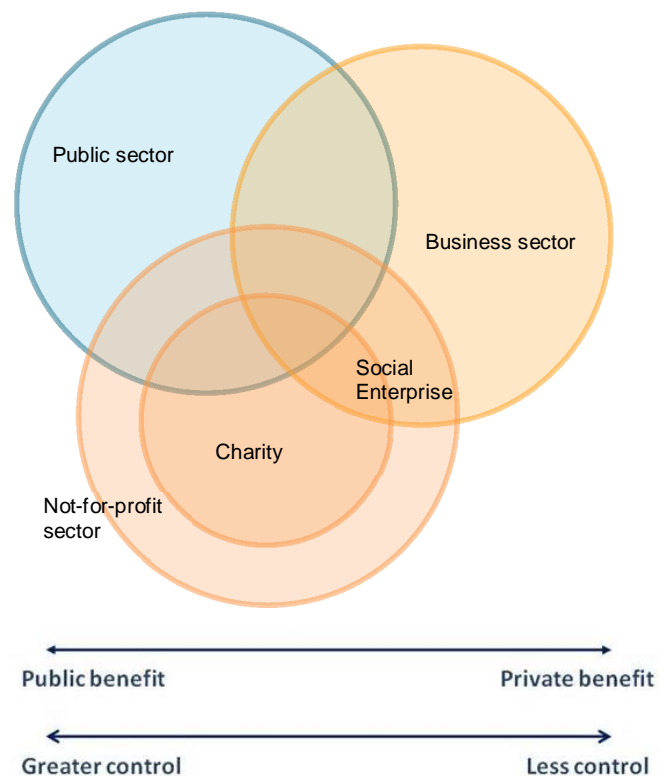


Figure 33: Spectrum of delivery models for low carbon investments (Source: Making ESCos Work)



Delivering large district heating projects, and other low carbon investments projects, may require the creation of a Special Purpose Vehicle (SPV) to channel investment and to manage risk, particularly in the case of hybrid/ partnership arrangements between public, private and/or non-governmental sectors. An SPV is a discrete legal entity created around a project, disconnected from other obligations or activities of participating organisations.

From a local authority perspective, potential advantages and disadvantages associated with publicly led and privately led delivery routes are shown in the table below.

	Private sector led delivery model	Public sector led delivery model
Advantages	<ul style="list-style-type: none"> <li>• Predominantly private sector capital (though could include some seed/ development funding from public sector)</li> <li>• Transfer of risks to private sector</li> <li>• Commercial and technical expertise (e.g. specialist energy service companies)</li> </ul>	<ul style="list-style-type: none"> <li>• More control over strategic direction</li> <li>• Lower cost of capital (e.g. where secured through Prudential Borrowing)</li> <li>• Relatively lower threshold for financial returns by accounting for wider social and/or environmental benefits</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>• Loss of control over strategic outcomes</li> <li>• Most profit retained by private sector</li> <li>• Incremental expansion more difficult and driven by commercial interests</li> <li>• High cost of capital</li> <li>• Higher threshold for financial return on investment</li> </ul>	<ul style="list-style-type: none"> <li>• Risks retained by public sector</li> <li>• Less access to private capital and expertise, though expertise can be obtained through outsourcing and specific recruitment</li> <li>• Prudential borrowing burdens local authority balance sheet; applicability limited by gearing covenants</li> </ul>

Table 4: Advantages and disadvantages of public and private sector led delivery routes

A review of delivery structures for heat networks<sup>28</sup> identified the following delivery models that have typically been adopted in the UK to date.

- **Public sector led, public sector ownership.** Typically the public sector leads the development of the project and takes full financial risk. However some elements of the construction and/or operation may be outsourced to specialist companies in the private sector. These include examples where the DH scheme is delivered and managed in-house (such as in case of Bunhill scheme by London Borough of Islington), or via an arm’s length wholly -owned company (e.g. Aberdeen Heat and Power Company Limited).
- **Public sector led, private sector ownership.** Public sector procures a private sector partner / ESCo (refer section 5.2.1) under a long-term service concession agreement. The private sector in this instance builds, owns and operates the scheme for the duration of the agreement. Assets may or may not revert to public sector ownership at the end of the term. Examples include Birmingham and the DH scheme led by Leicester City Council.
- **Private sector led, private sector ownership.** A developer procures a long-term private sector ESCo partner to develop, own and operate the scheme under a long-term concession, with ESCO retaining ownership of the assets. Some examples include King’s Cross, Southampton, Citigen (London), and Sheffield.

Even in case of a private sector led and owned model, the role of local authorities as a facilitator cannot be underestimated, in particular for area-wide schemes with multiple land ownerships and phased delivery. It is imperative that the local authority sets a clear long term

<sup>28</sup> Scottish Futures Trust, Guidance on Delivery Structures for Heat Networks, 2015

vision and a plan for the delivery (and expansion of heat networks) supported by the right policy instruments, both to give confidence to the private sector and to retain a degree of control on outcomes. As the local authority, Southwark Council is also best placed to identify synergies with other public sector initiatives and related opportunities.

#### 5.2.1 Energy Service Companies (ESCOs)

Energy Service Companies (ESCOs) is a broad term that can potentially include any entity that is involved in delivering, operating and managing energy efficiency and/or sustainable energy projects or initiatives. In the current context, the term ESCo is used to refer to commercial businesses (public owned, private sector owned or joint venture partnerships between public and private entities) that provide and manage energy solutions. A full ESCo service involves the following elements:

- Finance
- Design
- Installation
- Operation
- Maintenance
- Management and billing

On a particular scheme, the role and level of involvement of the ESCO can vary from delivering the whole end-to end service or be limited to one part of the project delivery. Typically ESCOs will be contractually responsible for the delivery of energy services to end consumers, maintenance and renewal of plant and equipment, managing purchase of fuel (and/or heat) and ensuring the on-going financial viability of the scheme.

ESCOs may be existing specialist companies or may be formed specifically for the project concerned (e.g. Aberdeen Heat and Power Company Limited). ESCOs could also offer

a broader multi-utility service beyond just energy services, referred to as MUSCOs.

### 5.3 Funding streams and sources of finance

The range of funding and financing options that may be available for district heating schemes are briefly listed below.

- Conventional project financing (e.g. via a private sector partner or ESCo);
- Prudential borrowing (e.g. in case of a public- sector led delivery model or where public sector provides initial seed funding);
- Non-recourse project finance (typically through creation of a 'Special Purpose Vehicle' involving public and/or private sector entities with a combination of bank debt and/or prudential borrowing).

The above can potentially be supplemented / coupled with the following sources of funding:

- Developer contributions, including both S106 and Community Infrastructure Levy (although the availability of both mechanisms to fund district heating infrastructure will be limited by other local priorities);
- Support available for low carbon technologies, such as through the Renewable Heat Incentive (RHI), which will be technology and scale dependent and likely to be phased out over time;
- National government capital support for heat networks. As part of the spending review, the government has recently announced £300m of capital support for heat networks from 2016 -2021, with a view to leverage up to £2bn of private and local investment;
- European Structural funding, e.g. via instruments such as JESSICA (Joint European Support for Sustainable Investment in City Areas).

To facilitate investment in climate change programmes and related infrastructure, the London Green fund was set up in 2011 as the first JESSICA Holding fund in the UK with circa £100m of public sector finance. The Fund consists of three Urban Development Funds (UDFs) – a Waste UDF, an Energy Efficiency Fund UDF, and a Greener Social Housing UDF. These are ‘revolving’ investment funds, where monies invested in one project are repaid and then reinvested in other projects. The Energy Efficiency UDF, called London Energy Efficiency Fund (LEEF), can provide finance for district heating schemes in the form of senior and mezzanine debt. The Lee Valley heat Network Ltd., established as a local authority controlled company to provide heating and hot water to local residents is an example of one such beneficiary.

Development funding and technical assistance grants may be available from the following sources to facilitate investment in district heating:

- Grant funding from DECC’s Heat Networks Delivery Unit (HNDU) for feasibility studies and detailed project development work;
- European development funding and technical assistance for low carbon investments, such as ELENA (European Local Energy Assistance) and MLEI (Mobilising Local Energy Investments).

The Greater London Authority (GLA) had set up a dedicated Decentralised Energy (DE) Project Delivery Unit (PDU) with funding from European Investment Bank’s ELENA (European Local Energy Assistance) to provide technical, commercial and commercial advisory support to public and private sector to develop DE projects. To date, support has been provided to over 40 projects over the 4-year programme with 10 projects progressing to procurement and delivery stage to date, and many more in the pipeline. After March 2016, DEPDU is expected to be followed by a

successor programme, Energy for London (EfL) that will build on and consolidate previous work programmes.

Further details on the potential funding and financing sources are provided in Appendix F.

**5.4 Delivery roadmap**

The following table sets out a broad roadmap for the delivery of district heating network in OKROA.

Step	Requirement
1	Develop local planning policy framework
2	Commission detailed technical & financial feasibility studies
3	Stakeholder engagement
4	Identify suitable delivery model and financing route
5	Set up delivery and governance structures
6	Select delivery partners/ specialist contractors and agree terms

*Table 5: Delivery roadmap outlining key next steps for delivery of DH networks in OKROA*

The steps are outlined in more detail below:

**Step 1 – Develop local planning policy framework**

This is currently underway and the findings from this high-level feasibility assessment will be used to inform the AAP / OAPF that is currently being developed for the OKROA. As outlined in Section 5.1, planning policy should require new developments to connect or futureproof development to connect to an OA-wide DH scheme. Additionally, planning

policy should also be used to help safeguard possible network routes and energy centre locations.

### Step 2 – Commission detailed technical & financial feasibility studies

A full feasibility assessment should be commissioned to assess the technical aspects in more detail, appraise energy centre location/s and associated constraints, provide more certainty of capital and operational costs, and to develop a comprehensive future strategy for scheme operation. This should also ideally include soft market testing to understand the appetite of the private sector to deliver and invest in associated infrastructure.

Grant funding for feasibility studies and detailed project development work may be sought from DECC's Heat Networks Delivery Unit (HNDU) (subject to this programme being extended beyond March 2016). Technical assistance can also be sought from DEPDU or its successor programme, Energy for London.

### Step 3 – Stakeholder engagement

This is an on-going exercise that will effectively run in parallel with the detailed feasibility studies, and will also help inform the next step on identification of suitable delivery models. Key stakeholders will need to be identified but will include developers, local businesses, ESCOs, utilities, GLA and other public sector agencies (such as TfL), as well as internal planning, sustainability, housing and/or finance teams.

### Steps 4 – Identify suitable delivery model and financing route

The appropriate delivery model will depend on a number of factors but the most significant will be the scale of financial investment and the allocation of risk. Consideration should be given to the role of the public sector and the balance of risk and reward that is deemed acceptable. The alternative

options should be appraised within the overall context of delivering the Council's key environmental and/or social objectives and targets.

The alternative financing options will also need to be considered. To improve the overall business case, this should include the opportunity to combine private sector funds with low cost finance from, for instance, LEEF and/or funding from the national government capital support announced as part of the October spending review<sup>29</sup>.

### Step 5 – Set up delivery and governance structures

The scope of this exercise will be dependent on the type of delivery model identified. This could include, for instance, setting up an in-house team or arm's length companies in case of a public sector led model, and SPVs (or other joint working arrangements) in case of a public-private partnership model. Appropriate governance arrangements should be defined for the delivery entity that will set out the overall framework and processes for operation, management and decision-making.

A wholly private sector led model would also typically require a steering board/ committee to be set up. The steering group would be formed of key stakeholders and ideally led by the Council with a view to provide strategic direction and facilitate coordinated decision-making.

### Steps 6 – Select delivery partners/ procure specialist contractors and agree terms

The scope of this exercise will again be dependent on the delivery model, which will determine the type of partners and/or range of specialist services required. In case of a public sector-led model, this will involve procurement of specialist services for which either skills do not exist in-

<sup>29</sup> Please note that details on the eligibility and funding criteria are not available at present.

house or those that are considered best to outsource from an efficiency viewpoint.

Procuring a private sector ESCo partner under a long-term service concession agreement will require full consideration of roles, responsibilities, ownership of assets, performance standards and associated penalties in case of default, and tariff structures. The contractual arrangements will to a large extent determine the level of control that the local authority will have over tangible outcomes.

# Appendices

## Appendix A: Glossary

**AAP** – Area Action Plan

**Anchor Loads** – These are pre-existing loads in a given area they can justify the start of development of a network owing to them being particularly large consumers (e.g. hospitals are one type of load often considered as an anchor).

**Air quality management Area (AQMA)** – are designated areas that do not meet the national air quality objectives and have a local air quality action plan put in place by the local authority to improve air quality

**CIBSE** – Chartered Institution of Building Services Engineers

**Combined Heat and Power (CHP)** – integrates the production of usable heat and power (electricity), in one single, highly efficient process.

**Community Heating** – means the distribution of thermal energy in the form of steam, hot water, or chilled liquids from a central source in a building which is occupied by more than one final customer, for the use of space or process heating, cooling or hot water.

**CIL** – Community Infrastructure Levy

**CO<sub>2e</sub>** – Carbon Dioxide equivalent

**DECC** – Department of Energy and Climate Change

**Discount rate** - The discount rate is used to convert all costs and benefits to 'present values', so that they can be compared. The discount rate which is used in financial calculations is usually chosen to be equal to the cost of capital.

**District Heating (DH) network** – means the distribution of thermal energy in the form of steam, hot water or chilled liquids from a central source of production through a network to multiple buildings or sites for the use of space or process heating, cooling or hot water.

**Energy Supply Company (ESCO)** – A commercial entity which typically operates and maintains the plant associated with a district heating network. They would also normally bill any user of the DH system.

**Target Fabric Energy Efficiency standard (TFE)** – that sets the minimum energy performance for new dwellings under Part L 2013

**Feed in Tariffs (FITs)** – Government incentive paid for electricity generated from renewable sources

**Geographic Information System (GIS)** – Visual representations in map form so that relationships of physical location can be observed

**Heat Density Mapping** – A visual representation of the heat demand in a given area, shown as thermal energy demand per unit area

**Heat Interface Unit (HIU)** – is an integrated solution for delivering and recording the heat consumed by an individual dwelling served from a centralised heating plant or district heating scheme

**Internal Rate of Return (IRR)** – is used for each potential project as a key tool in reaching investment decisions. It is used to measure and compare the profitability of investments. The IRR can be said to be the earnings from an investment, in the form of an annual rate of interest.

**KWh** – Kilowatt hours, unit of energy

**LZCs** – Low and Zero Carbon energy generation technologies, such as biomass, wind, solar etc.

**MWh** – Megawatt hour, unit of energy consisting of 1000 kilowatt hours

**Net Present Value (NPV)** - NPV is a central tool in discounted cash flow (DCF) analysis, and is a standard method for using the time value of money to appraise long-term projects.

**OKROA** – Old Kent Road Opportunity Area

**Opportunity area planning framework (OAPF)** – is a Supplementary Planning Guidance (SPG) to the London Plan (2015) and set out the development plans for the opportunity area

**Opportunity Area** – are designated areas in London that have significant capacity for development – such as housing or commercial use – along with existing or potentially improved public transport access

**Renewable energy** – Energy derived from sources which are replenished within the lifecycle of their consumption

and involve zero, or near zero, carbon emissions over this lifecycle

**Renewable Heat Incentive (RHI)** - Government's proposed fiscal incentive for sale of heat from renewable sources

**Special Purpose Vehicle (SPV)** – A subsidiary corporation designed for high risk investments.

**SPD** – Supplementary Planning Document



## Appendix B: Indicative development capacity for OKROA under the high scenario

Table 6: Development plots in the OKROA with the indicative capacities and phasing under the high development scenario

Site Ref	Indicative Capacities (sq. m)					Phasing
	Residential	Employment space	Schools	Retail	Culture	
1	4,523.8	13,835.6	0.0	0.0	0.0	2030-2036
2	36,149.2	6,807.7	0.0	1,936.6	0.0	2030-2036
3	31,323.5	0.0	0.0	2,109.5	0.0	2030-2036
4	42,777.4	0.0	0.0	0.0	0.0	2030-2036
5	31,841.6	5,235.8	0.0	0.0	4,058.7	2025-2030
6	45,934.0	0.0	0.0	0.0	0.0	2025-2030
7	32,315.0	0.0	0.0	0.0	0.0	2030-2036
8	6,593.4	6,464.2	0.0	2,242.1	0.0	2030-2036
9	12,529.0	0.0	0.0	723.6	0.0	2030-2036
10	0.0	0.0	2,592.5	0.0	0.0	2030-2036
11	14,949.9	0.0	0.0	1,814.9	0.0	2025-2030
12	15,719.2	0.0	0.0	2,182.7	0.0	2025-2030
13	15,227.0	0.0	0.0	2,142.3	0.0	2025-2030
14	22,329.4	0.0	0.0	1,931.8	0.0	2030-2036
15	30,600.4	0.0	11,296.5	0.0	0.0	2030-2036
16	15,026.5	0.0	0.0	1,811.7	0.0	2025-2030
19	0.0	3,169.1	0.0	528.2	0.0	2030-2036
20	23,217.2	766.5	0.0	0.0	0.0	2020-2025
21	25,036.0	881.5	0.0	0.0	0.0	2025-2030
22	24,109.4	396.7	0.0	480.0	0.0	2025-2030
23	10,005.1	0.0	0.0	1,283.5	0.0	2025-2030
24	23,551.4	0.0	0.0	1,788.1	0.0	2020-2025
25	30,812.6	0.0	0.0	754.3	0.0	2020-2025
26	10,205.4	11,370.6	0.0	3,000.0	0.0	2025-2030

Site Ref	Indicative Capacities (sq. m)					Phasing
	Residential	Employment space	Schools	Retail	Culture	
27	14,903.7	5,298.9	5,532.8	1,695.8	0.0	2025-2030
28	18,648.1	0.0	0.0	0.0	0.0	2030-2036
29	34,496.4	0.0	0.0	0.0	0.0	2025-2030
30	40,794.6	0.0	0.0	0.0	0.0	2020-2025
31	26,284.2	0.0	0.0	2,006.4	0.0	2020-2025
32	14,545.5	0.0	0.0	2,704.0	0.0	2025-2030
33	32,467.7	11,367.2	0.0	0.0	0.0	2015-2020
34	31,678.2	0.0	0.0	0.0	0.0	2025-2030
35	31,439.2	0.0	0.0	0.0	0.0	2025-2030
36	23,632.0	0.0	0.0	0.0	0.0	2020-2025
37	15,685.4	0.0	0.0	0.0	0.0	2020-2025
38	23,894.3	0.0	0.0	828.0	0.0	2020-2025
39	0.0	28,947.5	0.0	0.0	0.0	2020-2025
42	18,717.1	0.0	0.0	0.0	0.0	2020-2025
43	43,560.9	0.0	0.0	3,049.2	0.0	2025-2030
44	14,426.0	0.0	0.0	0.0	0.0	2020-2025
45	13,605.4	0.0	0.0	0.0	0.0	2020-2025
46	29,611.3	0.0	0.0	0.0	0.0	2025-2030
51	16,089.6	0.0	0.0	0.0	0.0	2030-2036
52	2,579.5	0.0	0.0	644.9	0.0	2030-2036
53	25,667.7	0.0	0.0	0.0	0.0	2030-2036
54	17,851.0	0.0	0.0	0.0	0.0	2030-2036
55	4,660.6	0.0	0.0	776.8	0.0	2030-2036
56	7,674.4	0.0	0.0	1,279.1	0.0	2020-2025
57	0.0	4,732.0	0.0	0.0	0.0	2020-2025

Site Ref	Indicative Capacities (sq. m)					Phasing
	Residential	Employment space	Schools	Retail	Culture	
58	7,402.9	0.0	0.0	0.0	0.0	2025-2030
60	48,259.4	0.0	0.0	0.0	0.0	2030-2036
61	32,086.0	0.0	0.0	495.5	0.0	2020-2025
62	46,418.8	0.0	0.0	0.0	0.0	2020-2025
63	16,322.1	0.0	3,659.8	0.0	0.0	2020-2025
64	15,889.3	0.0	0.0	0.0	0.0	2025-2030
67	13,240.9	0.0	0.0	0.0	0.0	2025-2030
68	51,691.5	0.0	0.0	0.0	0.0	2030-2036
69	38,409.1	0.0	0.0	0.0	0.0	2030-2036
70	16,284.8	447.6	0.0	0.0	0.0	2030-2036
71	21,077.6	758.0	0.0	0.0	0.0	2030-2036
72	54,136.3	0.0	0.0	0.0	0.0	2030-2036
74	4,264.6	710.8	0.0	0.0	0.0	2030-2036
75	17,462.1	0.0	0.0	0.0	0.0	2030-2036
76	11,187.3	0.0	0.0	0.0	0.0	2030-2036
77	11,642.4	0.0	0.0	0.0	0.0	2025-2030
79	7,596.5	0.0	0.0	0.0	0.0	2025-2030
82	3,798.3	0.0	0.0	0.0	0.0	2025-2030
83	10,852.2	0.0	0.0	0.0	0.0	2025-2030
84	7,961.7	0.0	0.0	987.4	0.0	2030-2036
85	14,400.0	0.0	0.0	576.0	0.0	2030-2036
86	24,913.4	0.0	0.0	2,613.0	0.0	2030-2036
87	33,036.8	8,022.5	0.0	2,889.6	0.0	2025-2030
88	7,606.4	0.0	0.0	1,267.7	0.0	2025-2030
90	16,324.0	0.0	0.0	0.0	0.0	2025-2030

Site Ref	Indicative Capacities (sq. m)					Phasing
	Residential	Employment space	Schools	Retail	Culture	
91	12,243.1	0.0	0.0	0.0	0.0	2025-2030
92	6,938.5	0.0	0.0	0.0	0.0	2020-2025
93	7,629.7	0.0	0.0	0.0	0.0	2020-2025
94	11,520.0	0.0	0.0	0.0	0.0	2020-2025
95	0.0	0.0	12,980.9	0.0	0.0	2030-2036
96	17,129.9	899.2	0.0	2,575.6	0.0	2025-2030
98	12,679.6	0.0	0.0	0.0	0.0	2020-2025
99	19,844.3	0.0	0.0	0.0	0.0	2025-2030
100	13,776.6	0.0	0.0	0.0	0.0	2025-2030
101	40,359.3	0.0	0.0	0.0	0.0	2025-2030
102	7,804.1	0.0	4,205.7	0.0	0.0	2020-2025
103	20,861.2	0.0	0.0	0.0	0.0	2020-2025
106	6,257.5	0.0	0.0	0.0	0.0	2020-2025
107	9,780.9	0.0	0.0	0.0	0.0	2020-2025
109	23,011.0	0.0	0.0	0.0	0.0	2025-2030
110	10,389.3	0.0	0.0	0.0	0.0	2025-2030
111	14,400.0	0.0	0.0	0.0	0.0	2025-2030
115	47,360.6	0.0	0.0	0.0	0.0	2020-2025
116	44,417.1	0.0	0.0	0.0	0.0	2025-2030
117	10,499.0	0.0	0.0	0.0	0.0	2015-2020
118	23,211.8	0.0	0.0	0.0	0.0	2030-2036
119	30,659.0	0.0	0.0	0.0	0.0	2020-2025
120	17,525.6	0.0	0.0	0.0	0.0	2015-2020
121	20,925.2	348.7	0.0	0.0	0.0	2025-2030
122	16,641.2	0.0	0.0	0.0	0.0	2015-2020

Site Ref	Indicative Capacities (sq. m)					Phasing
	Residential	Employment space	Schools	Retail	Culture	
129	7,612.1	0.0	0.0	0.0	0.0	2030-2036
131	18,065.5	0.0	0.0	0.0	0.0	2030-2036
132	5,156.7	0.0	0.0	573.0	0.0	2030-2036
135	2,391.6	0.0	0.0	797.2	0.0	2030-2036
137	5,793.5	0.0	0.0	0.0	0.0	2030-2036
143	23,448.9	0.0	0.0	0.0	0.0	2030-2036
144	12,911.6	0.0	0.0	0.0	0.0	2025-2030
145	42,991.9	0.0	0.0	0.0	0.0	2020-2025
146	22,720.0	1,008.0	0.0	0.0	0.0	2030-2036
150	24,224.8	0.0	0.0	0.0	0.0	2030-2036
<b>SUM</b>	<b>2,151,134.3</b>	<b>111,468.1</b>	<b>40,268.1</b>	<b>50,488.3</b>	<b>4,058.7</b>	

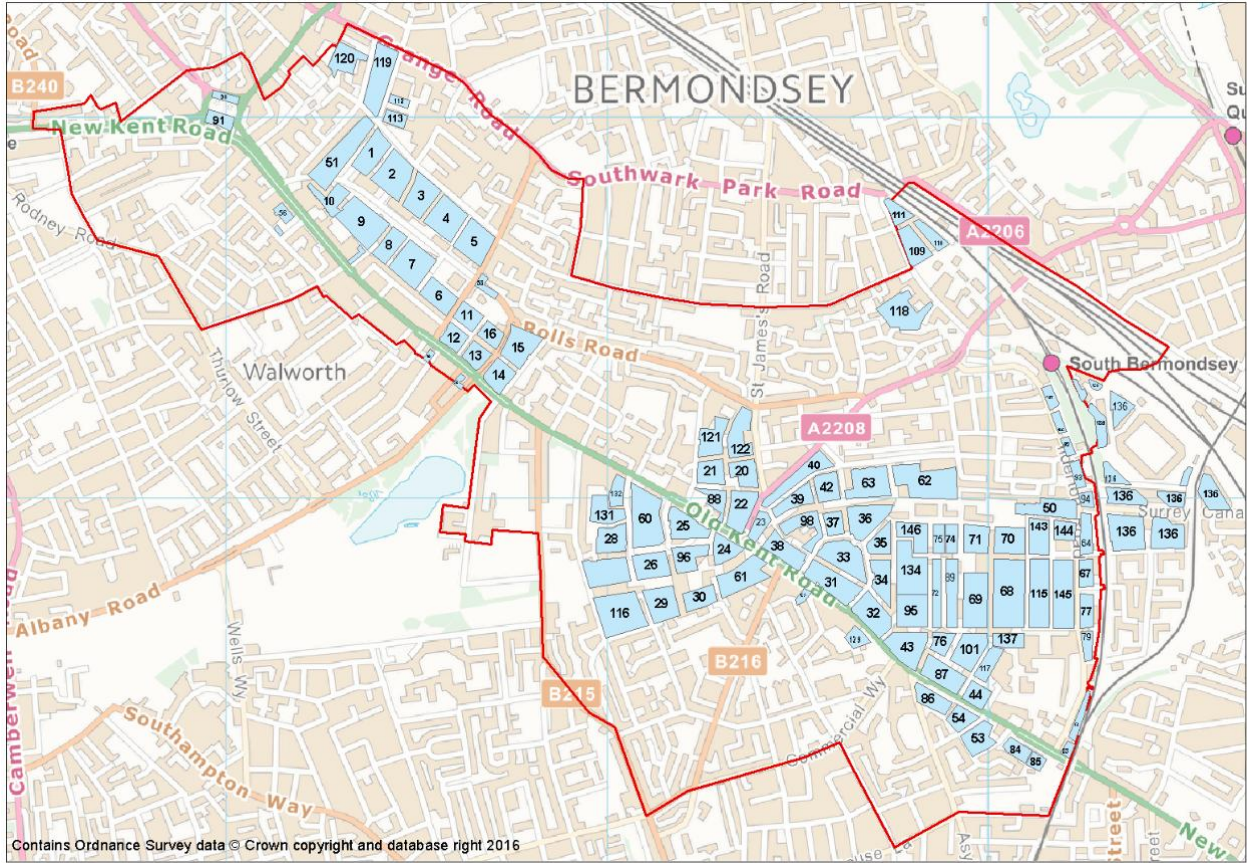


Figure 34: Map of development plots in the OKRO

## Appendix C: Input data and Assumptions

### C1. Assumptions for new-build development projections

Data on the quantum, type and timeline of likely new development in OKROA area was provided by Southwark Council on the 15<sup>th</sup> of January 2015, as shown in Appendix B. The following assumptions were made regarding the development projections to estimate the baseline energy demand for each of the development plots.

- All residential accommodation will be planning class C3.
- 90% of the residential units will be flats and 10% will be houses.
- On average, the dwellings will have 70m<sup>2</sup> of heated floorspace. This is in line with the assumption made in the place-making study commissioned by Southwark Council for the OA
- All employment space will be planning class B1, and will consist of 60% office accommodation and 40% light industry.
- 80% of the retail space will be planning class A1/A2 while the remainder 20% will be planning class A3/A4/A5.
- All cultural space will be planning class D (consisting of both D1 and D2 activities).

The assumed completion year for future phases of development is as tabulated below.

*Table 7: Estimated assumed completion year*

Phasing	Assumed completion year
2015 – 2020	2018
2020 – 2025	2023
2025 – 2030	2028
2030 – 2036	2034

### C2. Energy Demand from new and existing buildings

In order to incorporate the most appropriate energy benchmarks for the study, a number of data sources were considered.

These include:

- Metered data on annual fossil fuel consumption for existing sites, where available;
- CIBSE Guide F 'Energy Efficiency in Buildings' (Third Edition, May 2012);
- CIBSE TM46 'Energy Benchmarking' (October 2008); and
- Building Regulations approved software modelling experience from recent AECOM projects.

Depending on the nature, class and condition of the building, a combination of the above methodologies has been used for the baseline energy assessment. Our proposed approach is discussed in detail below.

### Existing buildings

CIBSE Guides F and TM46 are widely recognised industry standard documents on energy efficiency in buildings that include energy consumption benchmarks for fossil fuel and electricity consumption. Although benchmarks found in CIBSE Guides F and TM46 are considered outdated (given underlying survey data used to derive the benchmarks), they still form the most extensively accepted benchmark references in the industry and are considered the most reliable source for establishing energy use in existing buildings. Owing to the larger range of building use categories found in CIBSE Guide F, a greater resolution of consumption data can be achieved compared to say CIBSE TM46. CIBSE Guide F data has therefore been used to benchmark energy consumption for existing buildings other than dwellings. Other published sources, such as Energy Consumption Guide (ECON or ECGs), such as ECON 19 for offices, provide much more detailed breakdown of energy consumption data for certain building types but are based on the same underlying data from building surveys conducted in the early 1990s.

In the absence of specific data on the age of existing buildings, it is considered appropriate to assume that the 'Typical practice' standards included in CIBSE Guide F will accurately represent the current fuel consumption for heat and electricity.

For the existing residential estates, information was supplied by Southwark Council on the gas consumption, the electricity used in landlord areas and the size of the plant for five different sites. However, due to the inconsistency of the fossil fuel consumption data provided and the consequent uncertainty over those figures, CIBSE TM46 data has been used. CIBSE TM46 includes domestic data under its 'General Accommodation' category which is considered more relevant to dwellings compared to the data in CIBSE Guide F, which is mostly associated with residential institutions, such as care homes, student accommodation, etc.

Table 8 below shows the building use categories that have been applied for each development type. An 80% efficient heating system has been assumed to convert the fossil fuel consumption data to heat demand figures. It is worth noting that efficiency of non-condensing boilers will be lower than the 80% figures but this figure is used given the replacement frequency for boilers.

*Table 8: Benchmarking approach for existing buildings*

Development Type	Planning Class	Source	Building use categories applied
<b>Dwellings</b>	C3	CIBSE TM46	Flats, houses (Category 22 – General Accommodation)
<b>Residential Institutions</b>	C2	CIBSE Guide F 'Typical'	Care homes (combination of residential and nursing homes & residential care homes)
<b>Hotels</b>	C1	CIBSE Guide F 'Typical'	Hotels (typical business or holiday hotel)



Development Type	Planning Class	Source	Building use categories applied
<b>Employment</b>	B1	CIBSE Guide F 'Typical'	Offices (standard air-conditioned office unit)
	B2	CIBSE Guide F 'Typical'	Light industrial uses (light manufacturing unit)
	B8	CIBSE Guide F 'Typical'	Distribution / Storage
<b>Schools</b>	D1	CIBSE Guide F 'Typical'	Primary and secondary schools
<b>Retail</b> <sup>†</sup>	A1/A2	CIBSE Guide F 'Typical'	Clothes shops, department stores, post offices, supermarkets, banks and agencies
	A3/A4/A5	CIBSE Guide F 'Typical'	Fast food restaurants, restaurants with bar and restaurants in public houses
<b>Culture</b> <sup>†</sup>	D1	CIBSE Guide F 'Typical'	Day centres, libraries, museums
	D2	CIBSE Guide F 'Typical'	Cinemas, health centres, social clubs

<sup>†</sup> For non-domestic planning classes that contain a mixture of building types (e.g. cinemas and health centres in Class D2), an un-weighted average of the relevant buildings under each class has been used to establish a class-wide consumption benchmark.

### New development

The Building Regulations Part L 2013 modelling results derived from government-approved Dynamic Simulation Modelling (DSM) software (i.e. Standard Assessment Procedure (SAP) and Integrated Environmental Solutions (IES) modelling) have been used to derive energy benchmark data for new developments. Data from AECOM in-house modelling experience has been used for the purpose. It is important to note that for the baseline calculation exercise, the unregulated energy demand has also been taken into consideration in order to fully account for the electricity requirements in buildings. This is based on the BREDEM 2012 formula<sup>30</sup> for domestic buildings and outputs from the IES models for non-domestic buildings.

For the purpose of applying relevant energy benchmarks to each type of development, the following approach has been used.

- The Fabric Energy Efficiency (FEE) standard for houses and flats has been derived from AECOM in-house modelling experience and has been used to derive the space heating demand. For flats, the SAP models used consisted of a mix of building geometries and storey heights to derive an average FEE value for a typical apartment unit, whereas for houses an average FEE value for detached and semi-detached houses has been applied. It is

<sup>30</sup> BRE, BREDEM 2012 – A technical description of the BRE Domestic Energy Model, 2013

assumed that none of the dwellings have active cooling<sup>31</sup>. For the Domestic Hot Water (DHW) demand, a similar approach has been followed to derive average DHW demand per unit floor area for flats and houses separately.

- Energy benchmarks for retail space have been split into A1/A2 and A3/A4/A5 sub-classes. This is consistent with the Building Regulations as the approved Government software does not make a distinction between A1 and A2 classes as well as A3, A4 and A5 classes. For the A1/A2 uses, an average figure has been estimated from the modelling output for a standard A1 retail unit and a supermarket. For A3/A4/A5 uses, a restaurant has been used as a representative example of these sub-classes.
- Finally, any floorspace that falls under 'Culture' development type has been assumed to consist of both D1 and D2 planning classes and the energy benchmarks are derived as an average of a community hall, a general community space, a social club, a cinema and a leisure centre.

Table 9 below summarises these assumptions.

*Table 9: Benchmarking approach for proposed new development*

Development Type	Planning Class	Source	Building use categories modelled
<b>Dwellings</b>	C3	FEE standard and SAP Modelling	Flats (combination of ground floor, mid-floor and top floor newly built flats, middle and corner positioned. All typical sizes within a 50m <sup>2</sup> to 100m <sup>2</sup> range); Houses (average of one detached and one semi-detached newly built house; typical size circa 100m <sup>2</sup> )
<b>Employment</b>	B1	IES Modelling	Office building ( office building circa 10,000m <sup>2</sup> treated floor area, open plan, highly glazed block on all facades)
		CIBSE Guide F 'Good Practice'	Light industrial (light manufacturing category)
<b>Schools</b>	D1	IES Modelling	School (school unit with significant amount of external exposed façade)
<b>Retail</b>	A1/A2	IES Modelling	A1 retail (typical retail unit circa 300m <sup>2</sup> ) and Supermarket (typical supermarket unit circa 1500m <sup>2</sup> )
	A3/A4/A5	IES Modelling	Restaurant (typical restaurant unit circa 300m <sup>2</sup> )

<sup>31</sup> This is a conservative assumption. In reality, active cooling may be included on some schemes to reflect market demand and/or address overheating issues.

Development Type	Planning Class	Source	Building use categories modelled
Culture	D1/D2	IES Modelling	Community hall (circa 300m <sup>2</sup> community space with supporting office areas and associated changing and catering facilities); Community space (circa 200m <sup>2</sup> of general community floorspace without any specific facilities); Social club (circa 1,600m <sup>2</sup> community space comprising a gym a music room, a games room and a kitchen with a NE orientation); Cinema (circa 5,300m <sup>2</sup> of cinema space with associated uses); Leisure centre (16,000m <sup>2</sup> of leisure space with a gym and a swimming pool)

### Energy benchmarks

The approach outlined in the preceding sections has led to the following benchmarking data for existing and new developments.

Table 10: Benchmarking data for all development types

Development Type	Planning Class	Heat Consumption (Space Heating & Hot Water) (kWh/m <sup>2</sup> p.a.)	Electricity Consumption (kWh/m <sup>2</sup> p.a.)
<b>Dwellings<sup>32</sup></b>			
Existing	C3	13,440 ( <i>per unit</i> )	4,200 ( <i>per unit</i> )
New-built (Flats)	C3	4,764 ( <i>per unit</i> )	392 ( <i>per unit</i> )
New-built (Houses)	C3	5,775 ( <i>per unit</i> )	840 ( <i>per unit</i> )
<b>Employment</b>			
Existing	B1	114	226
	B2	192	70
	B8	118	43
New-built	B1	44	66
<b>Schools</b>			
Existing	D1	99	33
New-built	D1	15	52

<sup>32</sup> Please note that for all residential elements the heat and electricity consumption have been provided as kWh per unit, rather than kWh/m<sup>2</sup> as in all other classes.

Development Type	Planning Class	Heat Consumption (Space Heating & Hot Water) (kWh/m <sup>2</sup> p.a.)	Electricity Consumption (kWh/m <sup>2</sup> p.a.)
<b>Hotels</b>			
Existing	C1	256	140
<b>Residential Institutions</b>			
Existing	C2	258	77
<b>Retail</b>			
Existing	A1/A2	119	325
	A3/A4/A5	721	1,040
New-built	A1/A2	29	104
	A3/A4/A5	136	167
<b>Culture</b>			
Existing	D1	157	181
	D2	99	165
New-built	D1/D2	69	58

A 15% load factor was assumed to calculate the peak heating demand for all residential and non-domestic buildings.

### C3 Input values and assumption for techno-economic modelling

The key inputs and assumptions used for the technical and financial analysis are listed below. Specific data sources used for each of the variables are referenced. Cost data and financial assumptions are based on AECOM's previous project experience. Some cost variables, such as counterfactual costs, have been inferred from published sources. Energy prices and CO<sub>2</sub> emission factors are taken from data published by DECC / IAG. In case of marginal grid electricity factors for gas CHP analysis, the figures used are in line with guidance received from DECC in January 2016.

Input variable	Value	Reference & Notes																																																															
Network assumptions and costs																																																																	
Year investment commences	Assumed 2022	Informed by current heat densities and future growth projections																																																															
Year network becomes operational	Assumed 2023	Informed by current heat densities and future growth projections																																																															
District heating pipework capital cost	<table border="1"> <thead> <tr> <th>Pipe Size [mm]</th> <th>Cost (hard dig) [£/m]</th> <th>Cost (soft dig) [£/m]</th> </tr> </thead> <tbody> <tr><td>25</td><td>564</td><td>474</td></tr> <tr><td>32</td><td>590</td><td>500</td></tr> <tr><td>40</td><td>624</td><td>524</td></tr> <tr><td>50</td><td>656</td><td>551</td></tr> <tr><td>65</td><td>676</td><td>576</td></tr> <tr><td>80</td><td>728</td><td>618</td></tr> <tr><td>100</td><td>802</td><td>682</td></tr> <tr><td>125</td><td>918</td><td>778</td></tr> <tr><td>150</td><td>1132</td><td>962</td></tr> <tr><td>200</td><td>1332</td><td>1137</td></tr> <tr><td>250</td><td>1724</td><td>1514</td></tr> <tr><td>300</td><td>2114</td><td>1874</td></tr> <tr><td>350</td><td>2255</td><td>2042</td></tr> <tr><td>400</td><td>2516</td><td>2251</td></tr> <tr><td>450</td><td>2674</td><td>2399</td></tr> <tr><td>500</td><td>2912</td><td>2627</td></tr> <tr><td>600</td><td>3354</td><td>3044</td></tr> <tr><td>700</td><td>3680</td><td>3320</td></tr> <tr><td>800</td><td>3950</td><td>3600</td></tr> <tr><td>900</td><td>4380</td><td>4000</td></tr> </tbody> </table>	Pipe Size [mm]	Cost (hard dig) [£/m]	Cost (soft dig) [£/m]	25	564	474	32	590	500	40	624	524	50	656	551	65	676	576	80	728	618	100	802	682	125	918	778	150	1132	962	200	1332	1137	250	1724	1514	300	2114	1874	350	2255	2042	400	2516	2251	450	2674	2399	500	2912	2627	600	3354	3044	700	3680	3320	800	3950	3600	900	4380	4000	<p>Installation costs based on previous quotations from district heating pipework installers.</p> <p>These costs are assumed to cover civil and mechanical works</p> <p>Civil work:</p> <p>1) includes excavation and reinstatement per meter of trench</p> <p>2) excludes special surfaces, close shoring, dewatering &amp; traffic management</p> <p>Mechanical work:</p> <p>1) includes supply, delivery, offloading, installation, hydraulic testing, 10% NDT</p> <p>2) includes pipework, fittings, site joints, termination seals</p>
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Input variable	Value	Reference & Notes
Capital cost per m <sup>2</sup> energy centre <sup>33</sup>	£1,000	Previous project experience and quotations
Lifetime of DH network	50 years	Previous project experience and quotations
Capex of gas CHP per kW	£500 - £600/kW	Averaged quotes from installers; plant size/type dependent
Opex of gas CHP	£0.93 - £1/kW	
Lifetime of gas CHP plant	15 years	Previous project experience and quotations
Energy Centre electricity consumption	1% of energy centre gas consumption	Previous project experience
% of electricity demand of buildings assumed to be connected to DH network that is bought from CHP	0%	Conservative assumption
Developer contribution (domestic)	£1,350/ dwelling	Derived based on indicative savings compared to counterfactual scenario. Around 90% of the dwellings connected to the network have communal heating / CHP systems as counterfactual and the rest 10% have individual gas boilers. The figure is a weighted average assuming £1500 savings per dwelling on cost of energy centre (Source: mid-range value from Table 4 of EST and Carbon Trust publication 'Community heating for planners and developers', 2004) and no net counterfactual costs for the remainder of the dwellings with gas boilers (assuming boiler costs broadly cancelled out by cost for HIU)
Developers contribution (non-domestic)	£100/ m <sup>2</sup> no additional contribution for non-domestic accommodation on mixed use sites	Derived based on indicative savings compared to counterfactual scenario.
Other capital costs		
Heat Interface units (domestic)	£2,000 / dwelling	Previous project experience and quotations
Heat Interface units (non-dom)	£100/kW	
Top up/ back-up gas boilers for DH network	£110/kW	
Preliminaries	5% of capex	
Energy prices		
Baseline/ counterfactual retail prices of electricity and gas by	Refer to table 3.4.2 of referenced source	Prices of fuels purchased by non-domestic consumers in the UK, DECC, Dec 2015

<sup>33</sup> Excludes land costs

Input variable	Value	Reference & Notes
sector in 2016	Refer to table 2.2.3 and table 2.3.3 for domestic sector unit costs	<i>Quarterly Energy Prices, DECC, Dec 2015</i>
Tariff for heat sold on network	10% discount on counterfactual or baseline costs for heat (including counterfactual costs for operation and maintenance)	Assumption to incentivise connection to DH network
Gas costs for energy centre	Refer to table 3.4.2 of referenced source.	DECC 2015: <i>Prices of fuels purchased by non-domestic consumers in the UK</i>
Forward projections for retail prices of electricity and gas (i.e. energy price inflation)	Refer to tables in Annex M of referenced source.	DECC/IAG: <i>2014 energy and emissions projections: projections of greenhouse gas emissions and energy demand 2014 to 2030.</i>
Export tariff for electricity sold to National Grid	4p/kWh The price paid for electricity sold to the grid (that has been generated by CHP) has been indexed to the commercial electricity tariff in future years.	Broadly reflective of wholesale price of electricity in 2015 (Source: Ofgem website)
<b>Carbon emissions</b>		
Grid electricity emissions factors	Refer to chart on Pg. 67 of the DECC referenced report.	DECC/LCP: <i>Modelling the impacts of additional Gas CHP capacity in the GB electricity market</i> <sup>34</sup> . (in line with guidance from DECC received Jan 2016)
Forward projections for grid electricity emissions factors		
Natural gas emissions factor	Refer to Table 2a of the referenced source	DECC/IAG: <i>Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal</i>
<b>Financial assumptions</b>		
Timeframe for financial analysis	40 years	AECOM assumption to reflect project lifecycle
Discount rate	6%	AECOM assumption; typical for HNDU studies
<b>Incentives</b>		
RHI	Tariffs current at October 2015, paid for 20 years.	Refer to Ofgem table: <i>Tariffs that apply for installations with an accreditation date on or after 1 October 2015</i> <sup>35</sup>
<b>Counterfactual/ baseline assumptions</b>		

<sup>34</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/389070/LCP\\_Modelling.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/389070/LCP_Modelling.pdf)

<sup>35</sup> <https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/tariffs-apply-non-domestic-rhi-great-britain>

Input variable	Value	Reference & Notes
Heating technology costs	<p>To be calculated</p> <p>For typical initial capital cost for connection to a heat network refer Appendix 2 of the referenced source - £5,500 per unit</p> <p>Cost of gas boiler (domestic) - £2,000 per unit</p> <p>Cost of gas boiler (commercial) - £150/kW</p>	<p>Calculated as a weighted average of buildings/ plots connected to the network. Assumes individual gas boilers with the exception of new-build development plots with more than 100 residential units or &gt;1,000 sq. m of non-domestic floorspace. For these, the counterfactual cost will be based on the typical initial capital cost for connection to a heat network plus cost of HIU.</p> <p>Typical initial capital cost for connection as per <i>Energy Planning: Greater London Authority guidance on preparing energy assessments, April 2015</i></p>
CO <sub>2</sub> emissions baseline	<p>Calculated based on Table 2a of the referenced source</p>	<p>Calculated as a weighted average of buildings/ plots connected to the network.</p> <p>Assumes 80% efficient gas boilers for existing and 90% efficient for new buildings with the following exceptions:</p> <ul style="list-style-type: none"> <li>- For existing buildings with communal systems (where known) a 64% efficient system run on gas boilers is assumed. This is based on an 80% efficient gas boiler and 20% system losses.</li> <li>- For development plots with more than 100 residential units or &gt;1,000 sq. m of non-domestic floorspace the baseline assumes a 72% efficient system based on an 90% efficient gas boiler and 20% system losses</li> <li>- For development plots with more than 500 residential units or &gt;1,000 sq. m of non-domestic floorspace the baseline assumes a gas-CHP system and 20% system losses.</li> </ul> <p>DECC/IAG: <i>Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal</i></p>



## Appendix D: Heat loads and district heating pipework

Table 11: Heat loads connected to the district heating network

Heat Loads				
Ref/ ID <sup>36</sup>	Building/ plot type	Name	Heat Demand (MWh/yr)	Phasing
A	Housing estate	Brimmington Estate	9037	1
U	School	Camelot Primary School	29	1
AG	School	Haymerle School	157	1
106		Plot 106	282	1
107		Plot 107	441	1
115		Plot 115	2133	1
117		Plot 117	473	1
119		Plot 119	1381	1
120		Plot 120	789	1
122		Plot 122	750	1
145		Plot 145	1936	1
20		Plot 20	1079	1
24		Plot 24	1151	1
25		Plot 25	1426	1
30		Plot 30	1837	1
31		Plot 31	1285	1
33		Plot 33	1962	1
36		Plot 36	1064	1
37		Plot 37	706	1
38		Plot 38	1118	1
39		Plot 39	1271	1
42		Plot 42	843	1
44		Plot 44	650	1
56		Plot 56	410	1
57		Plot 57	208	1
61		Plot 61	1470	1
62		Plot 62	2091	1
63		Plot 63	790	1
92		Plot 92	313	1
93		Plot 93	344	1
94		Plot 94	519	1
98		Plot 98	571	1
Z	School	Grange Primary School	216	2
BH	School	Grange Road Dental Surgery	10	2
I	School	Harris Academy	972	2
Q	School	Harris Academy	379	2
AU	School	Harris Academy	61	2
P	School	Ilderton Primary School	418	2

<sup>36</sup> Please refer to Figure 34 for location of the plot numbers.

Ref/ ID	Building/ plot type	Name	Heat Demand (MWh/yr)	Phasing
V	School	Ilderton Primary School	239	2
T	School	Phoenix Primary School	309	2
AB	School	Phoenix Primary School	188	2
AS	School	Phoenix Primary School	76	2
BB	School	Phoenix Primary School	21	2
101		Plot 101	1818	2
11		Plot 11	765	2
116		Plot 116	2000	2
12		Plot 12	818	2
121		Plot 121	958	2
13		Plot 13	794	2
14		Plot 14	1103	2
144		Plot 144	582	2
15		Plot 15	1548	2
16		Plot 16	768	2
21		Plot 21	1166	2
22		Plot 22	1127	2
23		Plot 23	515	2
26		Plot 26	1110	2
29		Plot 29	1554	2
32		Plot 32	791	2
43		Plot 43	2115	2
5		Plot 5	1945	2
58		Plot 58	333	2
6		Plot 6	2069	2
64		Plot 64	716	2
77		Plot 77	524	2
79		Plot 79	342	2
82		Plot 82	171	2
83		Plot 83	489	2
87		Plot 87	1986	2
96		Plot 96	941	2
C	Housing estate	Setchell Estate	4980	2
S	School	St Francis RC Primary School	343	2
E	Housing estate	Barlow Estate	2239	3
W	School	Boutcher Church of England Primary School	233	3
AR	School	Boutcher Church of England Primary School	96	3
AZ	School	Boutcher Church of England Primary School	37	3
BA	School	Elibariki Day Nursery	36	3
AL	School	English Martyrs Roman Catholic Primary School	127	3

Ref/ ID	Building/ plot type	Name	Heat Demand (MWh/yr)	Phasing
G	School	Globe Academy Primary and Lower School	1499	3
J	School	Globe Academy Primary and Lower School	901	3
Y	School	Globe Academy Primary and Lower School	219	3
AC	School	Globe Academy Primary and Lower School	181	3
AY	School	Globe Academy Primary and Lower School	38	3
BD	School	Globe Academy Primary and Lower School	14	3
F	Public Service	Old Kent Road Fire Station	140	3
AJ	School	Old Kent Road Fire Station	157	3
1		Plot 1	811	3
10		Plot 10	39	3
109		Plot 109	1036	3
110		Plot 110	468	3
111		Plot 111	649	3
129		Plot 129	343	3
131		Plot 131	814	3
132		Plot 132	261	3
135		Plot 135	148	3
137		Plot 137	261	3
143		Plot 143	1056	3
146		Plot 146	1068	3
2		Plot 2	2024	3
27		Plot 27	1073	3
28		Plot 28	840	3
3		Plot 3	1517	3
34		Plot 34	1427	3
35		Plot 35	1416	3
4		Plot 4	1927	3
51		Plot 51	725	3
52		Plot 52	149	3
53		Plot 53	1156	3
54		Plot 54	804	3
55		Plot 55	249	3
60		Plot 60	2174	3
67		Plot 67	596	3
68		Plot 68	2328	3
69		Plot 69	1730	3
7		Plot 7	1455	3
70		Plot 70	753	3
71		Plot 71	983	3

Ref/ ID	Building/ plot type	Name	Heat Demand (MWh/yr)	Phasing
72		Plot 72	2438	3
74		Plot 74	223	3
75		Plot 75	787	3
76		Plot 76	504	3
8		Plot 8	694	3
84		Plot 84	408	3
85		Plot 85	678	3
86		Plot 86	1253	3
88		Plot 88	406	3
9		Plot 9	601	3
90		Plot 90	735	3
91		Plot 91	551	3
95		Plot 95	195	3
D	Housing estate	Salisbury Estate	3047	3
AK	School	Spa School	139	3
AQ	School	Spa School	101	3
AT	School	Spa School	68	3
AW	School	Spa School	56	3
BE	School	Spa School	12	3
N	School	St Saviours and St Olavs C of E school	541	3
R	School	St Saviours and St Olavs C of E school	366	3
AF	School	St Saviours and St Olavs C of E school	170	3
AN	School	St Saviours and St Olavs C of E school	120	3
AH	School	Townsend Primary School	157	3
AI	School	Townsend Primary School	157	3
BF	School	Townsend Primary School	11	3
AA	School	Victory School	190	3

Table 12: District heating pipe diameter and lengths for Option 1

Pipe Diameter [mm]	Pipe length [ m ]
25	80
32	145
40	600
50	185
65	1315
80	1185
100	2155
125	2970
150	1360
200	2175
250	1360
300	595
350	390
400	1150

## Appendix E: Risk Register

The key technical, financial and environmental risks associated with delivery of district heating networks in OKROA have been identified and noted below. The table quantifies the probability and likely impact of risks on a notional scale of 1-5, along with recommended actions for mitigation.

Risk Category	Specific Risk	Probability	Impact	Risk Rating	Mitigation / Action	Revised Probability	Revised Impact	Revised Risk Rating
Technical viability	Insufficiently diverse load profiles for a district heating scheme.	2	4	8	Assess the sensitivity of inclusion or exclusion of significant loads at detailed feasibility stage.	1	2	2
Technical viability	Existing heating systems found to be unsuitable for connection to a DH scheme.	3	2	6	Review existing plant in buildings at the detailed feasibility stage to assess the high level viability of connection.	3	1	3
Technical viability	Network is not flexible enough to allow future energy supply options	3	3	9	Designs need to be future-proofed to ensure the network could allow future energy supply options. Will need to assess risks of different future supply options and interconnections at detailed feasibility stage.	1	3	3
Technical viability	Incorrect installation of plant or network elements leading to underperformance or failure	2	5	10	Ensure provisions in procurement/delivery contracts to protect investors' and/or consumers' interests in this eventuality.	1	4	4
Technical viability	Network design or incorrect installation giving rise to excessive heat losses from the network.	2	4	8	A full feasibility study will account for heat losses when considering the heat source and distribution pipework to be used. Designers should consider ways to reduce the heat losses as far as practical such as by adopting standards for insulation above the regulatory minimum.	1	4	4
Technical viability	Certain network routes are not viable due to local constraints (e.g. archaeology, highways or utilities related issues)	3	3	9	Surveys are carried out at full feasibility stage to ascertain suitability of suggested routes. The findings are used to inform alternative route layouts.	1	2	2
Technical viability	Inability to secure energy centre site for initial and/or future network phase(s).	4	5	20	This study sets out the broad criteria for a suitable location and has identified an indicative location for the single energy centre option. The Council, supported by further investigations, will need to identify and promote their preferred option.	2	5	10
Regulatory / policy	Changes to local policy results in lower priority given to DH schemes. [Currently the scheme has high level support]	2	4	8	Continued engagement internally and with external stakeholders is essential for the scheme to be given the resources and priority required.	1	2	2
Regulatory / policy	Changes to regional or national policy/ strategy results in move away from promotion and support for DH schemes. [Currently the scheme has high level support at regional level]	2	4	8	Place a greater emphasis on schemes being economically attractive for commercial investment. Prioritise publically funded investment whilst support is strong. Engage with regional /national government to communicate benefits.	1	2	2

Risk Category	Specific Risk	Probability	Impact	Risk Rating	Mitigation / Action	Revised Probability	Revised Impact	Revised Risk Rating
Future strategy	Lack of integration with other planned works and building activities in the area - potentially missing opportunities and incurring extra costs, or delaying programme.	3	4	12	Design timetable for conducting detailed studies with awareness/reference to the timetable for key decision-making processes for delivery of local infrastructure. Use evidence from this study and detailed feasibility studies to inform revisions to the AAP and OAPF.	2	4	8
Future strategy	Desired future expansion of network not achieved or limited.	2	3	6	The risk of reduction in rate or scale of network expansion can be minimised by implementing an appropriate governance and delivery structure. If the scheme is delivered with strong council control / ownership or strong local policy drivers then control will be retained. If a commercial delivery route is taken, this control may be reduced.	1	3	3
Future strategy	Opportunities to connect existing buildings to the network missed.	5	2	10	Promote the benefits of the heat network to local businesses and developers.	3	2	6
Environmental risk	Negative visual impact from energy centre on local residents.	3	3	9	A full feasibility study should take into account the potential for visual impacts and seek to minimise these during the selection of a location for the energy centre. Examples of sympathetically designed energy centres in dense urban areas exist (e.g. Islington Bunhill scheme), and lessons learned from these should be considered in designing the energy centre.	1	1	1
Environmental risk	CO <sub>2</sub> emissions reductions not achieved in the medium to longer term due to decarbonisation of electricity grid making connection to the network less attractive for developers.	3	4	12	Scheme designs need to be future-proofed to ensure the network continues to deliver environmental benefits. Future energy supply options to be considered in detail at full feasibility stage (e.g. replacing gas CHP with alternative generation technologies) and revisited regularly as supply technology options change or improve.	1	4	4
Environmental risk	Adverse impact on local air quality from generation technologies (such as NO <sub>x</sub> emissions from CHP)	2	4	8	Investigate impact of energy centre location, system specification and flue heights on local receptors at full feasibility and at detailed design stage. Ensure provisions in procurement/delivery contracts for equipment with minimal impact on air quality.	1	4	4
Financial viability	Inability to secure funding for project development work.	3	5	15	Use evidence from this pre-feasibility study to support an application to HNDU for funding for a full feasibility study. The full feasibility study should be designed to support the recruitment of joint venture partners.	2	3	6
Financial viability	Increased capital costs of network due to increases in plant or labour costs etc.	2	5	10	Include detailed analysis and of sensitivity of scheme financial viability to capital costs as part subsequent full feasibility studies. Review costs throughout the project lifecycle.	2	2	4



Risk Category	Specific Risk	Probability	Impact	Risk Rating	Mitigation / Action	Revised Probability	Revised Impact	Revised Risk Rating
Financial viability	Increased maintenance and operational costs of network, for example, due to increases in plant or transactional costs.	2	5	10	Full feasibility study to contain detailed financial and sensitivity analysis which considers operational costs in more detail, specific to the chosen business model.	2	2	4
Financial viability	Uncertainty over future energy prices for development of business plan and future operation of scheme.	4	5	20	This high-level feasibility study has used IAG's energy price projections in the financial analyses. Full feasibility study should consider the suitability of these projections (in particular for short and medium term projections) and where necessary compare against a range of scenarios.	3	3	9
Financial viability	Costs of metering and billing for heat sales are higher than anticipated	2	1	2	Account for set up costs and 'teething' troubles in first two years at full feasibility stage. Ensure higher costs of metering and billing per customer in early phases are accounted for.	1	1	1
Development and construction	Programme delays at construction stage (e.g. due to getting approval for works in roads, delivery delays etc.).	3	3	9	Undertake careful forward planning and management to manage and minimise delays. Build in contingencies to construction programme to allow for unseen delays.	2	2	4
Development and construction	Congested existing buried services impacting on the routing of the DH network and the cost of installing.	3	4	12	Carry out detailed review and survey of existing utilities during the feasibility study and the design and construction stages.	2	4	8
Development and construction	Impact on transport routes. Development of the DHN may cause disruption to key or busy routes and impact on traffic.	4	3	12	Plan ahead to avoid disruption. The full feasibility study should look at this issue in further detail. As with other types of service maintenance/construction, actions may be taken to minimise the impact of disruption (such as carrying out works overnight).	3	1	3
Operational	Temporary failure of plant or network elements leading to interruption of service to network customers (failure to meet contractually agreed service level).	2	3	6	The system should be designed to be resilient, with back-up generation. Failures may result from errors in network design and errors in the assumptions made. The full feasibility study should examine and evaluate the assumptions made in this study. Procurement documentation should reflect this risk.	1	2	2
Commercial	Failure to attract a high uptake of customers willing to commit prior to or post construction and to accept long term contracts.	2	5	10	The DH network is primarily new development led. Use evidence from this study and subsequent studies to inform local policies that are conducive to uptake of district heating.	1	2	2

## Appendix F: Financial incentives and sources of funding

### Prudential borrowing

The Local Government Act 2003 empowered Local Authorities to use unsupported prudential borrowing for capital investment. It simplified the former Capital Finance Regulations and allows councils flexibility in deciding their own levels of borrowing based upon its own assessment of affordability. The framework requires each authority to decide on the levels of borrowing based upon three main principles as to whether borrowing at particular levels is prudent, sustainable and affordable. The key issue is that prudential borrowing will need to be repaid from a revenue stream created by the proceeds of the development scheme, if there is an equity stake, or indeed from other local authority funds (e.g. other asset sales).

Funds are accessed via the 'Public Works Loan Board'. The Board's interest rates are determined by HM Treasury in accordance with section 5 of the National Loans Act 1968. In practice, rates are set by Debt Management Office on HM Treasury's behalf in accordance with agreed procedures and methodologies.

This financing route enables councils and their partners to invest in key local priorities. Another key advantage is the low cost of finance. On the other hand, such borrowing burdens the local authority balance sheet and the applicability is limited by gearing covenants (that is, ability to borrow against assets).

### Developer contributions

#### Section 106 Agreements

Section 106 agreements are planning obligations in the form of funds collected by the local authority to offset the costs of the external effects of development, and to fund public goods which benefit all residents in the area.

### The Community Infrastructure Levy (CIL)

The Community Infrastructure Levy is a planning charge, introduced by the Planning Act 2008 as a tool for local authorities in England and Wales to help deliver infrastructure to support the development of their area. It came into force on April 2010. Development may be liable for a charge under the Community Infrastructure Levy (CIL), if the local planning authority has chosen to set a charge in its area.

Most new development which creates net additional floor space of 100 square metres or more, or creates a new dwelling, is potentially liable for the levy.

The type of infrastructure which can be funded by the CIL is defined under the Planning Act, and includes district heating schemes. The use of CIL funds is not geographically limited to the area of development, and may be used to fund schemes in other areas within the local authority's remit. Local authorities must however allocate at least 15% of levy receipts to spend on priorities that should be agreed with the local community in areas where development is taking place. This can increase to a minimum of 25% in certain circumstances.

### Financial Support available for low carbon technologies

#### Renewable Obligations Certificates

The Renewables Obligation (RO) was designed to incentivise large-scale renewable electricity generation in the UK, and requires licensed electricity suppliers to source a specific percentage of the electricity they supply from renewable sources. Each MWh of electricity generated from renewable sources receives a certain number of Renewables Obligation Certificates (ROCs) depending on the source used.

The RO is scheduled to close to new capacity on 31 March 2017, and will be replaced by the Contracts for Difference (CFD) scheme which was introduced in 2014.

### Contracts for Difference (CfD)

CFD are a mechanism introduced as part of the Government's Electricity Market Reform programme to support new investment in all forms of low-carbon generation. They have been established as private law contracts between the generator and the Low Carbon Contract Company (LCCC) and will require generators to sell renewable energy into the market as usual. Under CfD, generators receive a variable top-up from the market price to a pre-agreed 'strike price'. At times when the market price exceeds the strike price, the generator is required to pay back the difference, thus protecting consumers from over-payment.

The strike price for each contract is determined via a competitive auction process. Eligible technologies include established technologies (such as onshore wind and solar) and less established technologies such as offshore wind, biomass CHP and advanced biomass conversion technologies).

CfD does not provide funding for gas CHP or air-sourced heat pumps and would not offer a revenue stream for any of the network options in this study.

### Feed-in-tariffs (FITs)

Feed-in-Tariffs policy, introduced in April 2010, is designed to provide a financial incentive to promote the uptake of small-scale (typically <5MW) renewable and low-carbon electricity generation technologies. It requires licensed electricity suppliers to make tariff payments on both generation and export of renewable and low carbon electricity. The technologies are eligible for the scheme include solar photovoltaic, wind, hydro, anaerobic digestion and micro CHP.

Generation and export tariff rates are index-linked which means that they will increase or decrease with inflation. The tariffs available for new generation capacity will fall over time to reflect the impact of increasing installation rates on technology prices and other factors that impact on rate of return in generation technologies. The latest tariff are available on the [Ofgem website](#).

### Renewable Heat Incentive (RHI)

The Renewable Heat Incentive (RHI) is a subsidy scheme funded by the UK Treasury, providing payments for heat generated by eligible technologies. Payments are made for 20 years. District heating schemes qualify for the RHI, provided the heat is supplied by a qualifying renewable technology (gas-fired CHP does not qualify).

Current non-domestic tariffs for district heating technologies are shown in Table 13.

Technology	Tariff (p/kWh)
Water/ground source heat pumps	8.84
Air source heat pumps	2.54
Commercial biomass <200kWth	3.76
Commercial biomass 200kW-<1MWth	5.18
Commercial biomass ≥1MWth	2.03
Solid biomass CHP	4.17
Deep geothermal	5.08
Biogas combustion <200kWth	7.62
Biogas combustion 200kW-<1MWth	5.99
Biogas combustion ≥1MWth	2.24

Table 13: RHI tariffs (October 2015) for potential district heating technologies<sup>37</sup>.

<sup>37</sup> Tariffs that apply for installations with an accreditation date on or after 1 January 2016: <https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/tariffs-apply-non-domestic-rhi-great-britain>

**Enhanced Capital Allowances**

Commercial organisations can benefit from Enhanced Capital Allowances (enhanced tax relief) on energy saving equipment, including CHP. Business can write off 100% of the capital costs of eligible technologies against their taxable profits in the first year after the investment is made instead of spreading this write-off.

**European Structural funding**

**JESSICA and the London Green Fund**

The Joint European Support for Sustainable Investment in City Areas (JESSICA) is a policy initiative of the European Commission and European Investment Bank that aims to support Member States to exploit financial engineering mechanisms to bring forward investment in sustainable urban development in the context of cohesion policy.

JESSICA allows EU Member States to make contributions from their Structural Fund Programmes, along with funding from other public and/or private sources, to urban development funds (UDFs). The UDFs then invest these monies, in the form of equity, loan and/or guarantee, in urban development projects. Returns can be reinvested in other urban development projects.

The £120million London Green Fund (LGF) is the first JESSICA Holding fund in the UK. The LGF provides funding for three UDFs that invest in waste, energy efficiency, decentralised energy and social housing projects.

The London Energy Efficiency Fund (LEEF) is of those UDFs that is managed by Amber infrastructure. Further details and investment criteria are available on the [LEEF website](#).

**Development funding and technical assistance grants**

**Heat Networks Delivery Unit (HNDU) grant funding**

DECC’s Heat Networks Delivery Unit (HNDU) provides grant funding to local authorities to facilitate delivery of heat networks. Local authorities can apply for grants to cover up to 67% of external costs of heat mapping, feasibility studies and detailed project development work (including technical design, financial modelling and exploration of commercial models and contracts). The unit is currently scheduled to run until March 2016.

Phase	Detail
Heat mapping	Area-wide exploration, identification and prioritisation of heat network project opportunities
Energy master planning	Area-wide exploration, identification and prioritisation of heat network project opportunities
Feasibility study	Project specific - An increasingly detailed investigation of the technical feasibility, design, financial modelling, business modelling, customer contractual arrangements and delivery approach, up to business case
Detailed project development	Project specific - An increasingly detailed investigation of the technical feasibility, design, financial modelling, business modelling, customer contractual arrangements and delivery approach, up to business case

Figure 33: Annotated extract from DECC website

**European Local Energy Assistance (ELENA) and the Decentralised Energy Project Delivery unit (DEPDU)**

ELENA is a European Facility offering technical assistance to help public authorities develop bankable energy investment projects. It aims to support regional or local authorities in accelerating their investment programmes in the fields of energy efficiency and renewable energy sources. Projects within the following areas are supported:

- energy efficiency in public and private buildings
- integration of renewable energy sources into the built environment

- investments into renovating, extending or building new district heating/cooling networks,
- urban transport to support increased energy efficiency and integration of renewable energy sources
- local infrastructure including smart grids, information and communication technology infrastructure for energy efficiency, energy-efficient urban equipment, inter-modal transport facilities and refuelling infrastructure for alternative fuel vehicles.

Up to 90% of the eligible costs necessary to prepare, implement and finance the investment programme may be funded. These could include, for instance, feasibility and market studies, structuring of programmes, business plans, energy audits, preparation of tendering procedures and contractual arrangements and project implementation units. All development funding is subject to a minimum 'Leverage Factor' (that is, the ratio between technical assistance funding and investments in sustainable energy projects) of 1:20.

Four different ELENA facilities (European Local Energy Assistance) are managed by public banks. The EIB (European Investment Bank) ELENA facility typically provides development assistance for public sector agencies for projects of more than EUR 50m. The KfW ELENA facility provides assistance for financial institutions aiming to support the deployment of energy investments with a project size of between EUR 6m – 50m.

The Decentralised Energy Project Delivery Unit (DEPDU) was a four-year programme set up by the GLA in 2011 with €3.3m funding, 90% of which was secured from the European Investment Bank's ELENA facility. The programme provided London Boroughs and other project sponsors with technical, financial and commercial

assistance to develop and bring DE projects to market. It will offer specialist advice until March 2016 and is expected to be replaced by a successor programme - Energy for London (EfL) that is expected to run until July 2019. EfL is expected to be 50% funded by a European Regional Development Fund (ERDF) grant and 50% by the GLA.

### **Mobilising Local Energy Investments (MLEI)**

Development funding is available from the European Commission to support to develop energy project concepts into 'bankable projects'. It covers the development process (such as legal costs, surveys, staff time) but does not provide capital funding. It is targeted at local authorities and pays for 75% of the eligible costs, with a minimum €400,000 of eligible technical assistance cost. The project needs to achieve a minimum leverage ratio of 15, with a total project size of between EUR 6m to 50m.