Decarbonising heat in Lambeth – final presentation

Will Rivers & Ben Robertson

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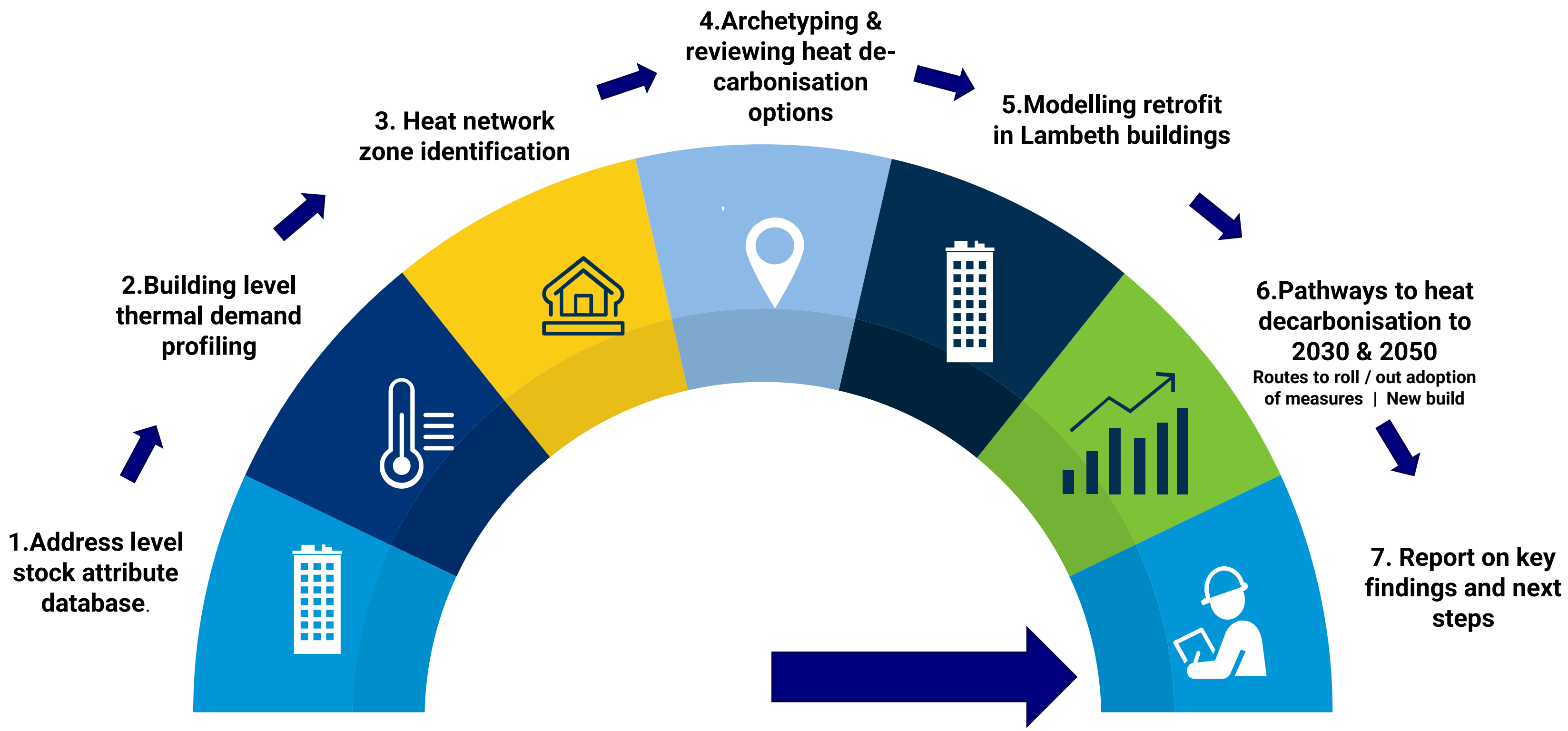
Project objectives

- Develop a detailed understanding of heat demand in Lambeth at the building level
- Identify common building archetypes in the Borough
- Appraise options for retrofitting these archetypes that would be compatible with net zero carbon targets
- Identify potential zones for heat networks in the Borough
- Assess pathways to heat decarbonisation for the Borough to 2030 and 2050.

Lambeth heat decarbonisation study - Overview of approach



Lambeth heat decarbonisation study - Contents Page

Lambeth building attribute and energy use database

Address and Building level databases

Overview of methodology

Data sources

OS Addressbase
Address
UPRN
TOID
OS Archetype

EPC , Non-domestic EPCs and DECs
Property age
Building attributes (Walls, floors, roofs, windows)
Heating system characteristics
Modelled energy use
Tenure

Lambeth energy use data
kWh energy use (gas and electricity for some Lambeth sites

Lambeth Estate and Housing Association ownership
Areas of land in Lambeth or Housing Association ownership

Data processing

Address matching

Data cleansing and prioritisation

Extrapolation of missing values
Property age, EPC band, floor areas, building attributes (wall type, glazing, roof), Heating systems

Archetype identification

Heat and energy demand modelling
EPC, NDEPC, DEC, Lambeth data, CIBSE benchmarks,

Data reporting

Building database

Address database

GIS

Address level database attributes

List of data fields

Lambeth building key	Lambeth sub-archetype	Tenure type	Secondary heat description	Building environment (non-domestic only)
Address	Building age	Address EPC rating	Hot water system	Heat network zone
Postcode	Domestic EPC match	Total floor area	Lighting description	
UPRN	Domestic EPC reference number	Space heating demand (kWh)	Window type	
OS TOPO TOID	Non-domestic EPC match	Water heating demand (kWh)	Wall type and insulation	
Dom/ non-dom	Non-domestic EPC reference number	Heating fuel and type	Roof type and insulation	
Archetype	DEC match	Heating type (simplified)	Floor type and insulation	

	OS AddressBase				Multiple sources				EPCs, ND EPCs & D	
Lambeth ddress key	Address	Postcode	UPRN	OS TOPO TOID	Dom/ non-dom	Archetype	Lambeth sub-archetype	Building age	Domestic EPC match	Domestic EPC reference numb
1	FLAT 8 HUNTER COURT, 10 HERBERT MEWS, SW2 2YG	SW2 2YG	200000490225	osgb1000042534014	Domestic	Flats	3c	1983 - 2002	Yes	4135513078
2	FLAT 10 OAKDENE, OAKS AVENUE, SE19 1RB	SE19 1RB	100021877068	osgb1000006009618	Domestic	Flats	-	1950 - 1982	Yes	9992881668
3	FLAT 19 44 CLARENCE AVENUE, SW4 8DJ	SW4 8DJ	10090197394	osgb5000005100172601	Domestic	Flats	-	1983 - 2002	Yes	5284503968
4	FLAT 13 PORY HOUSE, 149 LAMBETH WALK, SE11 6EH	SE11 6EH	100021861406	osgb1000005571199	Domestic	Flats	2c	1950 - 1982	Yes	7338517968
5	3 LAVENDER SQUARE, SW9 0AY	SW9 0AY	10023853736	osgb1000001769682894	Domestic	Flats	-	2003 onwards	Yes	2547978668
6	APARTMENT 85 81 BLACK PRINCE ROAD, SE1 7ET	SE1 7ET	10090201743	osgb5000005141616092	Domestic	Flats	5a	1983 - 2002	Yes	3556699278
7	49B, LEIGHAM COURT ROAD, SW16 2NF	SW16 2NF	10090201522	osgb1000005548204	Domestic	Flats	1e	pre 1900	Yes	6686163078
8	APARTMENT 34 12 LAWN LANE, SW8 1UD	SW8 1UD	10093056826	osgb1000005568563	Domestic	Flats	-	2003 onwards	Yes	5252974478
9	86 CEDARS ROAD, SW4 0QB	SW4 0QB	100021821257	osgb1000005278740	Domestic	House / Flats	2c	1950 - 1982	Yes	9352507968
10	106D, CRICKLADE AVENUE, SW2 3HH	SW2 3HH	100021829816	osgb1000005547441	Domestic	Flats	2c	1930 - 1949	Yes	1222914178
11	FLAT 4 MELBURY HOUSE, RICHBORNE TERRACE, SW8 1BA	SW8 1BA	100021884094	osgb1000005569545	Domestic	Flats	3c	1900 - 1929	Yes	6555859078
12	FLAT 3 105 COLDHARBOUR LANE, SE5 9NS	SE5 9NS	100023276183	osgb1000005879241	Domestic	Flats	4c	1900 - 1929	Yes	4095225468
13	FLAT 6 294 LEIGHAM COURT ROAD, SW16 2QP	SW16 2QP	10000443669	osgb1000005702680	Domestic	Flats	4a	1900 - 1929	Yes	9720684968
14	CAVENDISH GARDENS, 33 TROUVILLE ROAD, SW4 8QW	SW4 8QW	100021903445	osgb1000041778553	Domestic	Flats	4a	1900 - 1929	Yes	4099801678
15	GROUND FLOOR FLAT, 73 WOLFINGTON ROAD, SE27 0RH	SE27 0RH	10008791825	osgb1000005699001	Domestic	Flats	2b	1900 - 1929	Yes	5235490768
16	FLAT 3 39 CORNWALL ROAD, SE1 8TJ	SE1 8TJ	10093379365	osgb1000005731311	Domestic	Flats	-	1900 - 1929	Yes	9068989578
17	FLAT 15 HAZEL COURT, LEIGHAM COURT ROAD, SW16 3RD	SW16 3RD	100021864370	osgb1000005702240	Domestic	House / Flats	-	1950 - 1982	Yes	8974617968
18	15 AKERMAN ROAD, SW9 6SP	SW9 6SP	100021805503	osgb1000005718832	Domestic	House / Flats	1e	1983 - 2002	Yes	1831491078
19	FLAT 471 IMPERIAL COURT, 225 KENNINGTON LANE, SE11 5QN	SE11 5QN	100021856261	osgb1000005726265	Domestic	Flats	3c	pre 1900	Yes	4843230868
20	122 AMESBURY AVENUE, SW2 3AB	SW2 3AB	100021806795	osgb1000005547826	Domestic	Flats	2a	pre 1900	Yes	4323107968
21	FLAT 8 EMILY MANSIONS, LANDOR ROAD, SW9 9RU	SW9 9RU	100021862049	osgb1000005561257	Domestic	Flats	2b	1900 - 1929	Yes	874442568
22	FLAT 6 VICKERY HOUSE, RUBENS PLACE, SW4 7RB	SW4 7RB	200000488982	osgb1000042665446	Domestic	Flats	3c	1983 - 2002	Yes	7235706668
23	FLAT 25 OAKLEY HOUSE, 4 HOTSPUR STREET, SE11 6BT	SE11 6BT	10023851018	osgb1000001769658115	Domestic	Flats	-	1983 - 2002	Yes	3861826568
24	FLAT 60 9 ALBERT EMBANKMENT, SE1 7HD	SE1 7HD	10000442757	osgb1000001769441967	Domestic	Flats	2d	2003 onwards	Yes	3894944768
25	FLAT 1 10 WYNNE ROAD, SW9 0BB	SW9 0BB	10091121410	osgb5000005202582342	Domestic	Flats	-	1950 - 1982	Yes	7175880578
26	FLAT 70 3 CORNELL SQUARE, SW8 2ER	SW8 2ER	10023851435	osgb1000042214127	Domestic	Flats	-	2003 onwards	Yes	5193050668
27	238 BARCOMBE AVENUE, SW2 3BE	SW2 3BE	100021809928	osgb1000005547591	Domestic	House / Flats	2b	1900 - 1929	Yes	816688078

Total number of addresses:	**182,227**	
Domestic addresses:	149,496	
Domestic EPC coverage:	88,101	59% coverage
Non-domestic addresses:	32,731	
Non-domestic EPC/DEC coverage:	3,414	10% coverage
Number of buildings:	**63,900**	
Geomni buildings coverage:	60,266	94% coverage

Building attribute database

List of data fields

Lambeth building key	Archetype	Building age	Estimated peak thermal demand (kW)	Dominant window type for building
Address	Lambeth sub-archetype	Dominant EPC band in building	Building dominant heating fuel and type	% of addresses in building with single glazing or partial double glazing
Postcode	Tenure type	Total Floor Area (excludes communal areas)	% of addresses in building with primary electric heating	Dominant wall type and insulation
OS TOPO TOID	Tenure (simplified)	Total space heating demand (kWh)	% of addresses with secondary electric heating	Dominant roof type and insulation
UPRN	Count of domestic EPCs	Total water heating demand (kWh)	Building dominant hot water system	Dominant floor type and insulation
Count of UPRNs in building (TOID)	Count of non-domestic EPCs	Total Cooling demand (kWh)	% of addresses with electric immersion heaters	Building environment (non-domestic only)
Dom/ non-dom	Count of DECs	Total Electricity (non-heat) demand (kWh)	% of addresses with hot water cylinder	Heat network zone

	OS AddressBase					Multiple s		
Lambeth building key	Address	Postcode	OS TOPO TOID	UPRN	Count of UPRNs in building (TOID)	Dom/ non-dom	Archetype	Lambeth sub-archetype
57001	THE SCHOOL HOUSE STONHOUSE STREET SW4 6BJ	SW4 6BJ	osgb1000005412101	200000499263	1	Non-domestic	urseries and seasonal publi	6a
57017	LONGFIELD HALL KNATCHBULL ROAD SE5 9QY	SE5 9QY	osgb1000005718374	200000469008	3	Non-domestic	urseries and seasonal publi	6a
57060	ALL SAINTS CHURCH LOVELACE ROAD SE21 8JY	SE21 8JY	osgb1000005869334	200000478639	2	Non-domestic	urseries and seasonal publi	6a
57073	61 LYHAM ROAD SW2 5DH	SW2 5DH	osgb1000005556174	200000471924	1	Non-domestic	urseries and seasonal publi	6a
57081	CHURCH HALL POPLAR WALK SE24 0BS	SE24 0BS	osgb1000005876280	200000476670	1	Non-domestic	urseries and seasonal publi	6a
57534	ST VINCENTS COMMUNITY CENTRE TALMA ROAD SW2 1AS	SW2 1AS	osgb1000005715439	200000483133	2	Non-domestic	urseries and seasonal publi	6a
57612	BRIXTON TATE LIBRARY BRIXTON OVAL SW2 1JQ	SW2 1JQ	osgb1000005716133	200000455963	2	Non-domestic	urseries and seasonal publi	6a
57789	SUNNYHILL PRIMARY SCHOOL SUNNYHILL ROAD SW16 2UW	SW16 2UW	osgb1000005544137	10000445313	3	Non-domestic	urseries and seasonal publi	6a
58580	T PATRICKS ROMAN CATHOLIC CHURCH CORNWALL ROAD SE1 8T	SE1 8TW	osgb1000005731436	100023226370	2	Non-domestic	urseries and seasonal publi	6a
58970	8 HARLEYFORD STREET SE11 5SY	SE11 5SY	osgb1000005720699	100023230387	2	Non-domestic	urseries and seasonal publi	6a
58983	11 SANCROFT STREET SE11 5UG	SE11 5UG	osgb1000005726922	10093056603	2	Non-domestic	urseries and seasonal publi	6a
59297	'S PRIMARY SCHOOL WEST NORWOOD 16 WOLFINGTON ROAD SE	SE27 0JF	osgb1000005699752	200000486942	2	Non-domestic	urseries and seasonal publi	6a
59741	GHT 1220034 LT ADSHEL OUTSIDE RECTORY GROVE CENTRE OLD	SW4 0EL	osgb1000001796200889	200000522148	1	Non-domestic	urseries and seasonal publi	6a
59920	EATHBROOK NURSERY PRIMARY SCHOOL ST RULE STREET SW8 3E	SW8 3EH	osgb1000005416448	200000480653	2	Non-domestic	urseries and seasonal publi	6a
60333	LARKHALL JUNIOR SCHOOL SMEDLEY STREET SW4 6PH	SW4 6PH	osgb1000005415762	200000479834	2	Non-domestic	urseries and seasonal publi	6a
60635	9 WEIR ROAD SW12 0LT	SW12 0LT	osgb1000041772457	10008792161	1	Non-domestic	urseries and seasonal publi	6a
60638	OAKFIELD SCHOOL THURLOW PARK ROAD SE21 8HP	SE21 8HP	osgb1000005869067	200000484202	1	Non-domestic	urseries and seasonal publi	6a
60639	UKES CHURCH ENGLAND PRIMARY SCHOOL LINTON GROVE SE27	SE27 0DZ	osgb1000042303272	200000471131	1	Non-domestic	urseries and seasonal publi	6a
60645	HENRY FAWCETT PRIMARY SCHOOL CLAYTON STREET SE11 5BZ	SE11 5BZ	osgb1000005720943	200000459612	1	Non-domestic	urseries and seasonal publi	6a
60646	WYVIL PRIMARY SCHOOL WYVIL ROAD SW8 2TJ	SW8 2TJ	osgb1000005570184	100023384015	1	Non-domestic	urseries and seasonal publi	6a
60648	BONNEVILLE PRIMARY SCHOOL BONNEVILLE GARDENS SW4 9LB	SW4 9LB	osgb1000041778886	100023365455	1	Non-domestic	urseries and seasonal publi	6a
60650	IARYS ROMAN CATHOLIC PRIMARY SCHOOL CRESCENT LANE SW4	SW4 9QJ	osgb1000005413727	200000460648	1	Non-domestic	urseries and seasonal publi	6a
60651	55-5 LEWIN ROAD SW16 6JZ	SW16 6JZ	osgb1000041768743	200000471001	1	Non-domestic	urseries and seasonal publi	6a
60653	ROSENDALE INFANTS SCHOOL ROSENDALE ROAD SE21 8LX	SE21 8LX	osgb1000005868237	200000485007	1	Non-domestic	urseries and seasonal publi	6a
60654	INGSWOOD PRIMARY (LOWER) SCHOOL 55 GIPSY ROAD SE27 9N	SE27 9NP	osgb1000042301672	10090196376	1	Non-domestic	urseries and seasonal publi	6a
60657	CLAPHAM MANOR PRIMARY SCHOOL BELMONT ROAD SW4 0BZ	SW4 0BZ	osgb1000005412067	200000454983	1	Non-domestic	urseries and seasonal publi	6a

Total number of addresses:	**182,227**	
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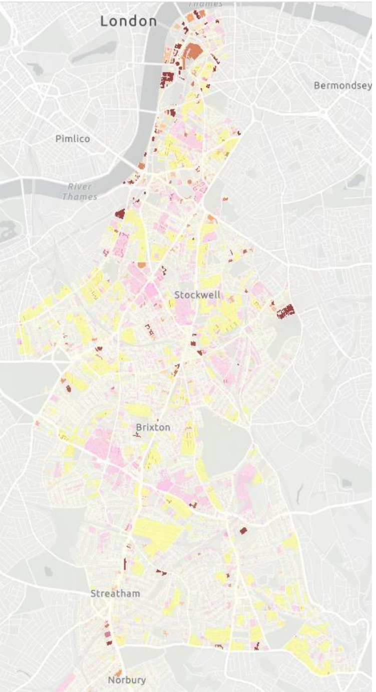
Number of buildings:	**63,900**	

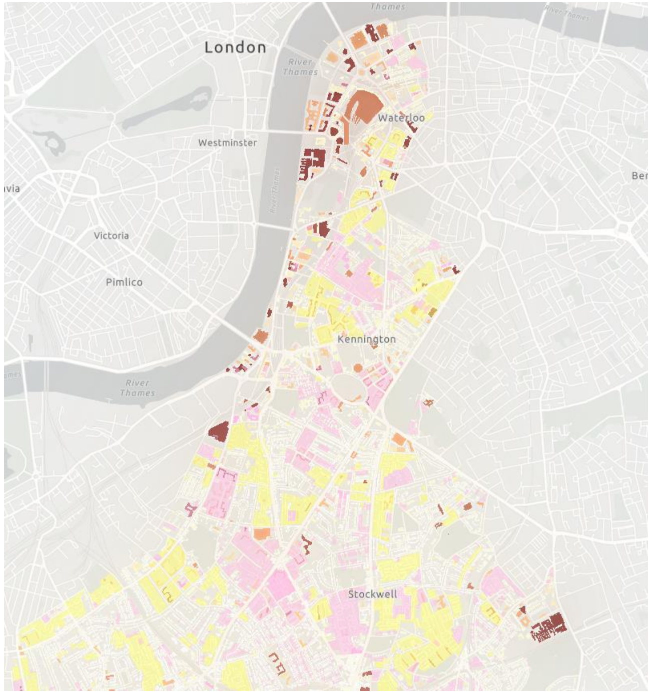
Lambeth Building level data

Example outputs - GIS

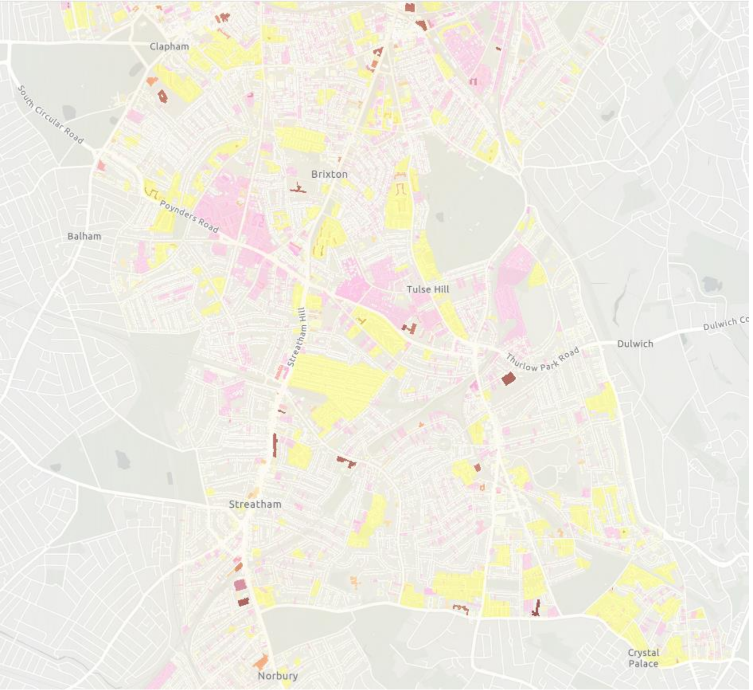
Lambeth



Lambeth North



Lambeth South



Lambeth Building level data

Example outputs – Wall type and insulation

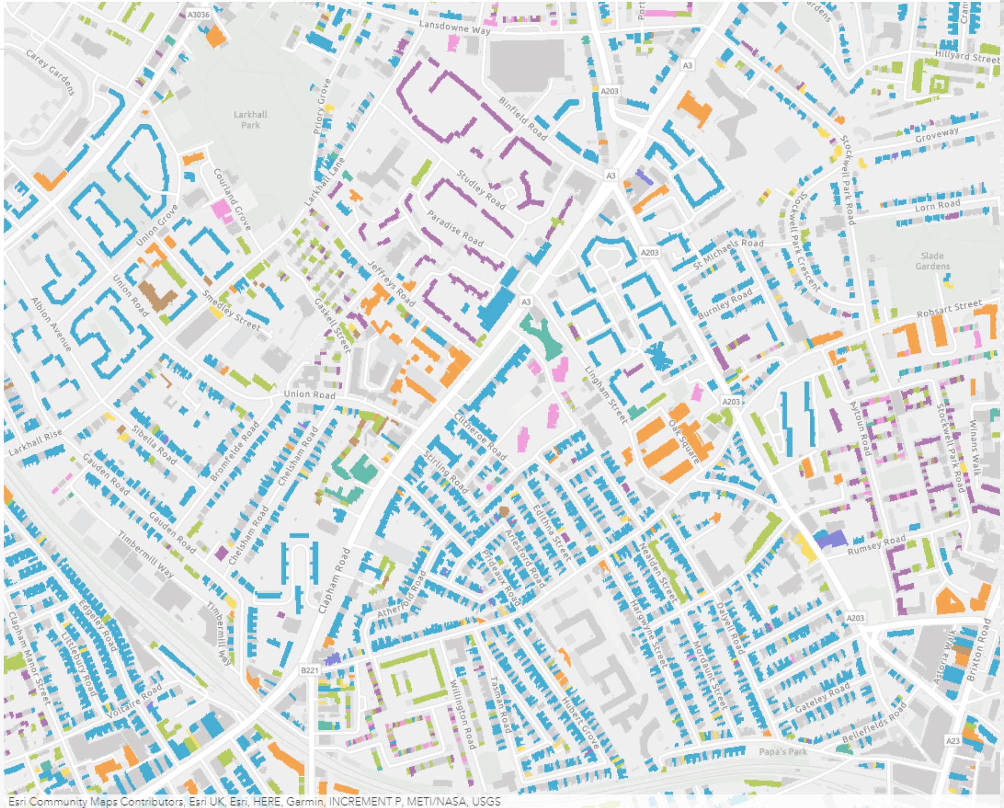
Legend

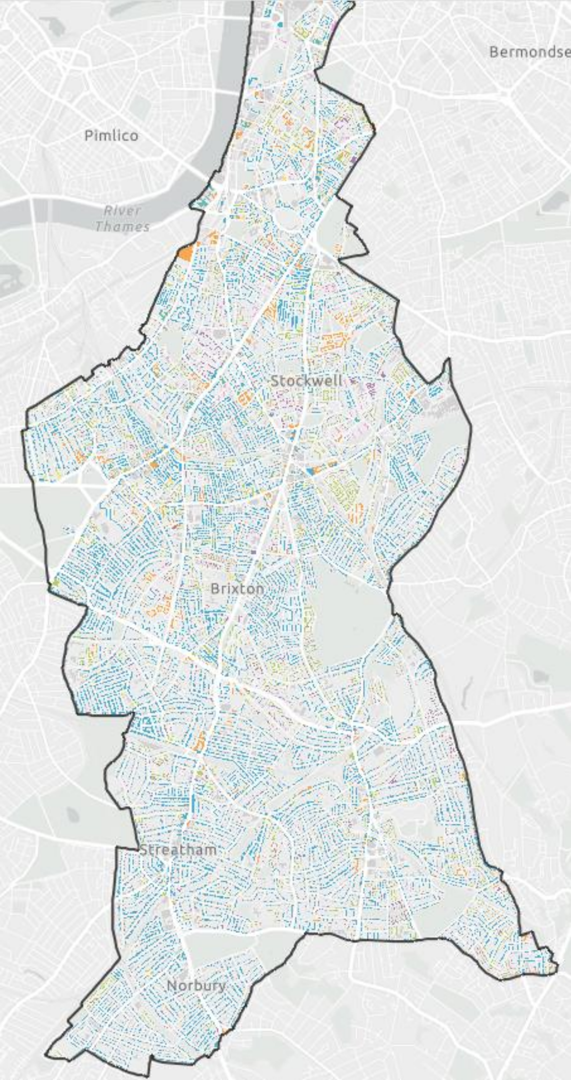
Current Data / BAU

Dominant Wall Type and Insulation

Dominant wall type and insulation (BAU)

- Cavity wall (no insulation)
- Cavity wall (insulated)
- Solid brick, sandstone or granite (no insulation)
- Solid brick, sandstone or granite (insulated)
- System built (no insulation)
- System built (insulated)
- Timber frame (no insulation)
- Timber frame (insulated)
- U-value below 0.5 W/K.m2
- Unknown





Lambeth Building level data

Example outputs – Wall type and insulation

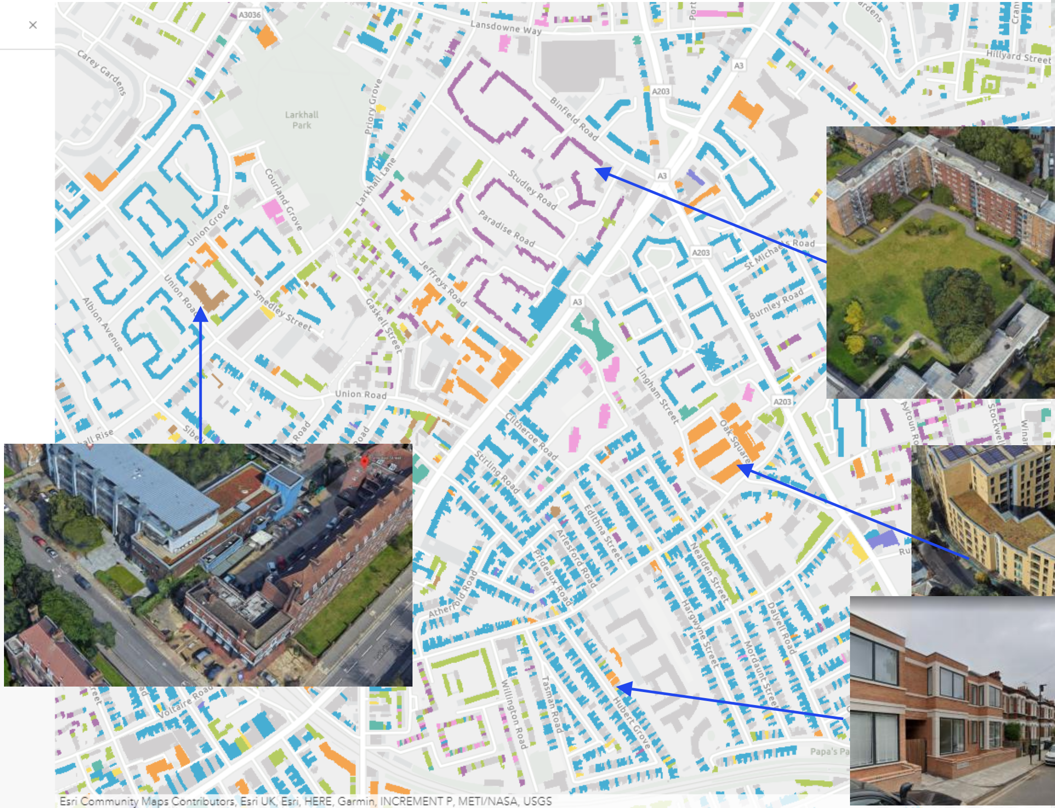
Legend

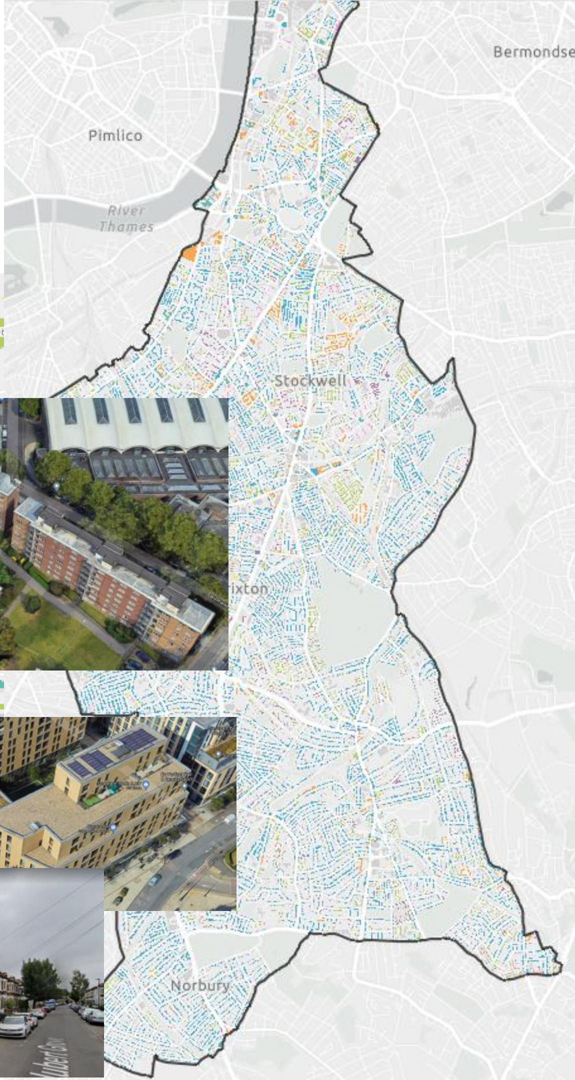
Current Data / BAU

Dominant Wall Type and Insulation

Dominant wall type and insulation (BAU)

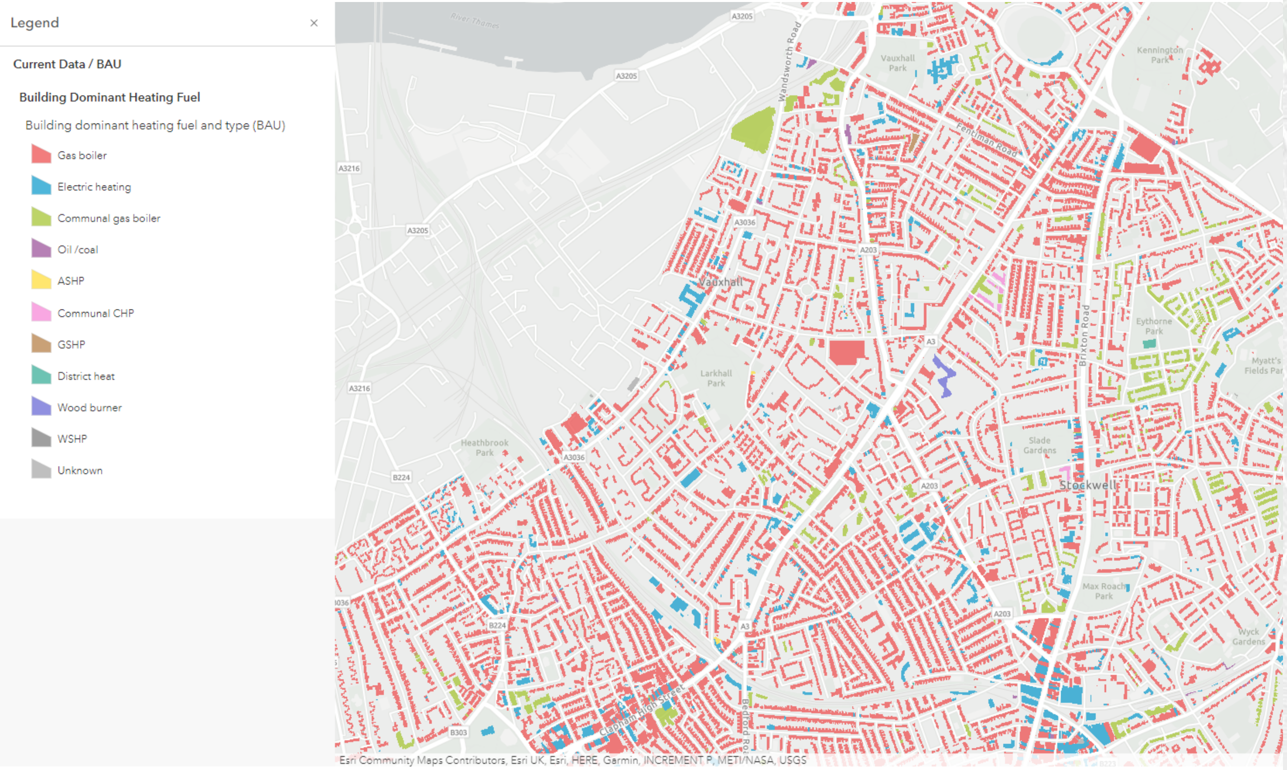
- Cavity wall (no insulation)
- Cavity wall (insulated)
- Solid brick, sandstone or granite (no insulation)
- Solid brick, sandstone or granite (insulated)
- System built (no insulation)
- System built (insulated)
- Timber frame (no insulation)
- Timber frame (insulated)
- U-value below 0.5 W/K.m2
- Unknown

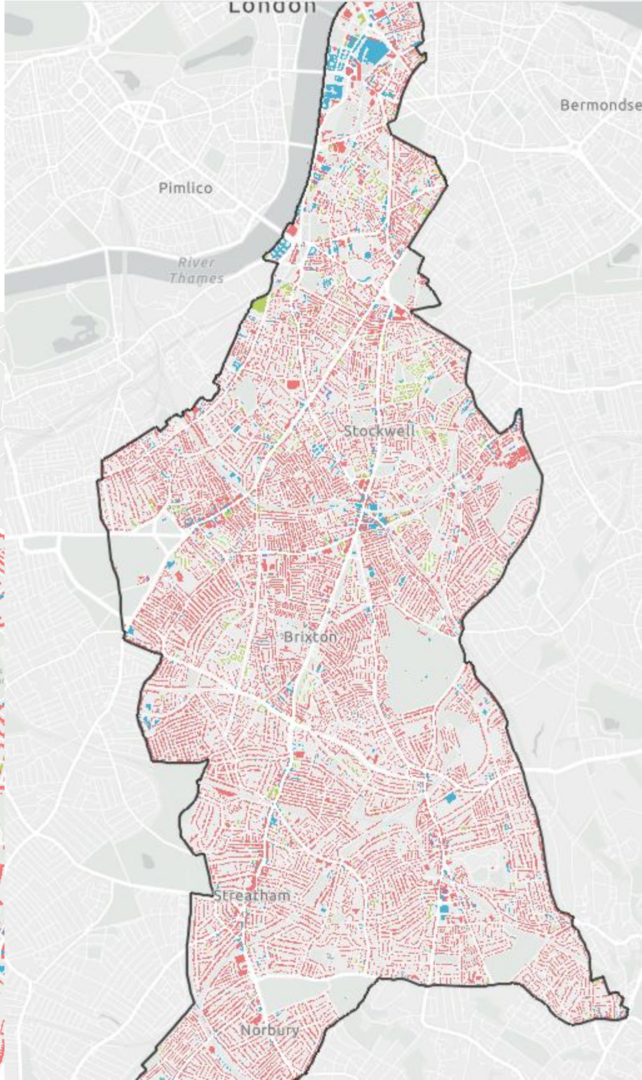




Lambeth Building level data

Example outputs – Dominant heating system

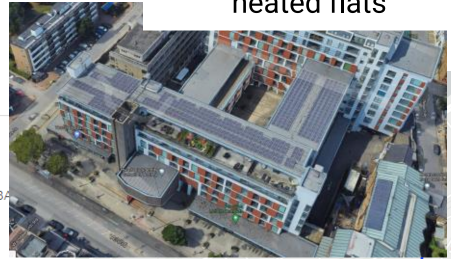




Lambeth Building level data

Example outputs – Dor

Modern electrically heated flats



Nine Elms Communal / District heating

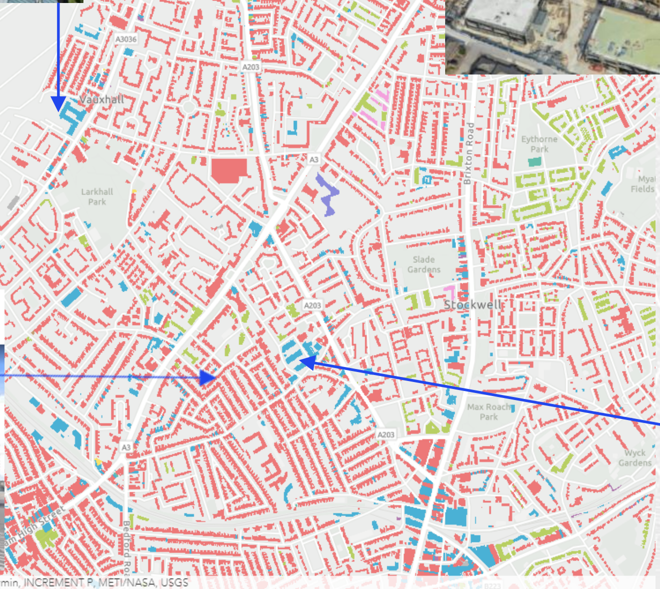
Legend

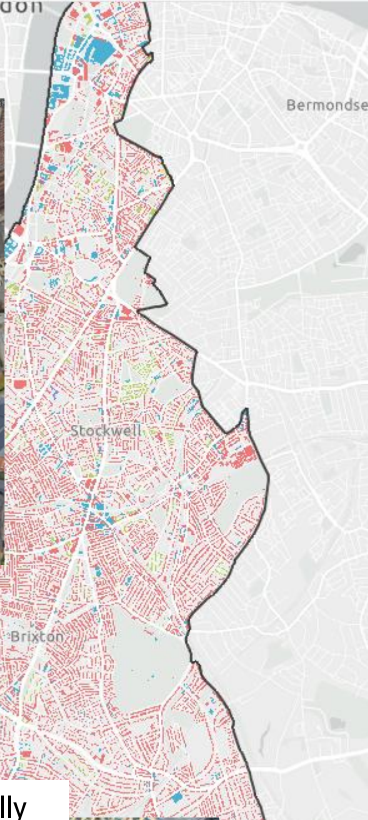
Current Data / BAU

Building Dominant Heating Fuel

Building dominant heating fuel and type (BA

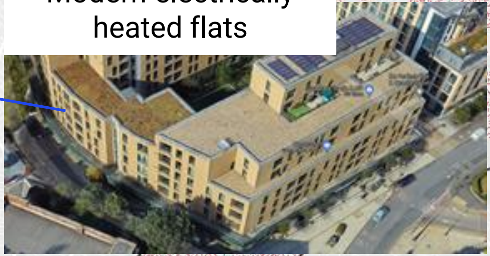
- Gas boiler
- Electric heating
- Communal gas boiler
- Oil /coal
- ASHP
- Communal CHP
- GSHP
- District heat
- Wood burner
- WSHP
- Unknown





Gas heated houses

Modern electrically heated flats



Lambeth Building level data

Example outputs – Building tenure and social housing estates

Lambeth Building level data

Example outputs – Building age (note inconsistency in EPC surveys)

Pre 1900 or Post 1900?

Pre 1930 or Post 1930?

Lambeth Building level data

Example outputs – pre 1930 terraces converted in to flats

Lambeth building database

Potential uses

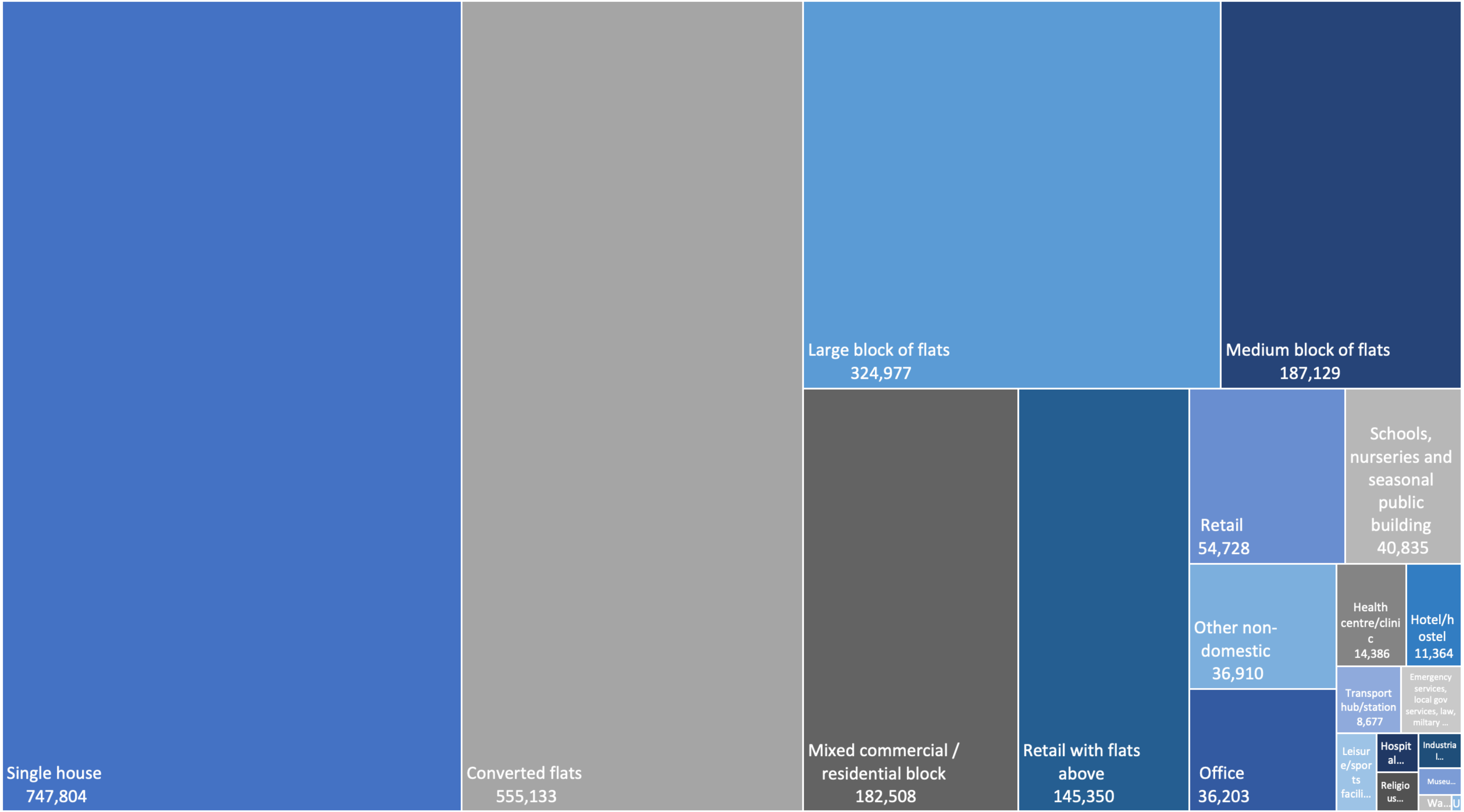
- Project identification and funding applications:
    - Social Housing Decarbonisation Fund,
    - Public Sector Decarbonisation Scheme etc
    - Heat Pump Ready Progamme
    - Energy Companies Obligation

- Heat Network zone identification
    - Green Heat Networks Fund

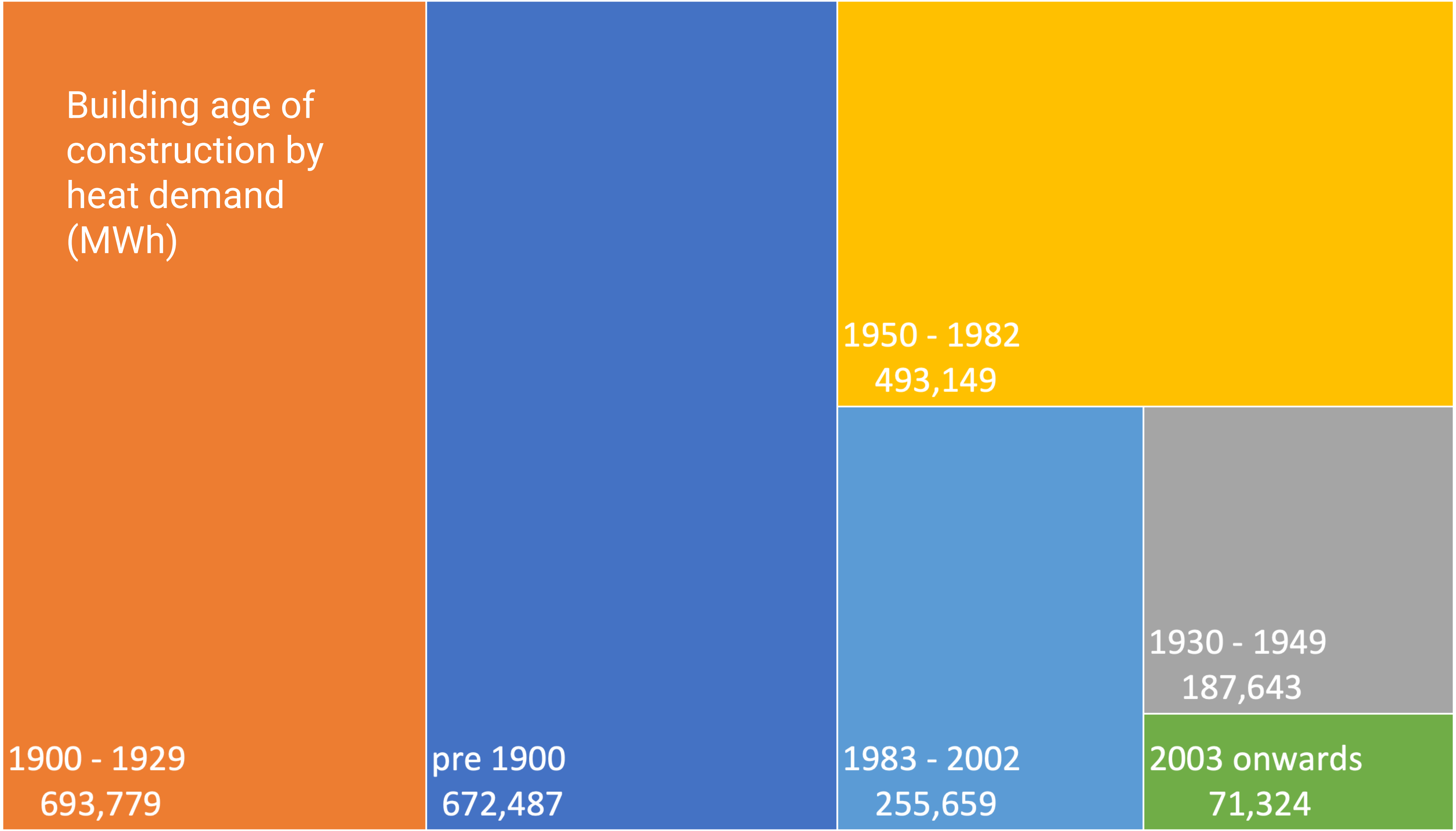
- Local Area Energy Planning:
    - mapping against DNO data

- Prioritising strategy, action planning and policy development

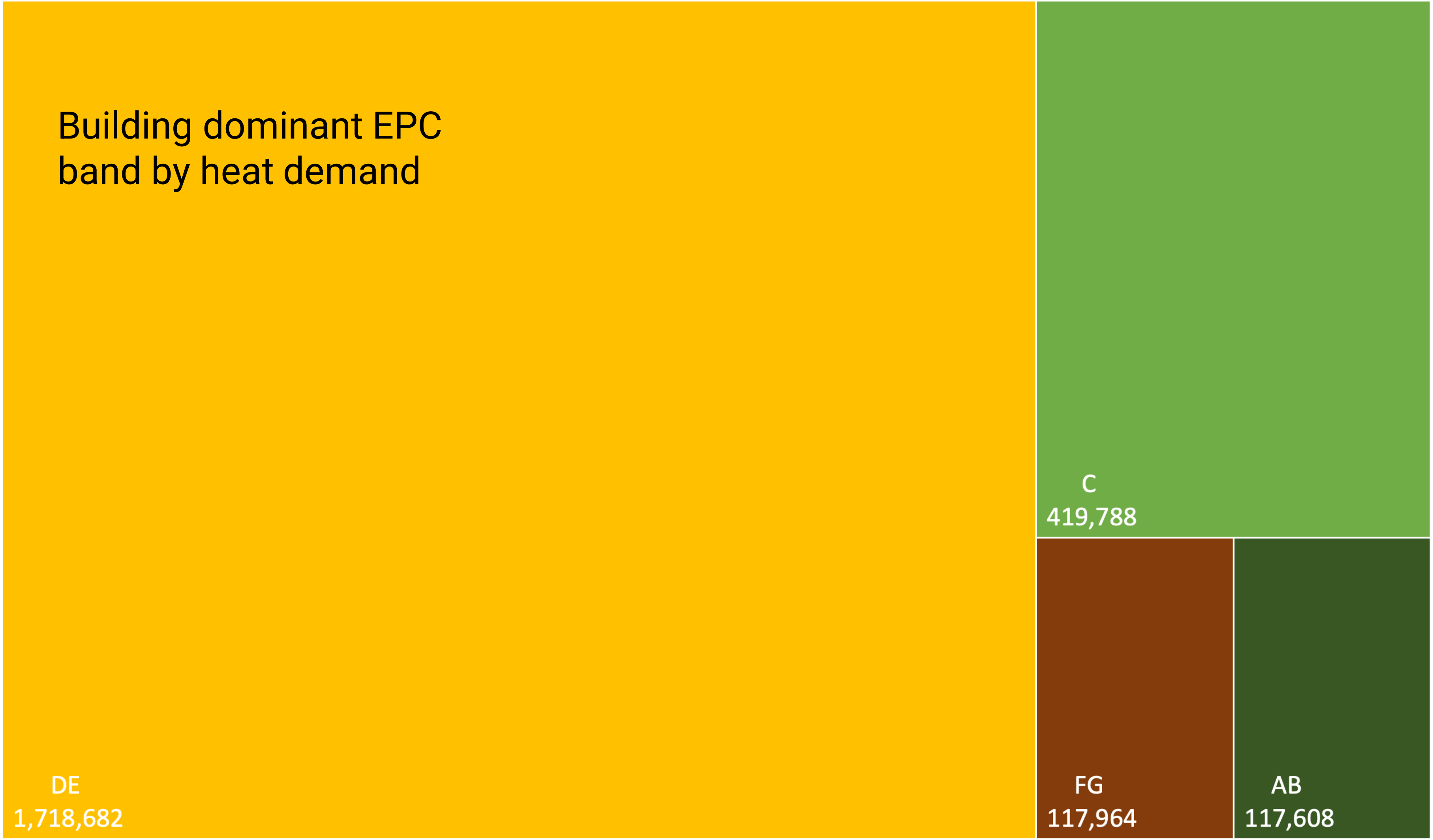
Identifying archetypes in the Lambeth building stock

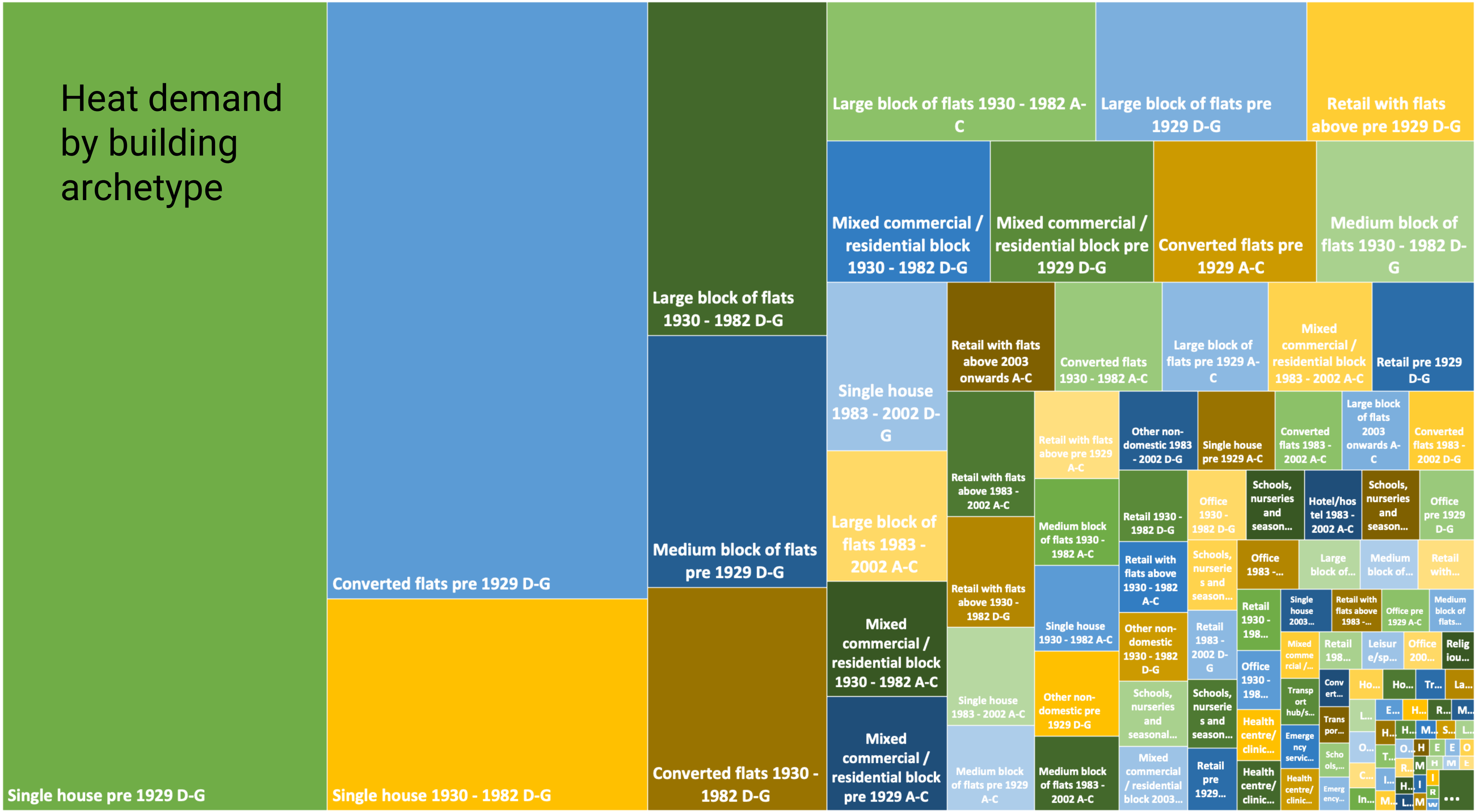


Single house
747,804
Converted flats
555,133
Large block of flats
324,977
Medium block of flats
187,129
Mixed commercial / residential block
182,508
Retail with flats above
145,350
Retail
54,728
Schools, nurseries and seasonal public building
40,835
Other non-domestic
36,910
Office
36,203
Health centre/clinic
14,386
Hotel/hostel
11,364
Transport hub/station
8,677
Emergency services, local gov services, law, miltary ...
Leisure/sports facili...
Hospital...
Industrial...
Religious...
Museu...
Wa...
U



Building age of construction by heat demand (MWh)
1900 - 1929
693,779
pre 1900
672,487
1950 - 1982
493,149
1983 - 2002
255,659
1930 - 1949
187,643
2003 onwards
71,324


Building dominant EPC band by heat demand
DE
1,718,682
C
419,788
FG
117,964
AB
117,608


Heat demand by building archetype
Single house pre 1929 D-G
Converted flats pre 1929 D-G
Single house 1930 - 1982 D-G
Large block of flats 1930 - 1982 D-G
Medium block of flats pre 1929 D-G
Converted flats 1930 - 1982 D-G
Large block of flats 1930 - 1982 A-C
Large block of flats pre 1929 D-G
Retail with flats above pre 1929 D-G
Mixed commercial / residential block 1930 - 1982 D-G
Mixed commercial / residential block pre 1929 D-G
Converted flats pre 1929 A-C
Medium block of flats 1930 - 1982 D-G
Single house 1983 - 2002 D-G
Large block of flats 1983 - 2002 A-C
Mixed commercial / residential block 1930 - 1982 A-C
Mixed commercial / residential block pre 1929 A-C
Retail with flats above 2003 onwards A-C
Converted flats 1930 - 1982 A-C
Large block of flats pre 1929 A-C
Mixed commercial / residential block 1983 - 2002 A-C
Retail pre 1929 D-G
Retail with flats above 1983 - 2002 A-C
Retail with flats above pre 1929 A-C
Other non-domestic 1983 - 2002 D-G
Single house pre 1929 A-C
Converted flats 1983 - 2002 A-C
Large block of flats 2003 onwards A-C
Converted flats 1983 - 2002 D-G
Medium block of flats 1930 - 1982 A-C
Retail 1930 - 1982 D-G
Office 1930 - 1982 D-G
Schools, nurseries and season...
Hotel/hostel 1983 - 2002 A-C
Schools, nurseries and season...
Office pre 1929 D-G
Retail with flats above 1930 - 1982 D-G
Retail with flats above 1930 - 1982 A-C
Schools, nurseries and season...
Office 1983 -...
Large block of...
Medium block of...
Retail with...
Single house 1930 - 1982 A-C
Single house 1983 - 2002 A-C
Other non-domestic pre 1929 D-G
Other non-domestic 1930 - 1982 D-G
Retail 1983 - 2002 D-G
Retail 1930 - 198...
Single house 2003...
Retail with flats above 1983 -...
Office pre 1929 A-C
Medium block of flats...
Office 1930 - 198...
Medium block of flats pre 1929 A-C
Medium block of flats 1983 - 2002 A-C
Schools, nurseries and seasonal...
Schools, nurseries and season...
Mixed commercial / residential block 2003...
Retail pre 1929...
Health centre/ clinic...
Health centre/ clinic...
Mixed commercial /...
Retail 198...
Leisure/sp...
Office 200...
Religiou...
Transport hub/s...
Emergency servic...
Conv ert...
Transpor...
Schools,...
Health centre/ clinic...
Emergency...

Building archetypes

	No. buildings	No. addresses	Heat demand (MWh)	% of Lambeth heat demand represented	Floorspace (sqm)
1a Large pre 1900 terraced house (E)	11016	11043	286,651	11.8%	1,566,537
1b Medium pre 1930 terraced house (D)	8650	8655	207,208	8.5%	1,137,585
1c 1960s terraced house (D)	6659	6685	108,868	4.5%	647,591
1d 1990s semi-detached house (D)	2327	2342	26,719	1.1%	220,756
1e 1980s terraced house (C)	4213	4247	43,361	1.8%	443,906
1f 1930s end terraced house (F)	988	989	38,374	1.6%	141,685
2a Pre 1900 top floor flat (D)	6281	16080	249,540	10.3%	1,423,368
2b Pre 1930 mid-floor flat (D)	4338	10721	165,553	6.8%	970,925
2c 1900s mid-floor flat (E)	2172	5076	60,750	2.5%	368,282
2d pre 1900 mid floor flat (C)	4586	17470	145,858	6.0%	1,377,666
2e Pre 1900 ground floor flat (F)	358	979	19,305	0.8%	103,970
3a Large 1920s tenement block of flats (C)	191	4370	53,096	2.2%	338,132
3b Large 1930s block of flats (C)	146	4544	48,337	2.0%	311,272
3c Large 1970s block of flats (C)	645	19250	149,942	6.2%	1,282,833
3d Large 1990s block of flats (B)	108	4208	31,448	1.3%	295,353
4a Pre 1900 converted flats (D)	1073	6860	86,391	3.6%	497,070
4b Small 1930s block of flats (D)	128	960	10,899	0.4%	65,133
4c Small 1970s block of flats (C)	869	5933	46,374	1.9%	402,641
5a Post 2000 Mixed commercial / residential block	13	1455	12,946	0.5%	157,201
6a 1970s school (C)	244	294	50,952	2.1%	398,703
7a 1990s large retail unit (C)	574	1258	41,413	1.7%	529,917
7b Pre 1900 small retail unit (F)	1677	3890	61,024	2.5%	663,540
8a Post 2012 large office block (C)	57	410	10,262	0.4%	113,705
8b Pre 1900 small office building (E)	248	1422	32,851	1.4%	357,710
9a Post 2000 leisure centre (B)	81	117	37,879	1.6%	119,272
9b Post 2000 Fire Station (B)	55	69	35,103	1.4%	141,950
11a Pre 1900 Library (E)	20	38	3,089	0.1%	31,080
12a 1990s large hospital (D)	14	54	19,396	0.8%	62,568
13a 1980s small health centre (C)	114	152	15,530	0.6%	79,166
14a Post 200 large hotel (A)	22	61	13,998	0.6%	106,019

Lambeth domestic archetypes – representative buildings


1a Large Pre-1900 terraced house (E)


1d 1990s semi-detached house (D)


2a Pre-1900 top floor flat (D)


2d Pre-1900 mid floor flat (C)


3b Large 1930s block of flats (C)


4a Converted flats Pre 1900 (D)


1b Medium Pre-1930 terraced house (D)


1e 1980s terraced house (C)


2b Pre 1930 mid-floor flat (D)


2e Pre 1900 ground floor flat (F)


3c Large 1970s block of flats (C)


4b Small 1930s block of flats (D)


1c 1960s terraced house (D)


1f 1930s end terraced house (F)


2c 1990s mid-floor flat (E)


3a Large 1920s tenement block of flats (C)


3d Large 1900s block (B)


4c Small 1970s block of flats (C)

Lambeth non-domestic archetypes – representative buildings

5a Post-2000 mixed residential / commercial (B)

7a Large 1990s retail unit (C)

8b pre 1900 small office (E)

11a Pre 1930s Library (E)

6a 1970s School (D)

7b Pre 1900 small retail unit (F)

9a Post 2000 Leisure centre (B)

12a Large 1990s hospital (D)

14a Post 2000 Large hotel (A)

6b Pre 1930 school (G)

8a post 2000 large office block (C)

10a Post 2000 fire station (B)

13a Small 1980s health clinic (C)

Retrofit packages of measures

Key measures for building retrofit considered in the options appraisals

Measures considered in Options Appraisals

Electric heating options for individual houses and flats

High temperature ASHP

Capable of delivering flow temperatures up to 65 – 70C but capable of modulating to lower flow temperatures when required.

Suitable for properties with poor fabric efficiency or where heating system replacement is not desirable.

SPF typically lower than standard heat pumps at between 2 – 2.5.

Size range 3.5kW – 16kW

Cost range £9,000 - £15,000

Standard ASHP

Capable of delivering flow temperatures up to 55C but with occasional delivery of 60C for legionella cycle.

Suitable for properties with a reasonable level of fabric efficiency, typically in combination with higher output double and triple panel radiators or UFH.

SPFs can be as high as 3.5 but typically in the 2.6 – 3.0 range in retrofits.

Size range 3.5kW – 14kW

Cost range £7,500 - £14,000

Electric storage boiler

Capable of delivering 35 – 80C flow temperatures making it a direct replacement for gas boilers.

Utilises off-peak electricity at lower tariffs (as low as £0.05 per kWh)

Max output around 6kw making it best suited to flats and smaller, energy efficient houses.

SPF less than 1.0 but low tariffs can mean low fuel bills.

Size range 3 – 6kW

Cost range £5,000 - £9,000

HHR smart storage heaters

Capable of delivering high temperature heat with excellent controls.

Smart functionality enables utilization of time of use tariffs.

Typically suitable for smaller or energy efficient properties due grid connection constraints.

SPF less than 1.0 but low tariffs can result in low fuel bills.

Size range considered 1kW – 3kW

Cost range approx £750 per kW

Infra-red heating panels

Radiant panels that heat objects, surfaces and people directly, rather than heating the air.

Direct heating means they are most likely to utilise on-peak tariffs

Typically suitable where heat demand is very low due to high energy use.

SPF in theory higher than 1.0 as radiant heat requires fewer kW to achieve comfort.

Size range considered 1W – 3kW

Cost range approx. £450 per kW

Measures considered in Options Appraisals

Electric heating options and ancillary measures

Internal ASHP

Internally sited ASHP with ducting to outside. Capable of delivering small levels of <55C heat.

Suitable for flats with very low levels of heat demand. Offers very good efficiency but siting and installing the heat pump to avoid noise issues is key.

SPF typically between 2.25 and 2.75 as primary output is hot water at 50 – 60C.

Size range considered1kW – 2.5KW

Cost range £9,000 - £12,500

Triple & double convector radiators

Higher capacity that can reduce flow temperatures relative to single panel and single convector radiators.

Suitable for any properties with wet heating systems. Typically installed where flow temperatures are in excess of 55C.

Cost range Approx £200 per kW installed for triple convector

Thermal store: Hot water cylinder

Heat pump specific hot water cylinder with large heating coil surface area to accommodate lower flow temperatures.

Suitable for any property but finding a suitable location can be difficult, particularly in smaller flats.

May or may not include integrated immersion heater for top up and/or legionella cycle.

Size range 150 – 300 liters.

Cost range £1,200 – £2,000 installed

Thermal store: (phase change)

Compact thermal energy storage utilising phase change material to provide similar levels of thermal storage to a hot water cylinder but at approximately 30% of the space.

Suitable for properties without space for a traditional cylinder.

Can also be configured to supplement space heating requirements.

Cost range approx £2,500 - £3,500 installed.

New distribution pipework

New distribution pipework including associated pumps, manifolds and connections may well be required, particularly when existing radiators are being replaced and/or when microbore pipework is currently used.

Even if not required, new pipework can often help to optimise system performance by optimising flow rates.

Cost range: Approx £1,200 - £2,800 per house

Measures considered in Options Appraisals

Additional options for blocks of flats

Shared ground loop heat pumps

Ground loop typically consisting of multiple bore holes, feeding in to one or more block of flats, with small individual heat pumps within each flat.

Can be easier to retrofit in to blocks of flats that do not have distribution for communal heating.

SPF typically between 2.25 and 2.75 as primary output is hot water at 50 – 60C.

Size range considered 3kW – 6KW per flat

Cost range £12,500 - £17,500 per flat

High temperature communal heat pumps

A large heat pump that may be utilising one or more sources of heat, typically from ground bore holes, water source or other waste heat, but may some times utilise air source.

Typically considered for flats currently heated by communal gas boilers or CHP where flow temperatures are high (80C).

Size range : Unlimited.

Cost range: £1,600 - £2,500 per kW (without costs of upgrades to secondary and tertiary systems)

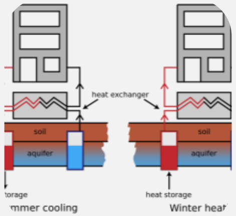
Standard temperature communal heat pumps

A large heat pump that may be utilising one or more sources of heat, typically from ground bore holes, water source or other waste heat, but may some times utilise air source.

Typically considered for flats with existing communal gas boilers where the required flow temperatures are lower (<60C) e.g where significant fabric retrofit has been undertaken.

Size range: Unlimited

Cost range: £1,500 - £2,000 per kW (without costs of upgrades to secondary and tertiary systems)



Ground source heat pumps with passive cooling

Passive cooling works by circulating the water and refrigerant mixture (brine) through the pipework buried in the ground (known as ground collectors or ground arrays), the brine is cooled by the lower temperature of the ground before being circulated to a heat exchanger which further reduces the temperature, providing chilled water. The water is then distributed to cooling fan coil units or underfloor heating.

Very low cost to run as it only required energy to pump the brine around the system.

Cost range £1,850 - £2,250 per kW (without costs of upgrades to secondary and tertiary systems)

Variable refrigerant flow units

VRF systems are based on the flow of refrigerant between an external condensing unit and multiple internal evaporators (typically fan coil units). Each internal evaporator serves a different thermal zone within the building, and the flow of refrigerant to each evaporator is adjusted depending on the local requirement.

Size range: unlimited

Cost range: £1,050 - £2,000 per kW (depending on existing heat distribution system).

Measures considered in Options Appraisals

Additional options for blocks of flats

Loft / roof insulation

Loft insulation: £16 - £24 per m^2 building footprint

Room in roof insulation: £50 - £75 per m_2 building footprint.

Flat roof insulation: £80 - £120 per m2 building footprint.

High performance glazing

Modern double glazing (PVC casement) £420 per m^2 glazed area. U-value ~2.2.

Wooden sash double glazing £550 per m^2 glazed area. U-value ~2.3.

High performance triple glazing: £590 per m^2. U-value ~2.0

Floor insulation

Suspended timber floor (Easy access) £54 per m^2 building footprint.

Suspended timber floor (difficult access) £88 per m^2 building footprint.

Insulate solid floor: £108 per m^2 building footprint.

Cavity wall insulation

£10 - £15 per m_2 external wall area.

U-value ~0.45

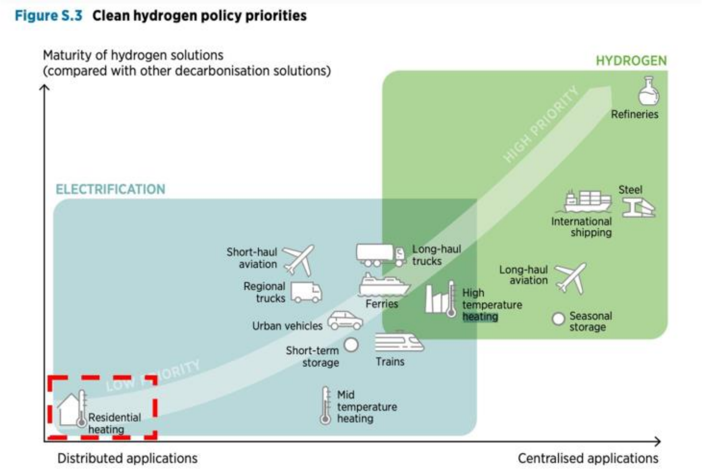
Solid wall insulation

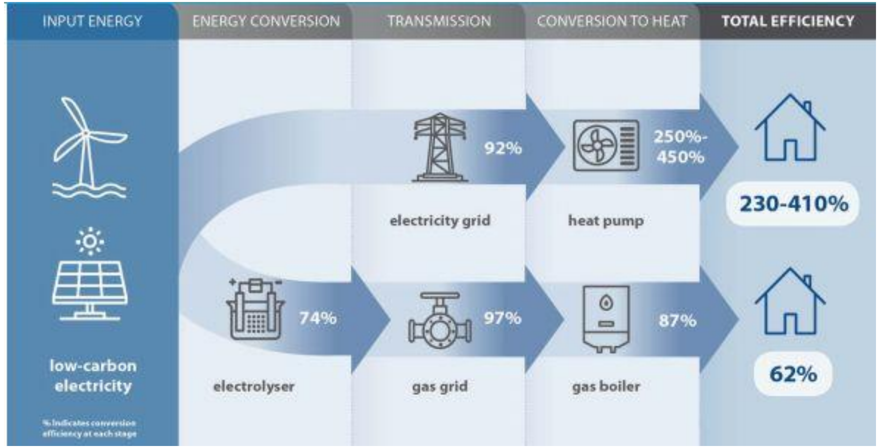
External wall insulation: £88 - £379 per m^2 external wall area depending on complexity of project, building facade and building height. U-value ~0.3.

Internal wall insulation: High price complex: £88 - £225 per m^2 external wall area depending on complexity of project and interior decoration. U-value: ~0.45

Why no hydrogen?

Hydrogen deemed out of scope

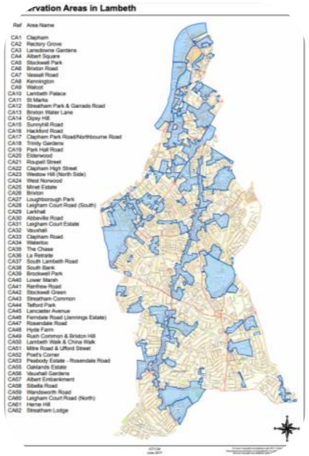




- Whilst some bodies see a limited role for Hydrogen in decarbonizing heat in buildings, this role is highly uncertain and independent analysis repeatedly shows that building heat will be amongst the lowest priorities for limited Hydrogen resource.
- From a buildings perspective, Hydrogen is also likely to be a very expensive form of fuel with costs per kWh estimated to be 3 – 6 x those of natural gas.
- For these reasons, Hydrogen was not included in the scope of this project.
- "The current technological immaturity of hydrogen production and the need to deploy the Hydrogen that is available to strategically important sectors represents a significant risk factor in the High Hydrogen scenario, both in terms of uncertainty of availability, emissions intensity, and future costs." *GLA; Analysis of a net zero 2030 target for Greater London.*

Considerations for retrofit

Taking in to account the practical context of each building



- Not in a conservation area but high heritage value
- High density terraced housing (5m width)
- Small garden with narrow side return
- High(ish) output double panel / single convector radiators
- Internal cornicing with high standard of decoration

Measures considered in Options Appraisals

Domestic electricity tariffs – standard and time of use

Treasury Green Book Central Domestic	Economy 7	'Super-off peak' time of use tariff	Dynamic time of use tariff	Solar export tariff
HM Treasure Central Domestic Forecast 2021 – 2060 October 2021 **21.1p** per kWh Standing charge weighted and included.	Bulb vari-fair Economy 7 October 2021 00:00 – 06:59 **14.3p** per kWh 07:00 – 23:59 **23.8p** per kWh See also: https://www.gocompare.com/gas-and-electricity/economy-7/	Octopus Go Time of Use tariff October 2021 01:30 – 06:29 **5.9p** per kWh 06:30 – 01:29 **24.6p** per kWh See also: https://www.smarthomecharge.co.uk/guides/energy-tariffs-how-to-keep-ev-charging-costs-low	Octopus Agile dynamic time of use tariff October 2021 (average of preceding year) 00:00 – 06:59 **15.8p** per kWh 07:00 – 23:59 **19.5p** pkWh 04:00 – 18:59 **32.7p** per kWh Min **–5p** per kWh Max **35p** per kWh	**4p** per kWh See also: https://www.solarpanelprices.co.uk/articles/solar-panels/best-smart-export-guarantee-tariffs/

Example options appraisals

Assessing different retrofit and energy system improvements for buildings

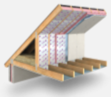
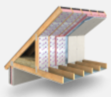
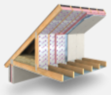
Options Appraisal summary

Archetype 1a: pre 1900 terraced house

Archetype 1a Large pre 1900 terraced house

22 Romala Road

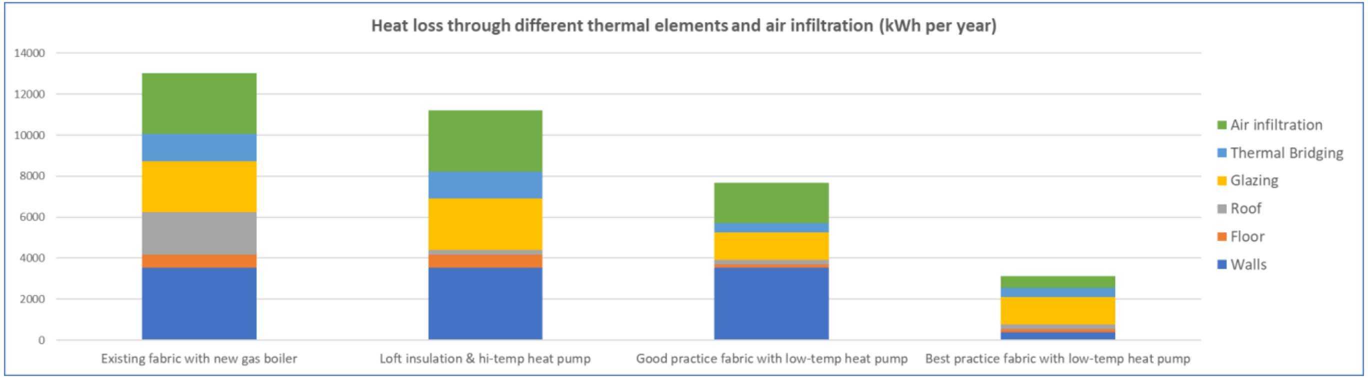
Measures installed

	Roof	Glazing	Floor	Walls	Heating system	Radiators	Cylinder	Pipework	Upfront CAPEX
1. Existing fabric. New gas boiler									£3,500
2. Loft insulation and high temperature ASHP									£15,426
3. Good practice fabric with standard ASHP									£42,923
4. Best practice fabric with standard ASHP									£83,679

Archetype 1a Large pre 1900 terraced house

22 Romala Road

Heat loss and system performance



	Existing fabric with new gas boiler	Loft insulation & hi-temp heat pump	Good practice fabric with low-temp heat pump	Best practice fabric with low-temp heat pump
Space heating demand (kWh pa)	24,107	20,721	14,202	5,791
Space heating consumption (kWh pa)	30,134	8,322	5,164	1,943
Required flow temperatures °C	70	57	45	31
Assumed heating system Seasonal Performance Factor (SPF)	80%	249%	275%	298%
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	122	105	72	29

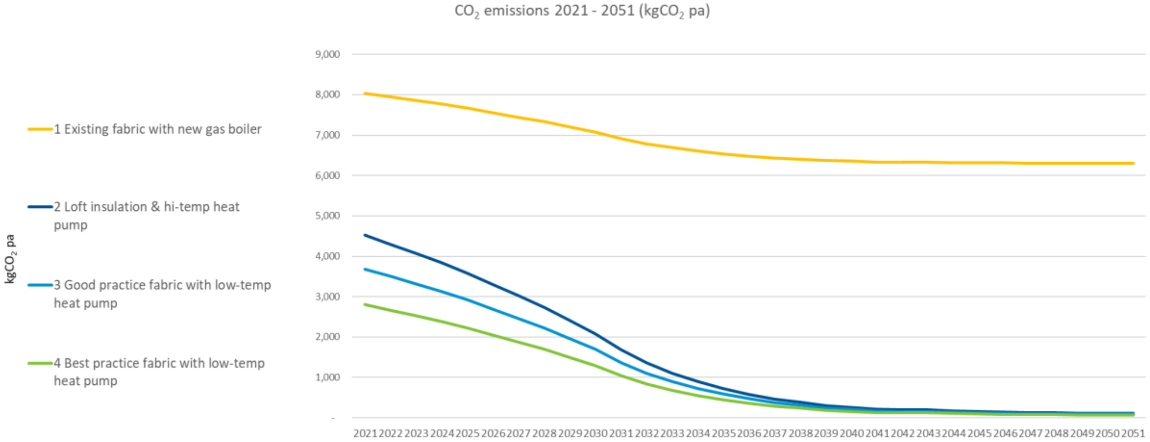
Fuel bills	£2,692	£3,370	£2,704	£2,030

Archetype 1a Large pre 1900 terraced house

22 Romala Road

CO_2 emissions

	Existing fabric with new gas boiler	Loft insulation & hi-temp heat pump	Good practice fabric with low-temp heat pump	Best practice fabric with low-temp heat pump
tCO_2 in 2021	**8.0**	**4.5**	**3.7**	**2.8**
tCO^2 in 2050	**6.3**	**0.1**	**0.1**	**0.1**
tCO^2 cumulative 2021 - 2050	**205**	**43**	**35**	**27**
CO_2 saving relative to baseline (30 year cumulative)	**0%**	**79%**	**83%**	**87%**
£ per tonne of CO_2 reduction (30 year cumulative)	**NA**	**£247**	**£240**	**£320**

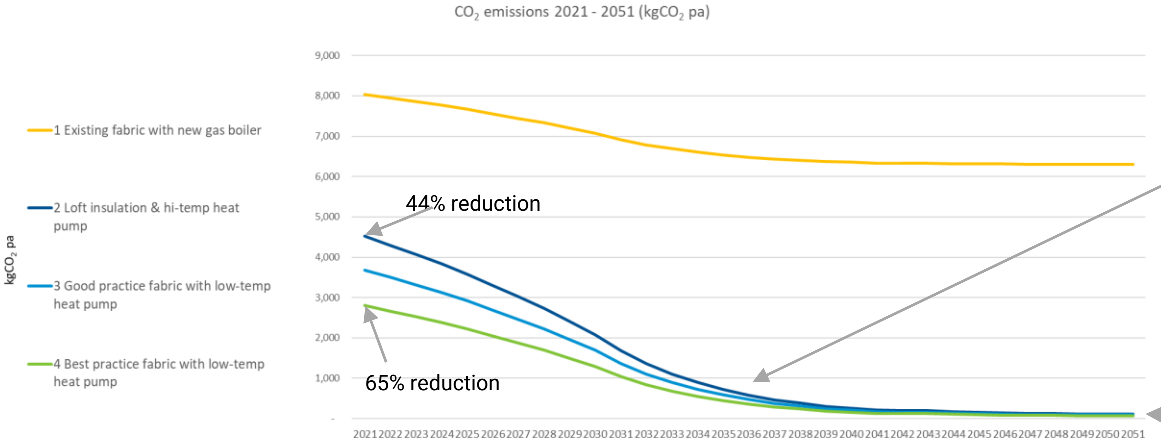


Archetype 1a Large pre 1900 terraced house

22 Romala Road

CO_2 emissions

	Existing fabric with new gas boiler	Loft insulation & hi-temp heat pump	Good practice fabric with low-temp heat pump	Best practice fabric with low-temp heat pump
tCO_2 in 2021	8.0	4.5	3.7	2.8
tCO^2 in 2050	6.3	0.1	0.1	0.1
tCO^2 cumulative 2021 - 2050	205	43	35	27
CO_2 saving relative to baseline (30 year cumulative)	0%	79%	83%	87%
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£247	£240	£320



98.5% reduction

After 2035, fabric retrofit makes little difference to CO_2 emissions

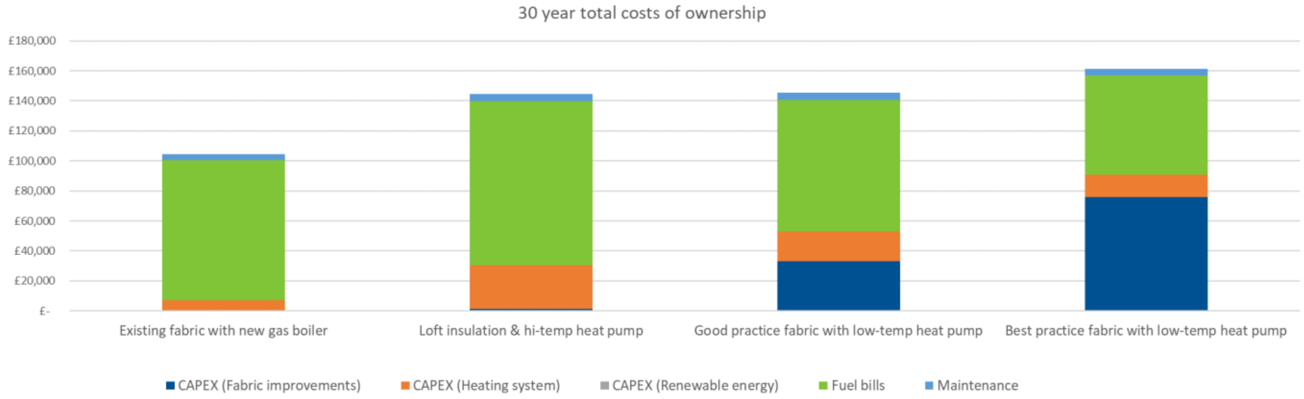
However, in practice, the forecast decline in electricity carbon intensity is dependent on a reduction in demand for heat. The CCC estimate 12 – 22%.

Archetype 1a Large pre 1900 terraced house

22 Romala Road

CAPEX, fuel bills and lifetime costs

	CAPEX	Annual fuel bill	Lifetime £ (30 yrs)
1. Existing fabric. New gas boiler	£3,500	£2,692	£104,515
2. Loft insulation and high temperature ASHP	£15,426	£3,370	£144,398
3. Good practice fabric with standard ASHP	£42,923	£2,704	£145,254
4. Best practice fabric with standard ASHP	£83,679	£2,030	£161,421



Archetype 1a Large pre 1900 terraced house

22 Romala Road

CAPEX, fuel bills and lifetime costs

	CAPEX	Annual fuel bill	Lifetime £ (30 yrs)
1. Existing fabric. New gas boiler	£3,500	£2,692	£104,515
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3. Good practice fabric with standard ASHP	£42,923	£2,704	£145,254
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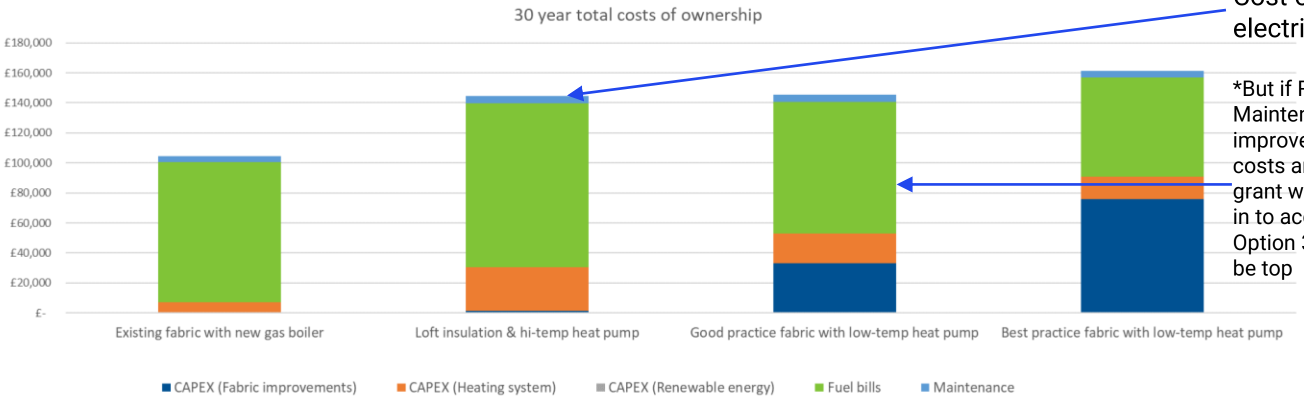


Cost optimal electrification

*But if Repairs, Maintenance & improvement costs and / or grant were taken in to account, Option 3 would be top

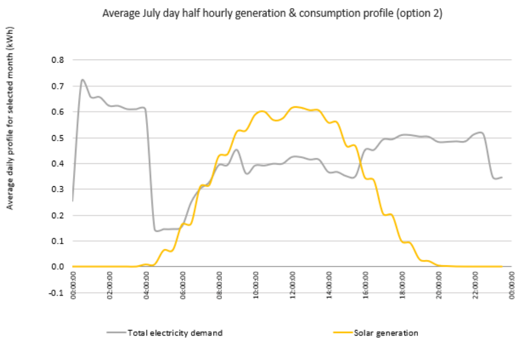
Archetype 1a Large pre 1900 terraced house

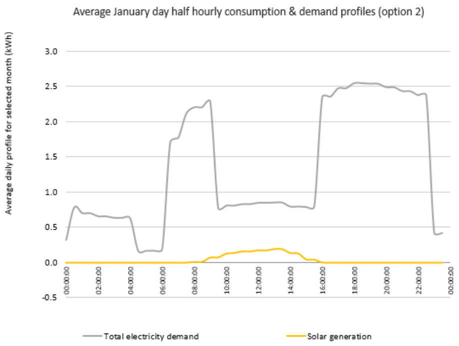
22 Romala Road

Impact of solar PV

	Existing fabric with new gas boiler	Loft insulation & hi-temp heat pump	Good practice fabric with low-temp heat pump	Best practice fabric with low-temp heat pump
System size kW Peak	2.5	2.5	2.5	2.5
System generation kWh pa	2,409	2,409	2,409	2,409
Utilisation on site kWh pa	1956	2109	2089	2042
Utilisation on site kWh pa	81%	88%	87%	85%
Assumed system cost £	3750	3750	3750	3750
Net impact on fuel bills £ pa	-£ 431	-£ 457	-£ 453	-£ 445

Impact of Solar PV on Scenario 2 - typical summer and winter days



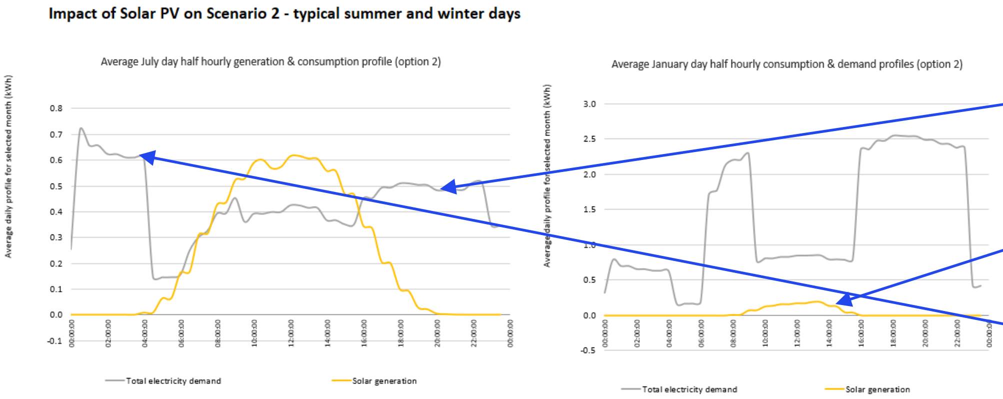


Archetype 1a Large pre 1900 terraced house

22 Romala Road

Impact of solar PV

	Existing fabric with new gas boiler	Loft insulation & hi-temp heat pump	Good practice fabric with low-temp heat pump	Best practice fabric with low-temp heat pump
System size kW Peak	2.5	2.5	2.5	2.5
System generation kWh pa	2,409	2,409	2,409	2,409
Utilisation on site kWh pa	1956	2109	2089	2042
Utilisation on site kWh pa	81%	88%	87%	85%
Assumed system cost £	3750	3750	3750	3750
Net impact on fuel bills £ pa	-£ 431	-£ 457	-£ 453	-£ 445



Small system in house with high year round energy use and 'stay-at-home' load profile means high utilisation.

Poor correlation of heat demand and solar generation means solar PV makes very little contribution to space heating.

However, moving heat pump water heating to midday could maximise on-site utilisation. Leading to good fuel bill reductions.

Archetype 1a Large pre 1900 terraced house

22 Romala Road

Summary

- For this archetype; **heat pump installation with only minimal improvements to fabric leads to an approx. 25% increase in fuel bills**, due to relatively low efficiency of heat pump @ 249%.
- **The investment in good practice fabric (loft, floor & windows) more or less pays for itself within 30 years.** This is especially likely to be the case if Repairs, Maintenance and Improvement costs are taken in to account or if grant were to be made available.
- **Investment in best practice fabric** achieves very low levels of heat demand, flow temperatures and high system efficiency. However, **the very high additional up-front CAPEX is not repaid within 30 years.**
- All packages reduce CO_2 emissions by 44% - 65% in 2021/22. However, **by 2035, CO_2 emissions at the individual building level are similar for all 3 electrification options.**
- The decision about how much fabric retrofit is needed is therefore more a product of:
  - How much reduction in demand is needed for a low carbon energy system
  - How much reduction in demand is necessary to avoid fuel poverty / stress
  - How much thermal fabric improvement is desirable from a comfort point of view.
- **Investment in best practice fabric could decrease peak electricity demand by approx 56%** relative to minimal fabric upgrades and leaves the home less prone to rising / fluctuating fuel prices.
- **Solar PV** has little impact on CO_2 emissions in the medium term. However, it **could play a crucial role in reducing fuel bills for those in or near fuel stress.**

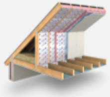
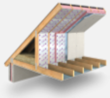
Options Appraisal summary

Archetype 2a: pre 1900 flat

Archetype 2a Pre 1900 flat

Top floor flat, Heyford Avenue

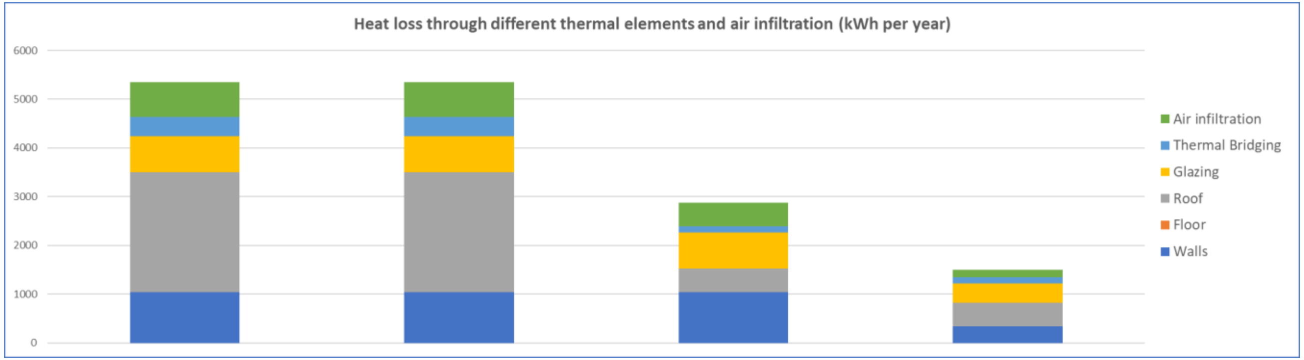
Measures installed

	Roof	Glazing	Floor	Walls	Heating system	Radiators	Cylinder	Pipework	Upfront CAPEX
1. Existing fabric. New gas boiler									£2,400
2. Existing fabric & Electric storage boiler									£7,750
3. Room in roof insulation & electric storage boiler									£13,220
4. Best practice fabric & HHR storage heaters									£21,850

Archetype 2a Pre 1900 flat

Top floor flat, Heyford Avenue

Heat loss and system performance



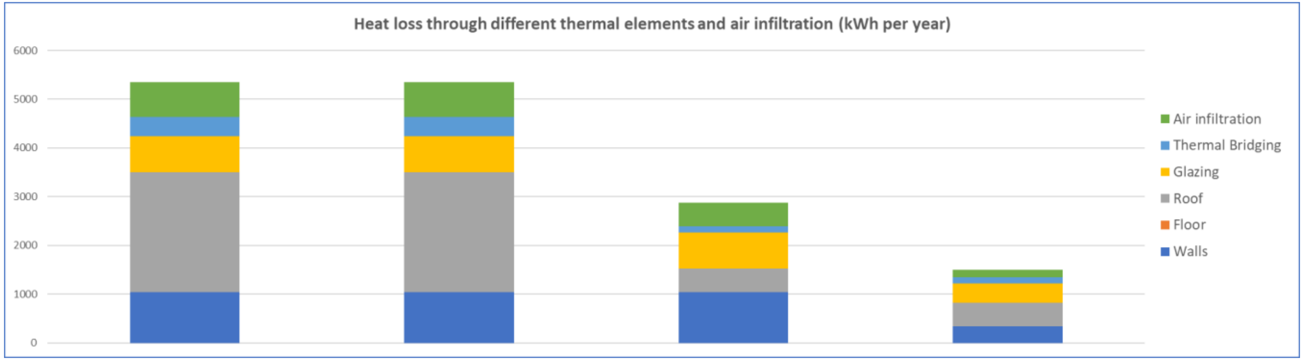
	Existing fabric with new gas boiler	Existing fabric & Electric storage boiler	Roof insulation & Electric storage boiler	Best practice fabric with HHR storage heaters
Space heating demand (kWh pa)	9,898	9,898	5,322	2,770
Space heating consumption (kWh pa)	12,372	10,700	5,753	3,259
Required flow temperatures °C	70	70	51	40
Peak electricity load @ 6:00pm	0.6	0.6	0.6	0.6
Assumed heating system Seasonal Performance Factor (SPF)	80%	93%	93%	85%
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	125	125	67	35

Fuel bills	£1,091	£1,363	£1,072	£914

Archetype 2a Pre 1900 flat

Top floor flat, Heyford Avenue

Heat loss and system performance



	Existing fabric with new gas boiler	Existing fabric & Electric storage boiler	Roof insulation & Electric storage boiler	Best practice fabric with HHR storage heaters
Space heating demand (kWh pa)	9,898			
Space heating consumption (kWh pa)	12,372			
Required flow temperatures °C	70			
Peak electricity load @ 6:00pm	0.6			
Assumed heating system Seasonal Performance Factor (SPF)	80%			
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	125	125	67	35

Health warning!! Highly sensitive to time of use tariff assumptions and availability.

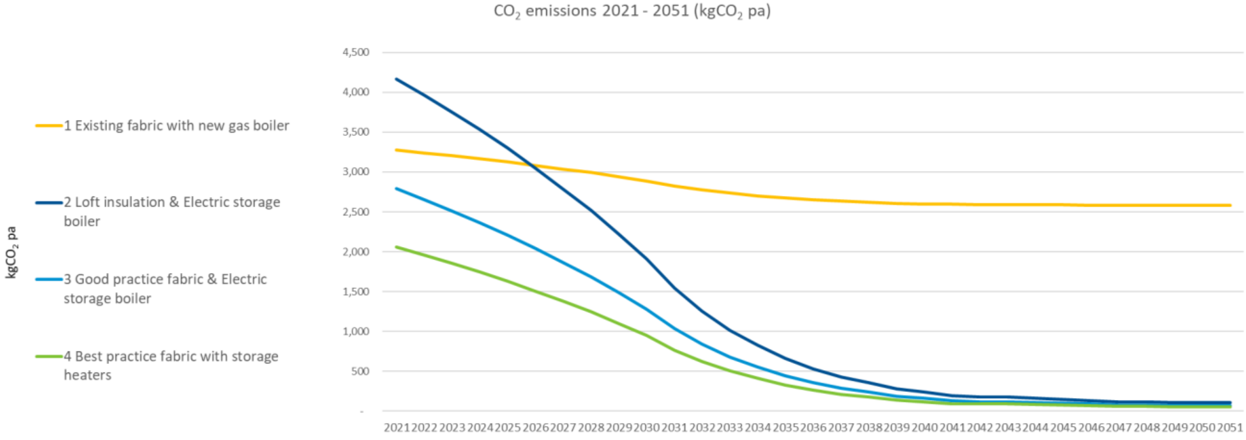
Fuel bills	£1,091	£1,363	£1,072	£914

Archetype 2a Pre 1900 flat

Top floor flat, Heyford Avenue

CO_2 emissions

	Existing fabric with new gas boiler	Existing fabric & Electric storage boiler	Roof insulation & Electric storage boiler	Best practice fabric with HHR storage heaters
tCO_2 in 2021	3.3	4.2	2.8	2.1
tCO^2 in 2050	2.6	0.1	0.1	0.1
tCO^2 cumulative 2021 - 2050	84	40	27	20
CO_2 saving relative to baseline (30 year cumulative)	0%	52%	68%	77%
£ per tonne of CO_2 reduction (30 year cumulative)	NA	£267	£136	£133

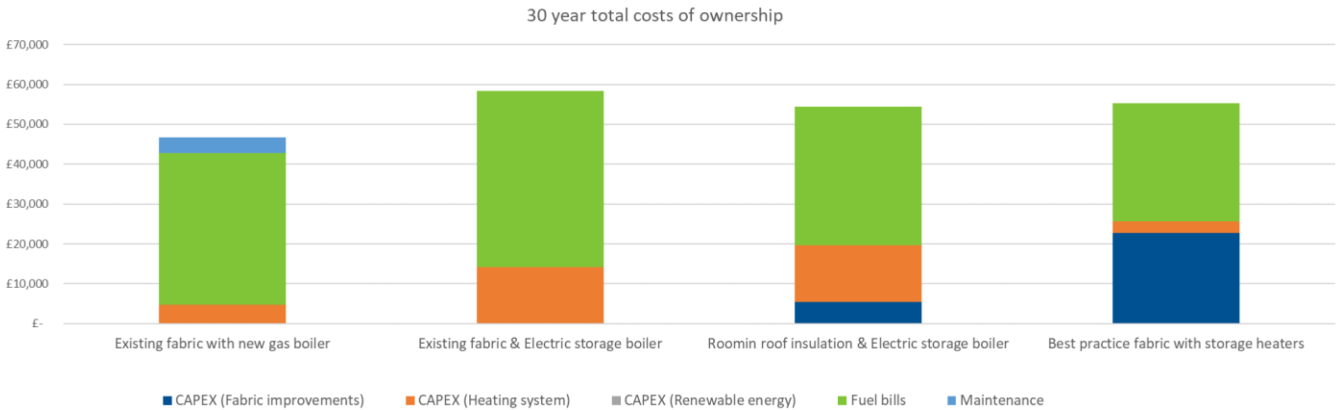


Archetype 2a Pre 1900 flat

Top floor flat, Heyford Avenue

CAPEX, fuel bills and lifetime costs

	CAPEX	Annual fuel bill	Lifetime £ (30 yrs)
1. Existing fabric. New gas boiler	£2,400	£1,091	£46,727
2. Existing fabric. Electric storage boiler	£7,750	£1,363	£58,430
3. Room in roof insulation with electric storage boiler.	£13,220	£1,072	£54,473
4. Best practice fabric with HHR storage heaters.	£25,628	£914	£55,244

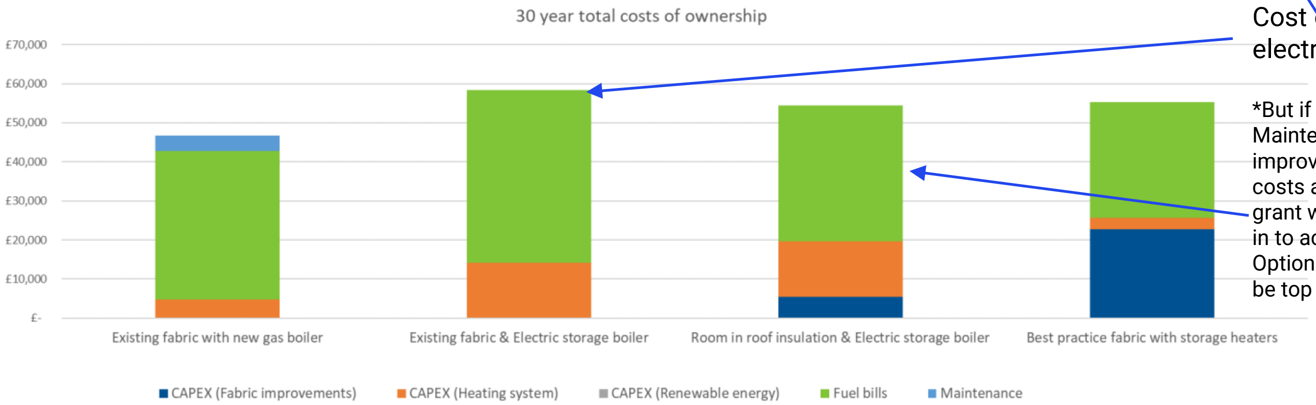


Archetype 2a Pre 1900 flat

Top floor flat, Heyford Avenue

CAPEX, fuel bills and lifetime costs

	CAPEX	Annual fuel bill	Lifetime £ (30 yrs)
1. Existing fabric. New gas boiler	£2,400	£1,091	£46,727
2. Loft insulation and high temperature ASHP	£7,750	£1,363	£58,430
3. Good practice fabric with standard	£13,220	£1,072	£54,473
4. Best practice fabric with standard ASHP	£25,628	£914	£55,244



Cost optimal electrification

*But if Repairs, Maintenance & improvement costs and / or grant were taken in to account, Option 3 would be top

Archetype 2a Pre 1900 flat

Top floor flat, Heyford Avenue

Summary

- **The lack of a suitable space for heat pump (**both air source and ground source) means that electric storage options were assessed as the primary heating options.
- For this archetype; the **switch to electric storage heating,** with no thermal fabric improvements, **results in a 25% increase in fuel bills.** This is despite the use of a very competitive tariff, with rates at £0.05 per kWh between 01:30 and 05:30.
- **The investment in fabric retrofit pays for itself within the 30 year period.** With the lighter fabric retrofit having a marginally better payback than the deep retrofit.
- Option 2 increases CO_2 emissions in the near term but after 2027 all options are predicted to result in a CO_2 saving.
- From a CO_2 emissions perspective, reducing demand in direct electric or storage electric properties is more important than for heat pumps, because they are only 85 – 100% efficient.
- **From an energy systems perspective, storage options represent both a major opportunity** (to completely avoid peak time emissions) **and a potential challenge** (in our modelling, a new peak could potentially be created at 3:00am) due to their poor efficiency relative to heat pumps. Investment in thermal fabric could reduce peak loads by 70%+.
- For consumers, **time of use tariffs represent a major opportunity** to significantly reduce bills compared to standard tariffs and traditional Economy 7 tariffs. **However, the market is nascent and carries risk.**
- Solar PV has little impact on CO_2 emissions in the medium term. **However, it could play a crucial role in reducing fuel bills for those in or near fuel stress.**

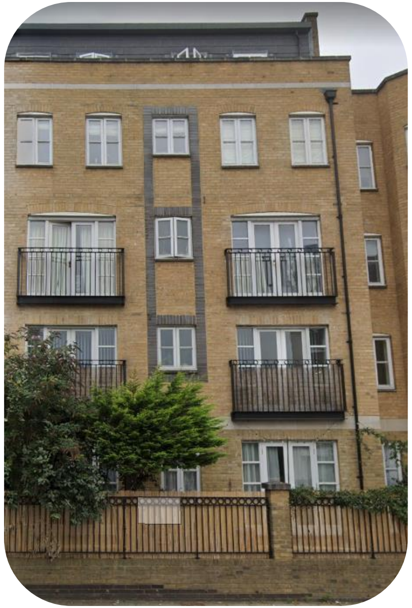
Options Appraisal summary

Archetype 3d: 1990s block of flats

Archetype 3d 1990s block of flats

Draymans Court, Stockwell Green (EPC C) 47 Flats

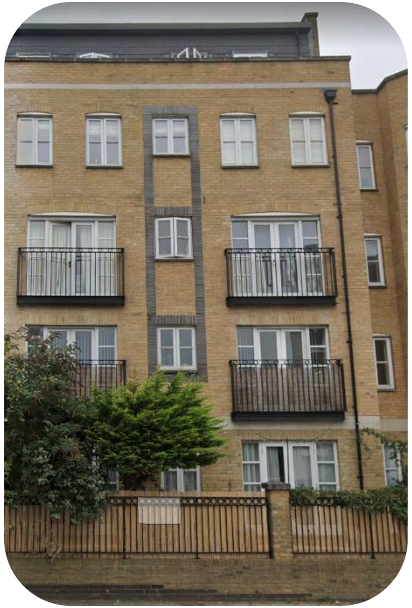
Measures installed



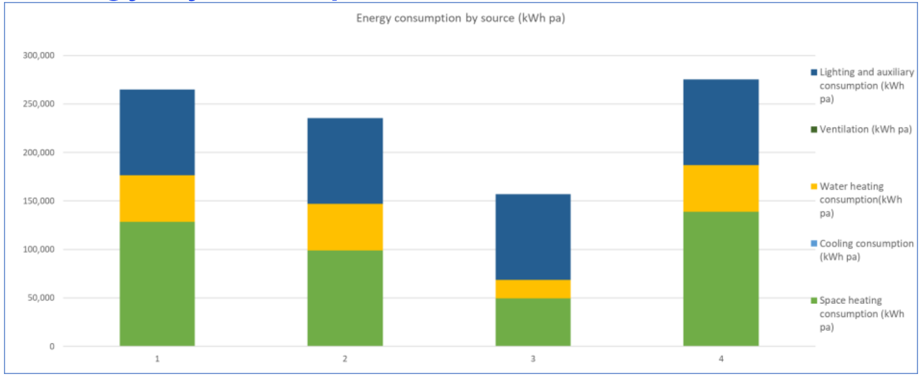
	Roof	Glazing	Floor	Walls	Heating system	Radiators	Cylinder	Pipework	Upfront CAPEX
1. Existing fabric. New direct electric heating									£89,758
2. Existing fabric & infra-red panel heaters									£95,230
3. Room in roof insulation & internal ASHP									£306,855
4. Existing fabric & HHR storage heaters									£122,590

Archetype 3d 1990s block of flats

Draymans Court, Stockwell Green (EPC C)



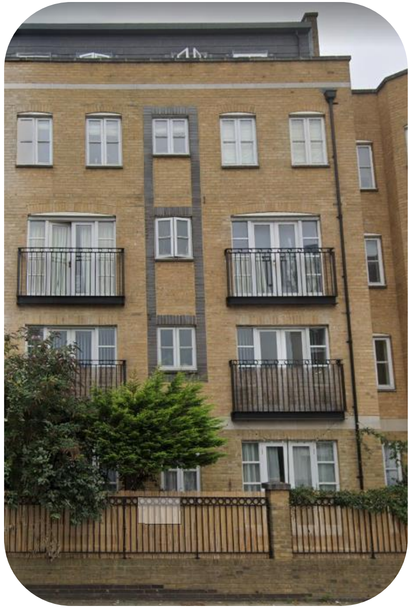
Energy system performance



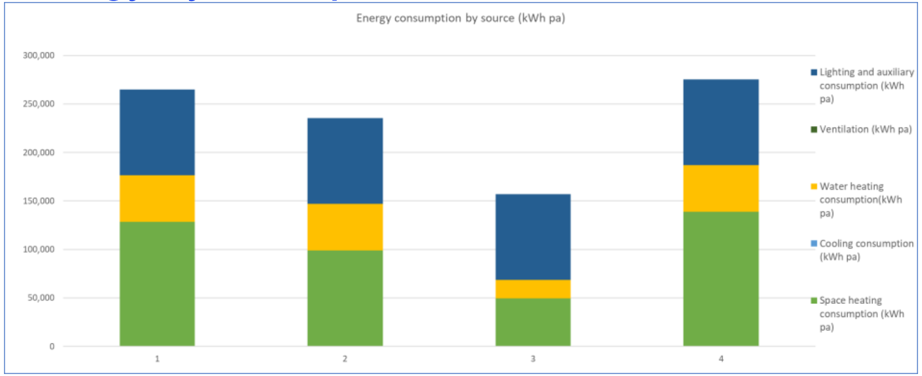
	Existing fabric with new electric room heaters	Existing fabric with infra-red panel heaters	Existing fabric with internal ASHP (integrated cylinder)	Existing fabric with HHR storage heaters
Space heating demand (kWh pa)	128,383	128,383	128,383	128,383
Space heating consumption (kWh pa)	128,383	98,756	49,378	138,792
Required flow temperatures °C	55	55	50	55
Peak electricity load @ 6:00pm	90.7	74.7	48.0	21.3
Assumed heating system Seasonal Performance Factor (SPF)	100%	130%	260%	93%
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	96	85	57	100
Fuel bills	£1,189	£1,056	£705	£988

Archetype 3d 1990s block of flats

Draymans Court, Stockwell Green (EPC C)



Energy system performance



Internal heat pump option has the lowest fuel bills due to high efficiency for space *and* water heating.

Energy use is lowest with internal ASHP and highest with smart HHR storage heaters

However, winter 6:00pm peak load is lowest with the HHR storage heat option

	Existing fabric with new electric room heaters	Existing fabric with infra-red panel heaters	Existing fabric with internal ASHP (integrated cylinder)	Existing fabric with HHR storage heaters
Space heating demand (kWh pa)	128,383	128,383	128,383	128,383
Space heating consumption (kWh pa)	128,383	98,756	49,378	138,792
Required flow temperatures °C	55	55	50	55
Peak electricity load @ 6:00pm	90.7	74.7	48.0	21.3
Assumed heating system Seasonal Performance Factor (SPF)	100%	130%	260%	93%
Space heating Thermal Energy Demand Intensity (kwh per m2 pa)	96	85	57	100
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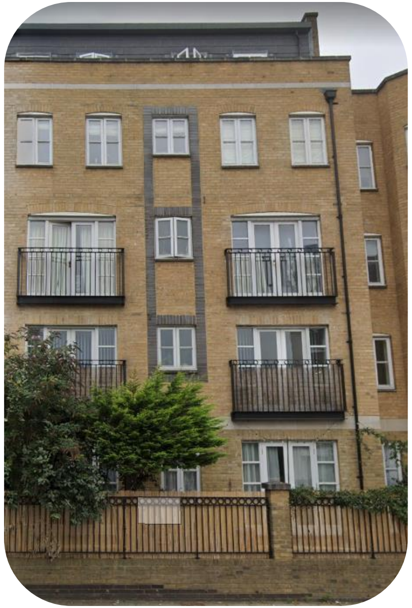
Archetype 3d 1990s block of flats

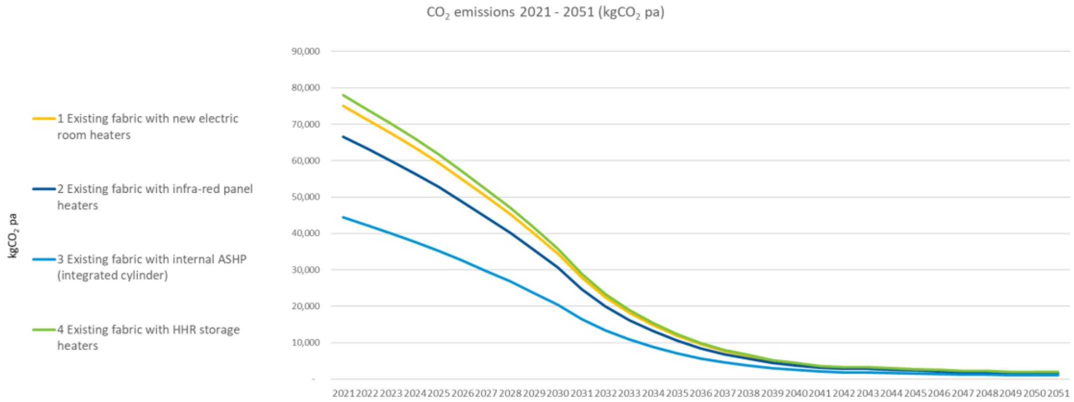
Draymans Court, Stockwell Green (EPC C)

CO_2 emissions



	Existing fabric with new electric room heaters	Existing fabric with infra-red panel heaters	Existing fabric with internal ASHP (integrated cylinder)	Existing fabric with HHR storage heaters
tCO_2 in 2021	75	67	44	78
tCO^2 in 2050	1.9	1.6	1.1	1.9
tCO^2 cumulative 2021 - 2050	716	636	424	744
CO_2 saving relative to baseline (30 year cumulative)	0%	11%	41%	-4%
Additional cost over BAU scenario (30 years)	£0	-£191,548	-£75,476	-£241,267
£ per tonne of CO_2 reduction (30 year cumulative)	NA	-£2,395	-£259	£8,584

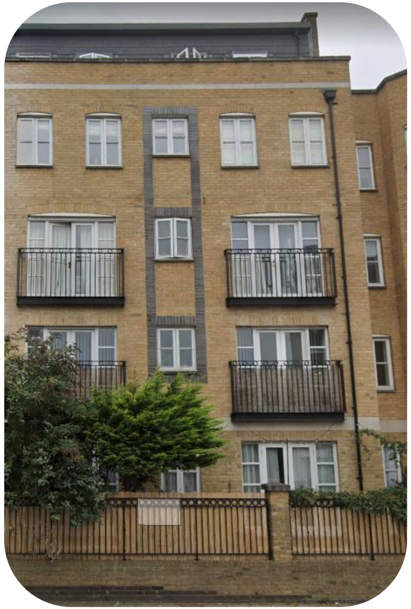
But with potentially large benefits for a low carbon energy system



Archetype 3d 1990s block of flats

Draymans Court, Stockwell Green (EPC C)

CAPEX, fuel bills and lifetime costs



	CAPEX	Annual fuel bill	Lifetime £ (30 yrs)
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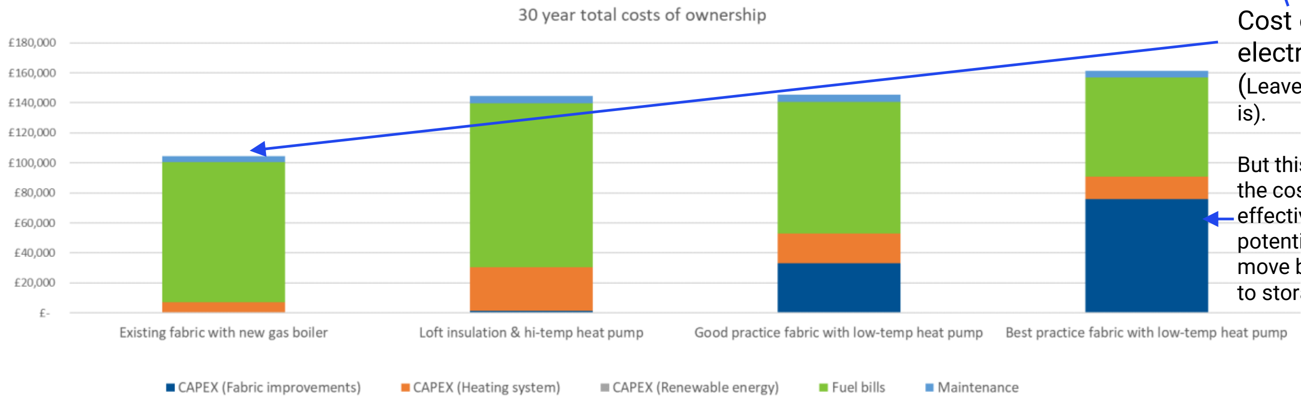


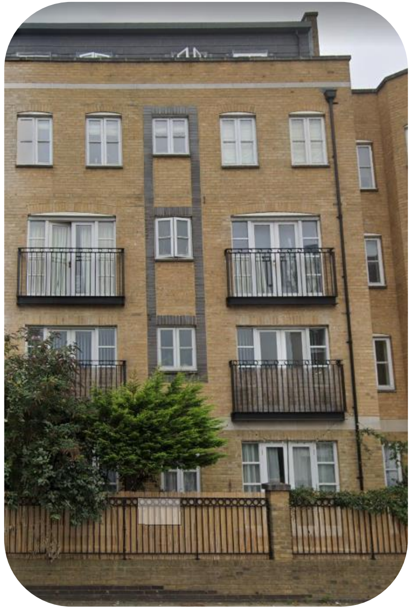
Cost optimal electrification

(Leave it as it is).

But this ignores the cost effective potential to move buildings to storage heat.

Archetype 3d 1990s block of flats

Draymans Court, Stockwell Green (EPC C)



Summary

- C Rated building which, on paper, has **no further cost effective potential for thermal fabric improvement.**
- Therefore used as an opportunity to compare different electric heating options (including the BAU which is direct electric heating).
- **Internal ASHP results in the lowest energy use and fuel bills.** This is because of the high efficiency of the heat pump, that is applied to both space and water heating (which make up a roughly equal share of heat demand).
- Both infra-red and HHR storage heaters also offer potential cost savings relative to direct electric.
- **HHR storage heaters lead to the highest energy use and,** on paper, an increase in CO_2 emissions. However, they provide a potentially valuable storage function in the context of a low carbon grid. **They significantly reduce winter 6:00pm peak load**.
- Only the heat pump option offers reasonable CO_2 emissions savings over the 30 years. But **by 2050, all electric options have very similar CO_2 emissions.**
- **The cost optimal electrification route is to replace with the BAU, direct electric heaters**. The additional CAPEX of the other options do not repay with marginally lower OPEX.
- This is partly due to the relative weighting toward CAPEX in the 30 year lifetime costs for flats.

Scenarios for heat decarbonisation – 2050

Decarbonisation pathways

Scenario analysis for decarbonising all of Lambeth's building stock

1 Buildings database creation

2 Grouped buildings into 30 archetypes

(median building selected)

3 Modelled 4 retrofit packages in options appraisal

4 **Decarbonisation pathways**

Scenario optimised projections of retrofit package installations

Optimised scenarios

- **BAU**
- **Lowest CO_2 emissions**
- **Electrification with lowest fuel bills**
- **Cost optimal full electrification**
- **Electrification with lowest peak load**
- **Electrification with lowest CAPEX**
- **Electrification with lowest CAPEX (heat networks)**

Inputs

- Target year for full electrification
- Deployment curve
- Heat network zones

Decarbonisation pathways – Example archetype - 1a

Archetype description:

	Description	No. buildings	Heat demand (MWh)	Floorspace (sqm)
1a	Single, pre-1900, Victorian terraced house. EPC rated D or E.	11,016	286,651	1,566,537

Options appraisal results:

(median building)

Package	Package description	Total CAPEX (£)	30-yr cost of ownership	6pm peak load (kWp)
1	Existing fabric with new gas boiler	£3,500	£104,515	1.5
2	Loft insulation & hi-temp heat pump	£15,426	£144,398	6.0
3	Good practice fabric with low-temp heat pump	£42,923	£145,254	4.3
4	Best practice fabric with low-temp heat pump	£83,679	£161,421	2.6

Cost optimal full electrification

In the cost optimal scenario, package 2 is selected

Electrification with lowest peak load

In the lowest peak electricity demand scenario, package 4 is selected

Electrification with lowest CAPEX

In the lowest CAPEX scenario, package 2 is selected

Decarbonisation pathways – What was measured

- Rate of interventions (determined by target year)
- CAPEX of electric heat systems and fabric measures
- Annual consumer costs (domestic and non-domestic)
- Annual heat demand
- 6pm (winter) peak electricity load
- Cumulative and annual CO_2 emissions
- Number of heat pumps
- Number of electric storage boilers
- Number of electric heaters
- Number of floor, window, wall and loft/roof insulation measures

2050 scenarios: numbers of measures in each scenario

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	Number of heat pumps	Number of electric storage boilers	Number of electric storage heaters	Number of loft/roof insulations	Number of floor insulations	Number of wall insulations	Number of window insulations
BAU	0	0	0	0	0	0	0
Lowest CAPEX	39536	33550	18275	18895	0	244	1422
Cost optimal Electrification	39443	17153	36187	36265	10283	8370	30248
Electrification with lowest fuel bills	39696	0	53378	43437	39892	46709	84529
Electrification with lowest CO2 emissions	46477	0	46597	43437	38187	45004	82824
Electrification with lowest peak load	28937	25730	38141	43202	38549	35111	63442

- Each scenario has a unique profile of measures installed
- In all scenarios, all heating systems in the Borough are replaced over the 30 years, but changed to different systems depending on the priority of the scenario.
- In contrast, not every home has fabric measures installed. The Lowest CAPEX scenario contains very few fabric interventions.
- The cost optimal electrification scenario contains far fewer fabric interventions than ‘best practice’ retrofits (lowest fuel bills).

Scenario comparisons: Current heating systems, Clapham area

Legend ×

2050 Heating System Installations

Current Heating System (BAU)

Building dominant heating fuel and type (BAU)

- Gas boiler
- Communal gas boiler
- Communal CHP
- Electric heating
- ASHP
- GSHP
- WSHP
- District heat
- Wood burner
- Oil /coal
- Unknown

Scenario comparisons: Heating systems: 2050 cost optimal electrification scenario, Clapham area

Legend

2050 Heating System Installations

Scenario 3: Cost Optimal Electrification

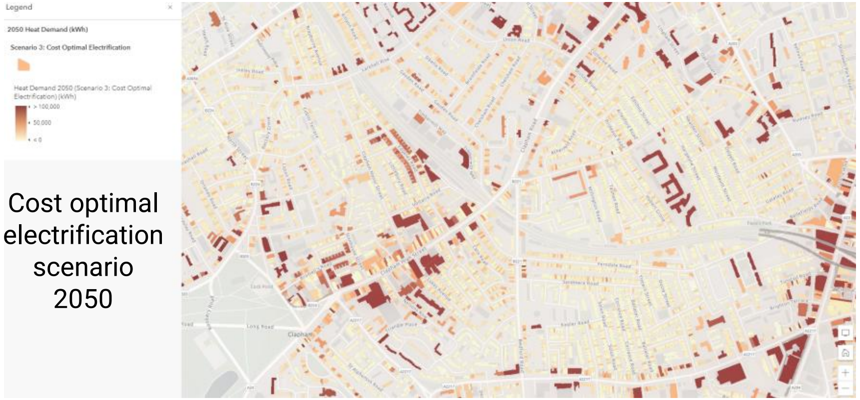
Heating System Type 2050 (Scenario 3: Cost Optimal Electrification)

- ASHP
- Hi-Temp ASHP
- Bi-Valent ASHP (80%) and gas boiler (20%)
- Electric Storage Boiler
- GSHP/WSHP
- GSHP/WSHP (w/ passive cooling)
- HHR Smart Storage Heaters
- Shared Ambient Loop Heat Pumps
- n/a

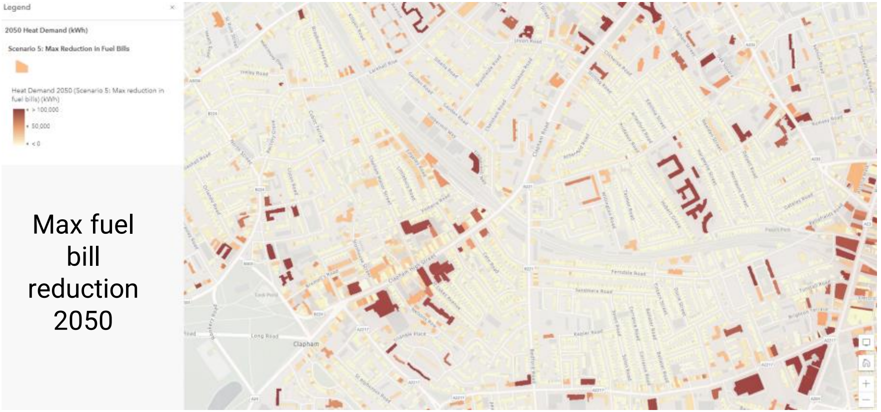
Scenario comparisons: Heat demand, Clapham area

Current heat demand (kWh)

Lowest CAPEX scenario 2050



Cost optimal electrification scenario 2050



Max fuel bill reduction 2050

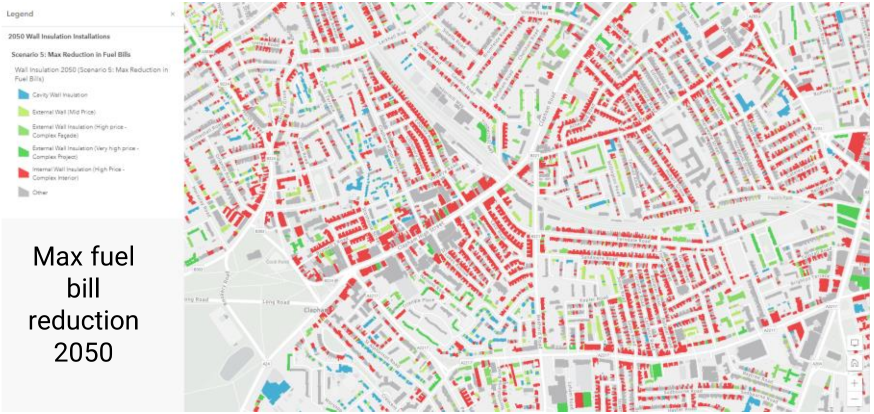
Scenario comparisons: Glazing type, Clapham area

Scenario comparisons: Wall insulation, Clapham area

Current wall type

Lowest CAPEX scenario 2050

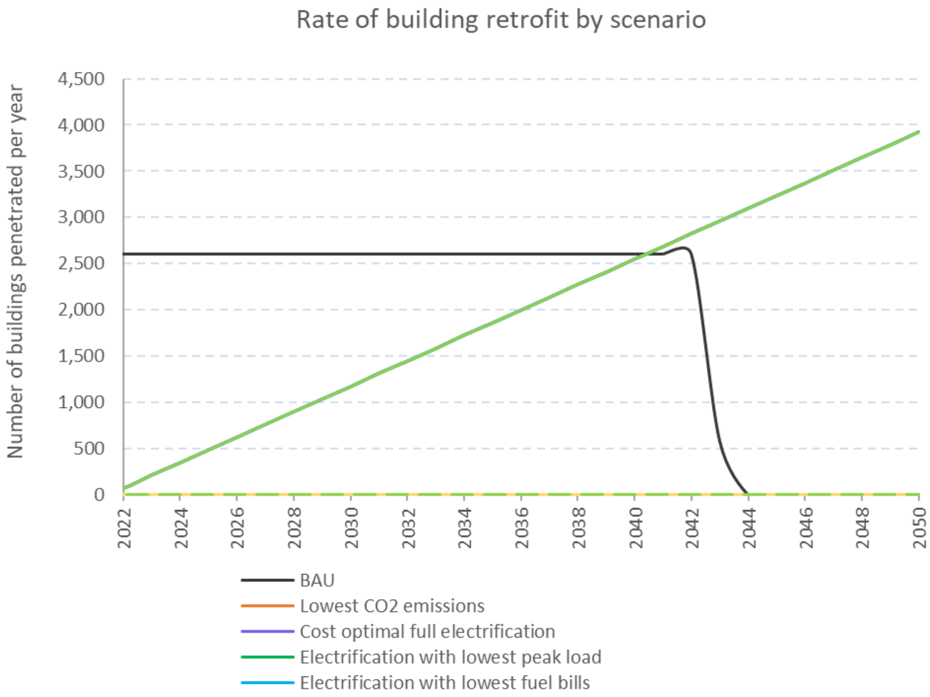
Cost optimal electrification scenario 2050



Max fuel bill reduction 2050

Decarbonisation pathways - Results

Installation curve

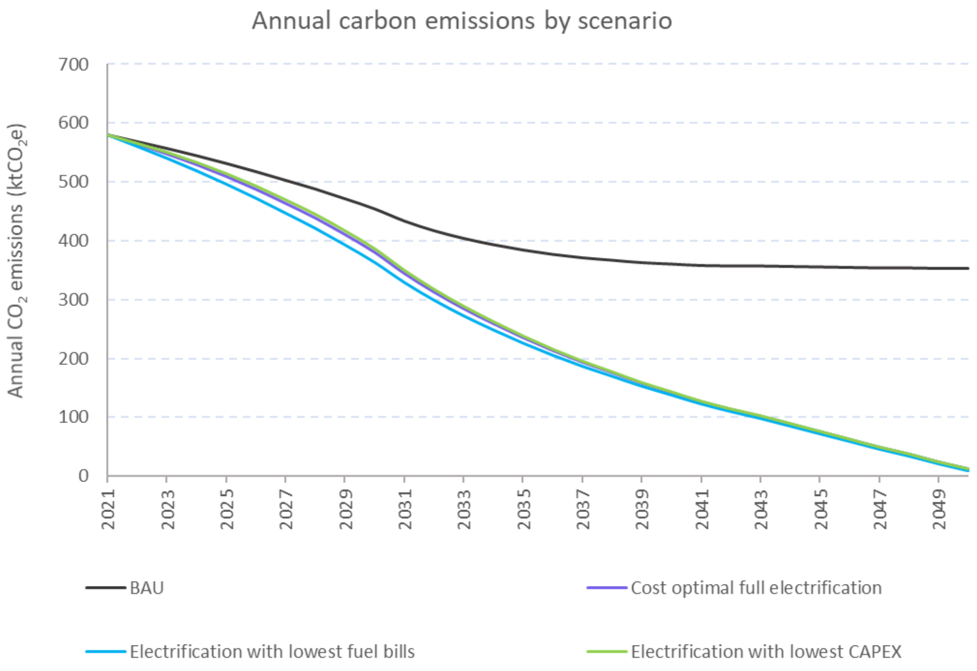


Key findings

- Installations of measures were predicted on a square function, with the rate of installations starting slowly and increasing toward 2050.
- This has important ramifications for the relative performance of the scenarios.
- BAU measures are predicted to carry on at their current rate. At current rates, all BAU heating systems would be replaced once by 2042. To avoid double counting, we assumed that installations then stop.

Decarbonisation pathways - Results

Annual CO_2 emissions

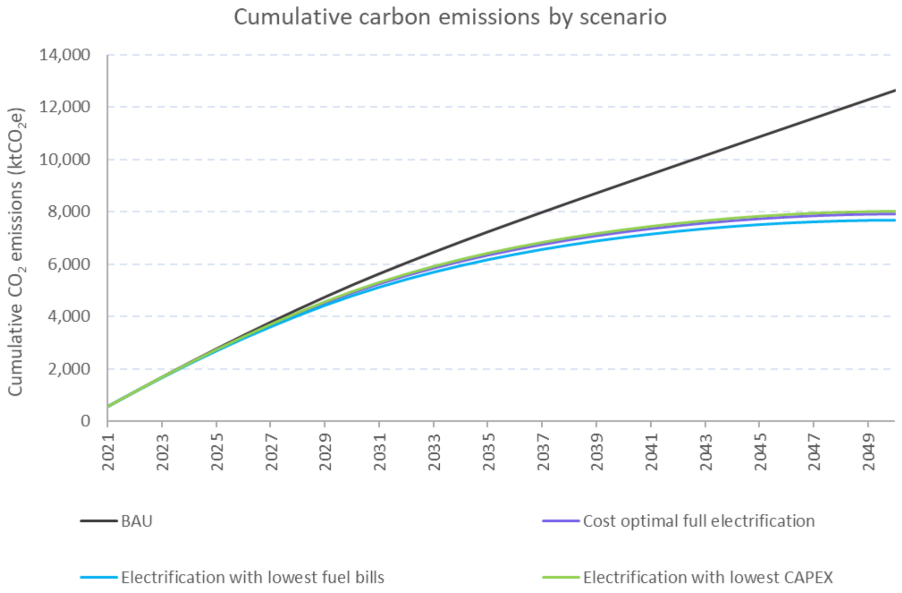


Key findings

- All electrification scenarios decline toward near zero carbon by 2050.
- This is based on the Treasury Green Book forecast for marginal carbon emissions factors.
- Scenarios that include high levels of best practice retrofit (e.g Electrification with lowest fuel bills) have marginally lower CO2 emissions than other scenarios prior to 2035.
- However, after 2035, annual CO_2 emissions converge to a broadly similar level.
- This is because the majority of installations happen post 2035

Decarbonisation pathways - Results

Cumulative CO_2 emissions



Key findings

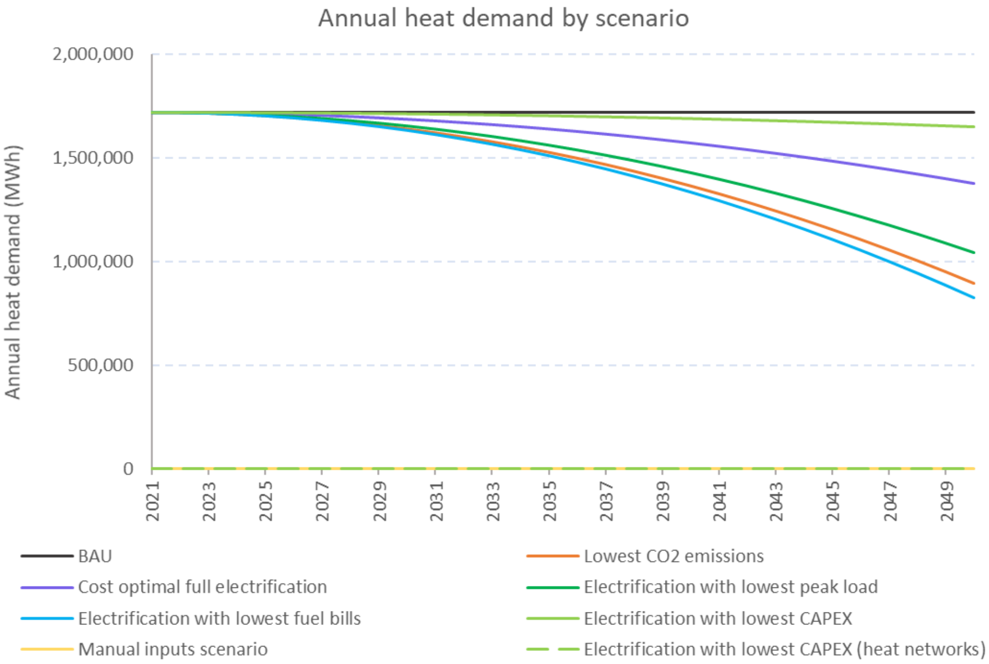
- On a cumulative basis, CO_2 emissions are lower for scenarios that assume higher levels of fabric retrofit.
- However, the difference is only 3% between the extremes.
- Whilst deeper fabric retrofits deliver larger CO_2 emissions reductions in the medium term, the installation curve assumes that installation rates are slow prior to 2035.

- *Caveat: the predicted decline in grid CO_2 emissions is predicated on a reduction in the demand for heat relative to current levels.

- It's clear that CO_2 emissions are not a useful basis for choosing between electrification scenarios.
- However, other factors may still drive a need for deeper fabric retrofit.

Decarbonisation pathways - Results

Reduction in heat demand



Key findings

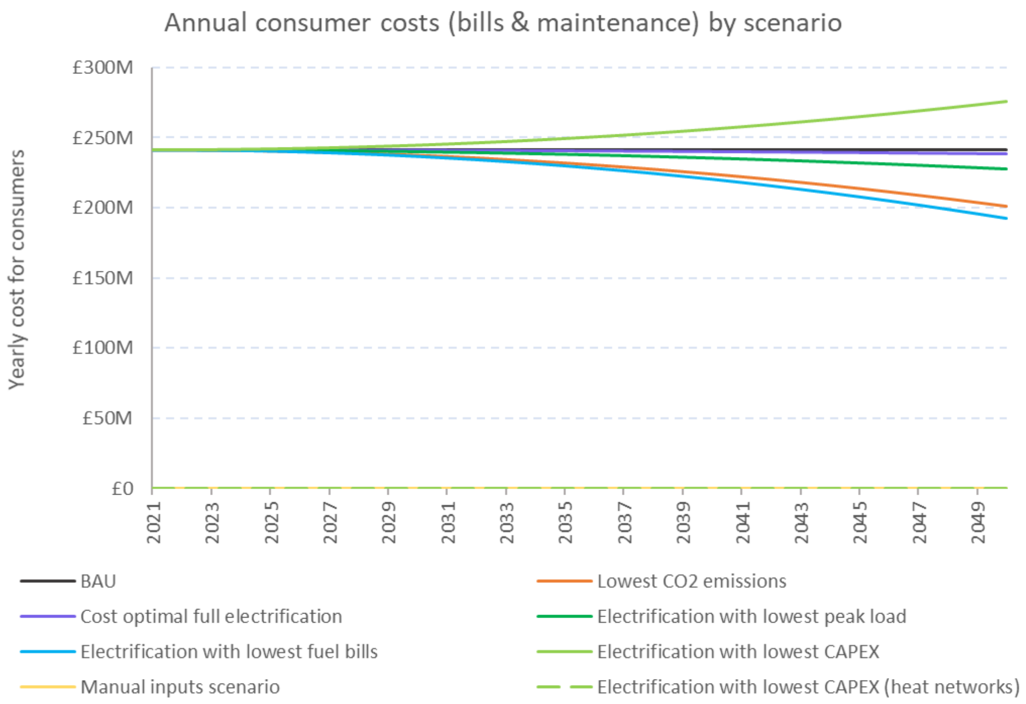
- All electrification scenarios assume at least a basic level of fabric retrofit, therefore demand for heat reduces in all scenarios.

- In the **lowest CAPEX scenario**, heat demand declines by only 4%
- In the **lowest fuel bill scenario,** heat demand declines by 52%
- In the **cost optimal electrification scenario,** heat demand declines by 20%

- The CCC, in their 6th carbon budget report, estimate that in order to be compatible with a net zero carbon energy system, heat demand from buildings will need to reduce by 16 – 22%.

Decarbonisation pathways - Results

Impact on consumer fuel bills

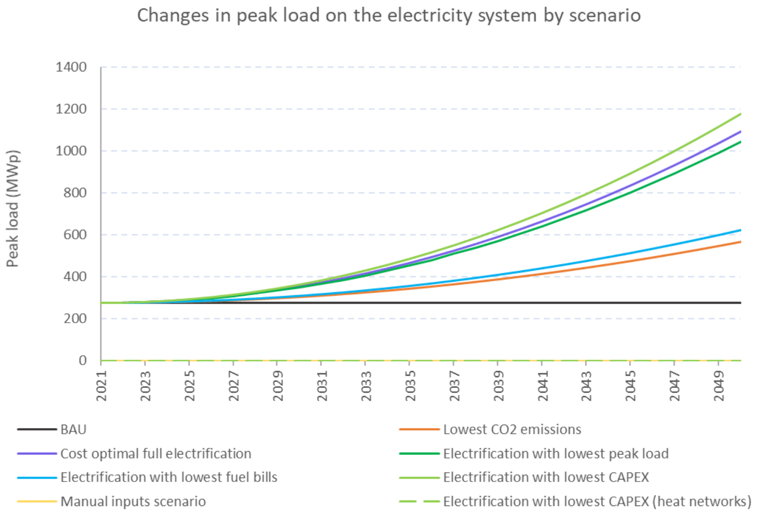


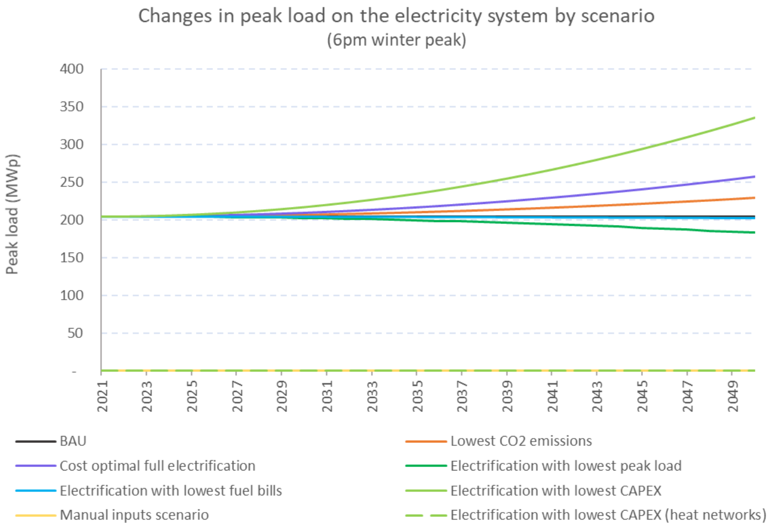
Key findings

- The **lowest CAPEX scenario** has the highest annual consumer bills. Putting domestic bills up by an average of 22%. However, average non-domestic fuel bills actually dropped by 5%, this is because a large number of non-domestic buildings are already using direct electric systems and the scenario assumes that these change to utilising more cost effective solutions such as ground source heat pumps with passive cooling.
- The **lowest fuel bill scenario** typically involved best practice deep retrofit of the buildings resulting in a reduction of 21% on domestic bills, and 18% on non-domestic bills.
- In the **cost optimal scenario**, average domestic consumer bills are assumed to be broadly on par with those under BAU. Non-domestic bills are assumed to be 12% lower than BAU.

Decarbonisation pathways - Results

Impact on peak electricity demand

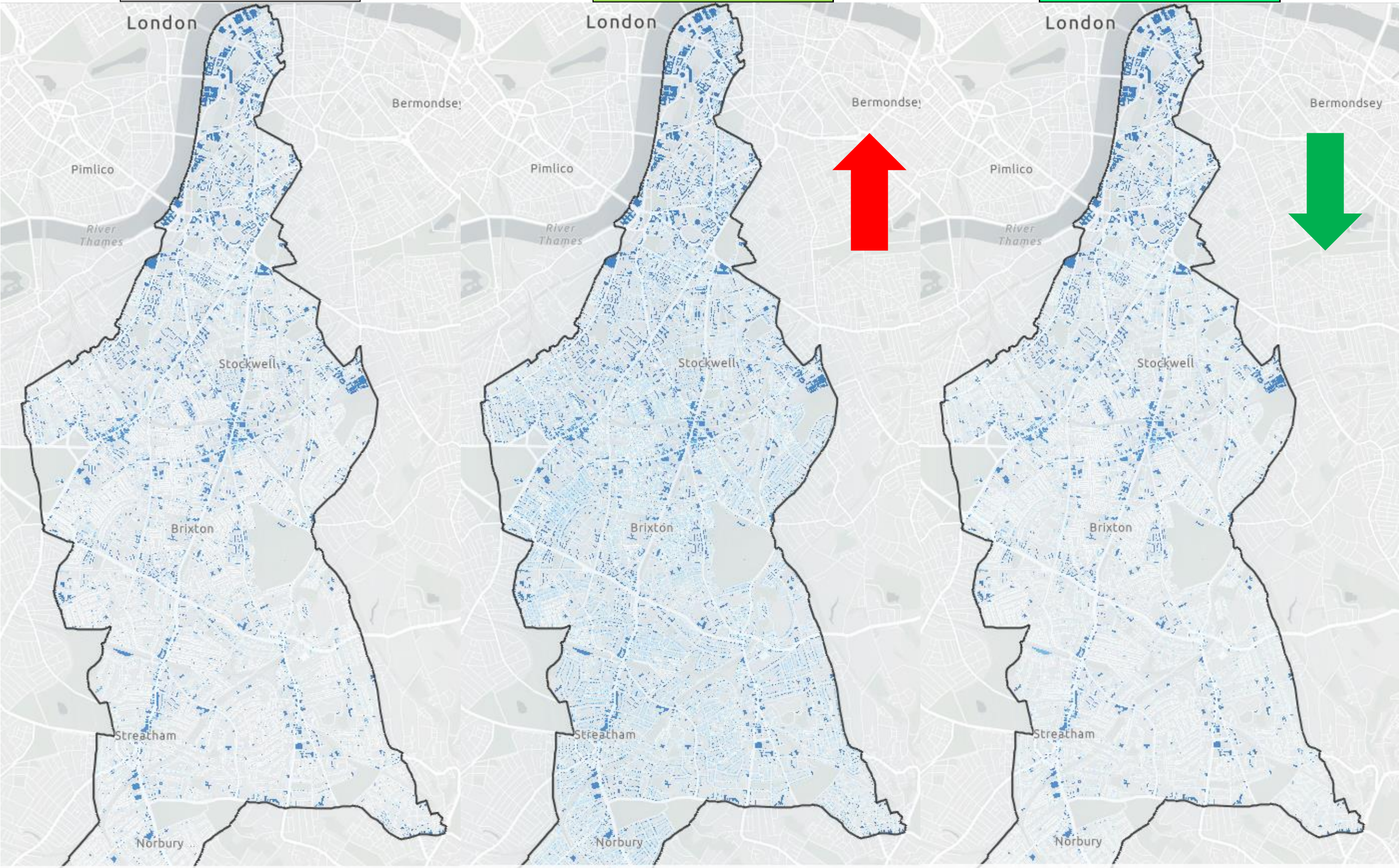




Key findings

- Theoretical peak electricity demand increases significantly in the **lowest CAPEX scenario**, by 420%. However, much of this increase is associated with storage heat solutions. When looking at the impact on winter day 6:00pm peak load, the increase is only 64%
- In the **lowest peak load scenario**, theoretical peak electricity increases by 370%. However, due to the high level of storage heat, winter 6:00pm peak loads actually decrease by 11% (in fact a new peak is created at 3:00am). This scenario also involves moving substantial quantities of current on-peak electric heating and cooling to off-peak and passive technologies.
- The **cost optimal scenario** results in a 390% increase in theoretical peak load. However, this is only a 26% increase in winter day 6:00pm peak load. This reflects the lower overall level of heat demand, the higher efficiency of the heat pump systems and also the high prevalence of off-peak storage heat in flats

BAU | **Electrification with lowest CAPEX** | **Electrification with lowest peak load**



Only 3% of domestic buildings currently use electricity as the primary source of heating. This is higher in non-domestic buildings (26%)

Electric heat systems with minimal energy efficiency measures raises the 6pm peak load

Smaller electric heat systems with best practice energy efficiency as well as a large proportion of off-peak systems means that the 6pm peak load reduces

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2050 peak electricity demand (kW), 6pm winter

>10

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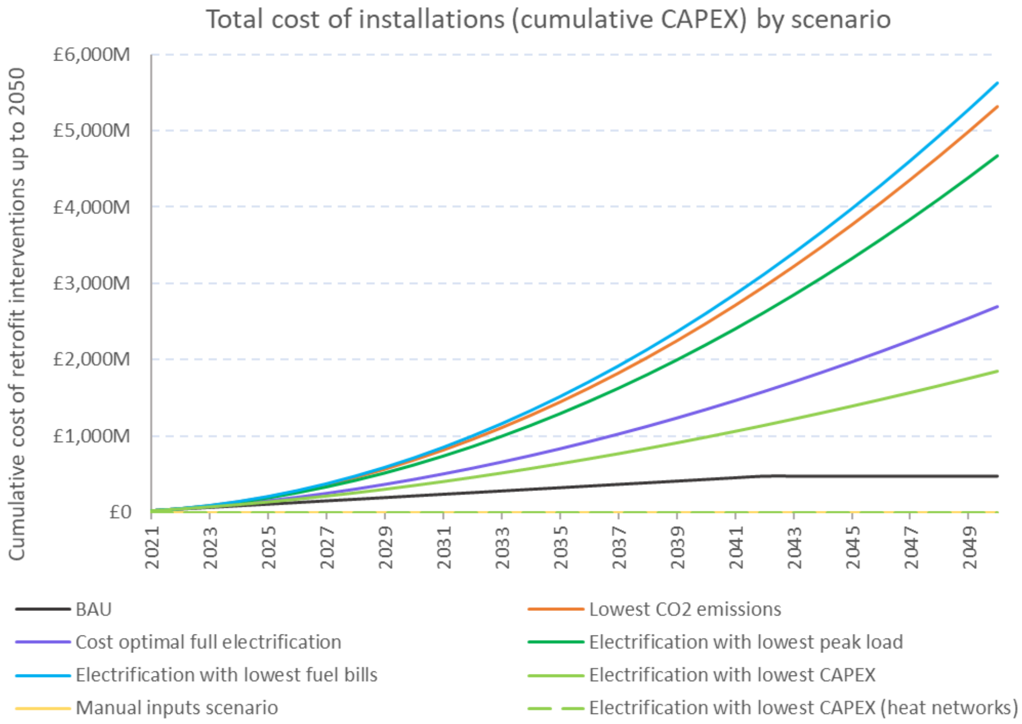
Decarbonisation pathways - Results

Cumulative cost of package rollout



<u>Key findings</u>

- The **lowest fuel bill scenario** achieves many objectives, reducing fuel bills significantly and avoiding the need for major grid infrastructure upgrades. However, it comes at a vast capital cost of £6.35 billion (11x higher than the BAU scenario)
- The **lowest CAPEX scenario** was approximately 4x the CAPEX of the BAU scenario
- The **cost optimal scenario** is approximately 6x the BAU scenario cost at £2.92 Billion

Decarbonisation pathways – Heat networks

Select scenario:	Electrification with lowest CAPEX	Full electrification target year:	2050

Select scenario:	Electrification with lowest CAPEX (heat networks)	Full electrification target year:	2050

Scenario	Output category	Units	2050
Electrification with lowest CAPEX	Total CAPEX	£	£1,761,735,166
	Average domestic consumer bill	£ pa	£1,622
	Average non-domestic consumer bill	£ pa	£7,794
	Peak electricity load (winter 6pm)	MWp	336
	Cumulative CO_2 emissions from 2020	$ktCO_2e$	8,009
	Number of heat pumps	#	39,536
	Number of electric storage boilers	#	33,550
	Number of heat networks	#	0

Scenario	Output category	Units	2050	
Electrification with lowest CAPEX (heat networks)	Total CAPEX	£	£1,761,045,258	–
	Average domestic consumer bill	£ pa	£1,668	↑
	Average non-domestic consumer bill	£ pa	£9,717	↑
	Peak electricity load (winter 6pm)	MWp	341	↑
	Cumulative CO_2 emissions from 2020	$ktCO_2e$	8,078	–
	Number of heat pumps	#	38,106	↓
	Number of electric storage boilers	#	30,794	↓
	Number of heat networks	#	8	

Key findings

- Inclusion of heat networks is compared to the **Electrification with lowest CAPEX** scenario which assumes minimal energy efficiency measures
- 8 potential heat network zones in Lambeth account for 9% of the building stock
- Similar **CAPEX** between scenarios as the alternative to heat networks includes many expensive ambient loop options for individual buildings
- The 6pm winter peak electricity load increases in the scenario with heat networks as there are less electric storage boilers in the blocks of flats that can shift the on-peak to off-peak

Key findings: Cost optimal electrification

- Electrification reduces CO_2 emissions in all scenarios. **There is little difference between the electrification scenarios in terms of their impact on CO_2 emissions reduction**, despite the scenarios ranging in cost from 4 x BAU to 11 x BAU.

- However, simply **electrifying heat with the lowest CAPEX options will lead to several problems**:
    - Fuel bills would increase by an average of 22% and in some cases even more.
    - The impact on the electricity network would be incompatible with a net zero carbon energy system * based on CCC modelling.
    - Heat pumps will be larger, noisier and more difficult to site.

- **The max fuel bill reduction scenario mitigates against all these risks, but at a huge financial cost** and with huge level of intervention in the building stock.

- **The cost optimal electrification scenario would seem to offer the best basis for a real-world scenario;** it delivers the key objectives of
    - Decarbonisation: a 98.5% reduction in annual CO_2 emissions by 2050.
    - Mitigating fuel bill increases: Fuel costs could marginally reduce relative to the BAU.
    - Minimising impact on the grid: Theoretical peak would increase by 390% but 6:00pm peak could increase by only 26%.
    - At a cost of £2.92 billion (6 x BAU cost).

The cost optimal electrification scenario offers the best blueprint for a net zero carbon strategy

Key findings: cost optimal electrification scenario

	Number of heat pumps	Number of electric storage boilers	Number of electric storage heaters	Number of loft/roof insulations	Number of floor insulations	Number of wall insulations	Number of window insulations
BAU	0	0	0	0	0	0	0
Lowest CAPEX	39536	33550	18275	18895	0	244	1422
Cost optimal Electrification	39443	17153	36187	36265	10283	8370	30248
Electrification with lowest fuel bills	39696	0	53378	43437	39892	46709	84529
Electrification with lowest CO2 emissions	46477	0	46597	43437	38187	45004	82824
Electrification with lowest peak load	28937	25730	38141	43202	38549	35111	63442

- In practice, **a combination of scenarios will be necessary**. Some buildings will opt for lowest CAPEX measures meaning that other buildings will need to 'take up the slack' with deep retrofit. For example, social housing and public buildings may need to adopt deeper retrofit approaches to deliver overall objectives.
- The **role of the energy network is also key**. There may be areas where greater demand reduction are more cost effective than others.
- However, in general this study shows **that the deep retrofit of *all* or even the majority of buildings to 'best practice' standards** may bring many benefits at the individual building level but **is not required from a carbon reduction perspective**.

Key findings: Electric storage heat and time of use tariffs

- **Storage heat plays a fundamental role** in the electrification options.

- **Flats account for approximately half of Lambeth's heat demand**. A range of options exist for these buildings:
    - Shared ground loop heat pumps
    - Internal ASHPs
    - Direct electric and infra-red panels
    - Communal heat pumps for buildings with communal heat infrastructure
    - Electric storage heat (storage boilers and HHR smart storage heaters)

- This analysis suggests that, when combined with time of use tariffs, storage heat options can offer low fuel bills, lower CAPEX, lower impact on peak demand and, potentially, less disruption for building owners.

- However, **this finding is incredibly sensitive to the availability of suitable tariffs.** The market is nascent and it is unclear how mass adoption of storage technology would impact the availability of, for example, super off peak overnight tariffs. *Also, this depends on the ubiquity of smart meters which is currently poor in flats. Nevertheless, the **direction of travel seems to be toward increasing numbers and sophistication of time of use tariffs** and the benefits of flexibility to the energy system are well documented.

Storage heat could play a fundamental role in decarbonising heat but needs further research

Recommendations for future research

- Local Area Energy Planning
    - Combining this research with **supply side information from the DNO** to understand how future scenarios could interact with constraints and upgrades to the distribution network.
    - Identify a **pilot retrofit project** in combination with a constrained area to demonstrate a whole energy system approach to retrofit planning and delivery e.g. Heat Pump Ready programme.
- **Updating guidance, policy (e.g planning policy) and programmes** in line with findings to demonstrate retrofit approaches in the real world.
- Conduct **further qualitative and quantitative research on storage heat solutions in flats**, combined with time of use tariffs. Work with energy supplier to identify the best ‘heat pump ready’ and ‘storage heat ready’ tariffs
- **Work with local landlords and local supply chains to** educate them on appropriate retrofit measures. The cost optimal electrification scenario involves many measures that could be undertaken as a matter of course during repairs, maintenance and improvements to properties. E.g. glazing and roof replacement, loft conversions and rear extensions. Undertaking cost effective retrofit at these trigger points could be a primary delivery route over 30 years.
- **Work with local heating installers** to motivate them to offer electric heating options to appropriate archetypes.
- **Work with homeowners to understand their motivations and concerns** for moving to electric heat.
- Further explore the feasibility of the most viable heat network areas.
- Build on this research to understand likely scenarios for building emissions to target setting.

Q&A

Thanks for listening

APPENDIX

Heat Network Zones

Introduction to heat network zoning

Context

- The objective of the heat network zoning study is to **identify locations and buildings** in Lambeth that could be suitable for a heat network.
- This was done by **mapping a number of attributes** (e.g. thermal demand of buildings) from the buildings database created in the first phase of the project.
- The study sits alongside the wider project looking at heat solutions for Lambeth's building stock. The study provides an alternative heat solution for the pathway analysis, and **does not** suggest that heat networks should be built in **all** the identified zones.
- The **costs** of constructing a heat network and connecting different types of building to it will be included in the options appraisal for each of the buildings in the zones identified.
- We looked at other heat network feasibility studies in Lambeth and in London to inform our process for forming the zones.

Methodology

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Determine criteria for heat network zones → Outline suitable areas on GIS → Detailed analysis of the zones

- There are 3 stages for the heat network study
- We have identified 9 zones using a predetermined set of criteria
- We are currently undergoing the third stage, looking at the buildings in the zones, the local heat sources available and carrying out a high level analysis of the associated costs

Criteria for determining heat network zones (GIS layers)

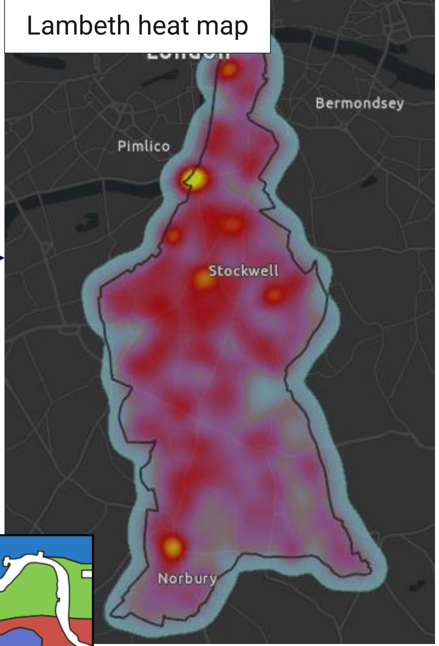
The initial criteria examined are taken directly from the buildings database:

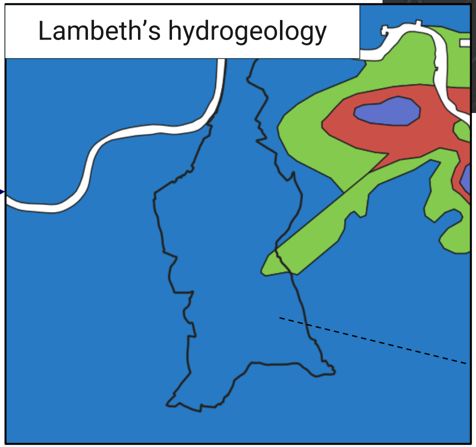
- **Thermal demand of buildings**
- **Communal heat systems**
- **Anchor loads**
  (buildings with a consistent heat demand e.g. hospitals, emergency services, leisure facilities, train stations)
- **Public ownership**
  (social housing and other non-domestic buildings owned/managed by the council)

We then looked at heat sources (where data was available) that could supply a heat network:

- **Proximity to Thames**
- **Geological conditions**
- **Waste heat from buildings and industry**
  (e.g. supermarkets, datacentres, crematoriums)
- **Sewer pipes and London Underground**

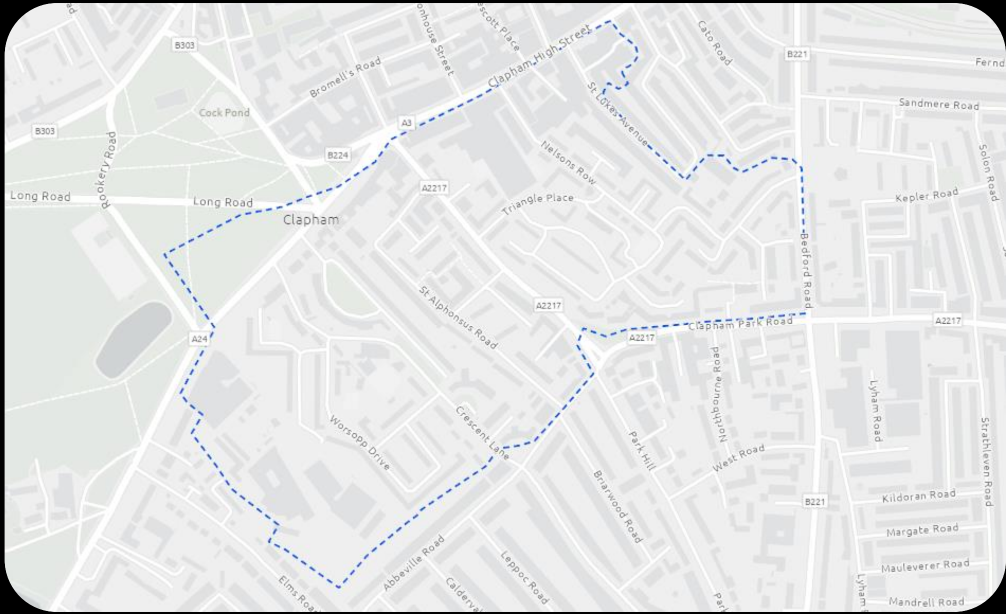
Finally, we looked at the locations of **housing estates** and **housing associations**





Example run through

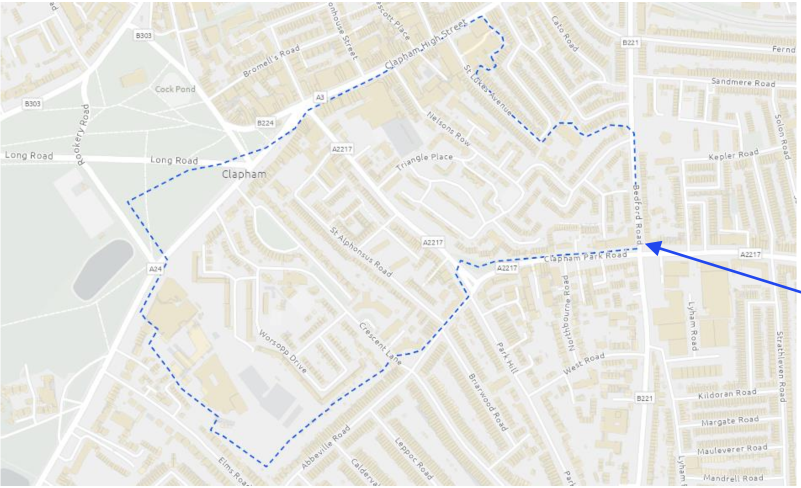
Clapham (north)

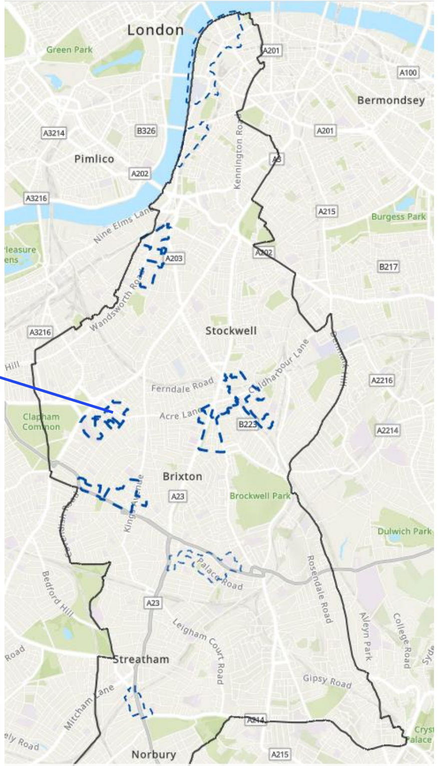


Clapham (north) –

Statistics

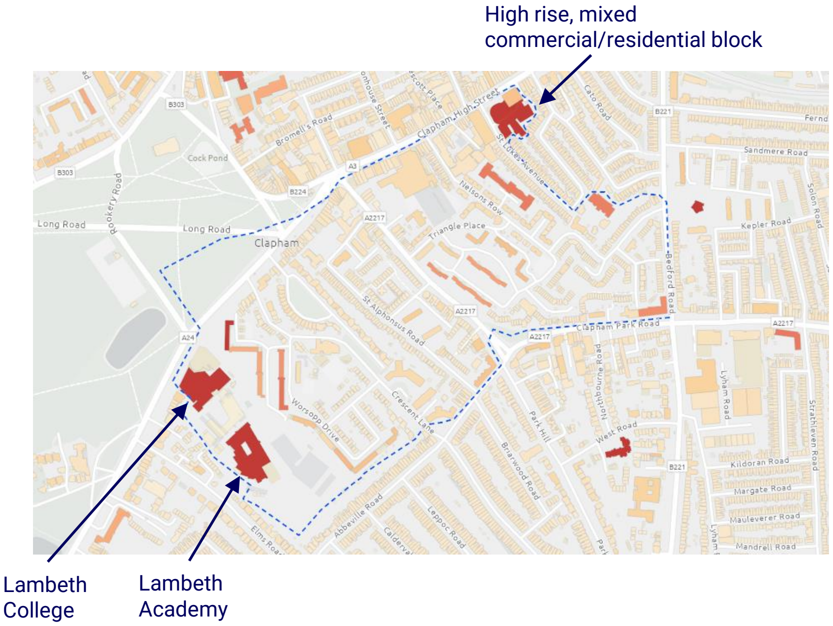
- Area: 35 ha
- Number of buildings: 731
- Heated floor area: 108,928 m^2

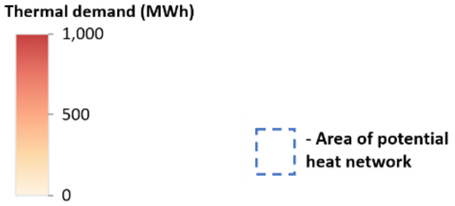




- Area of potential heat network

Clapham (north) – thermal demand

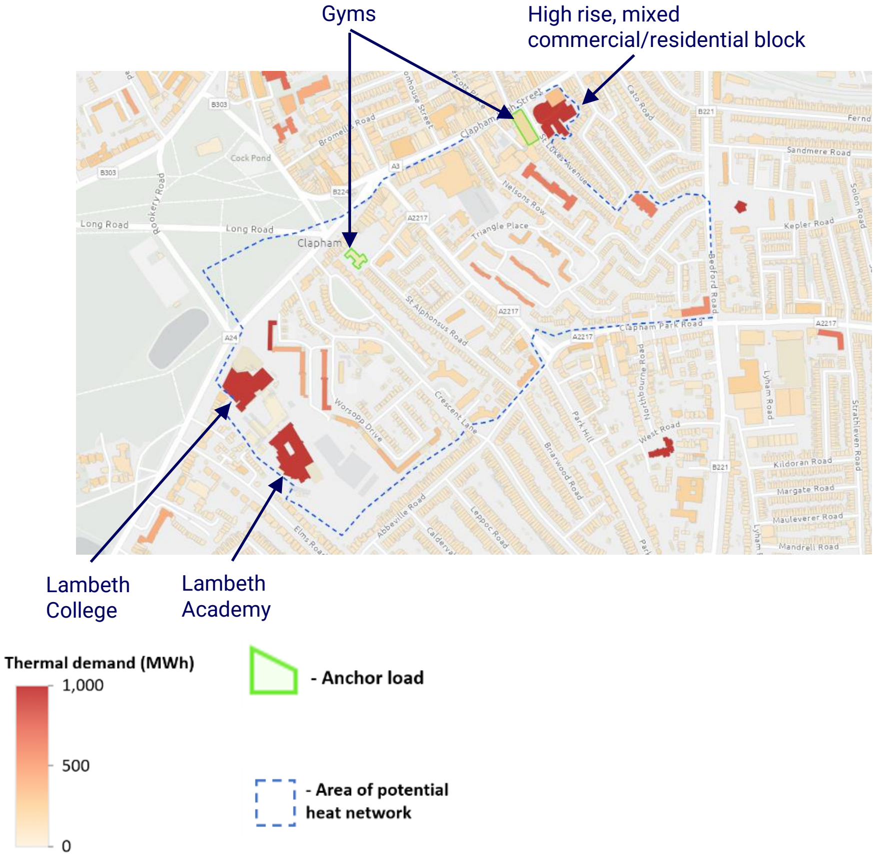




Statistics

- Area: 35 ha
- Number of buildings: 731
- Heated floor area: 108,928 m^2
- Thermal demand of buildings: 35,807 MWh

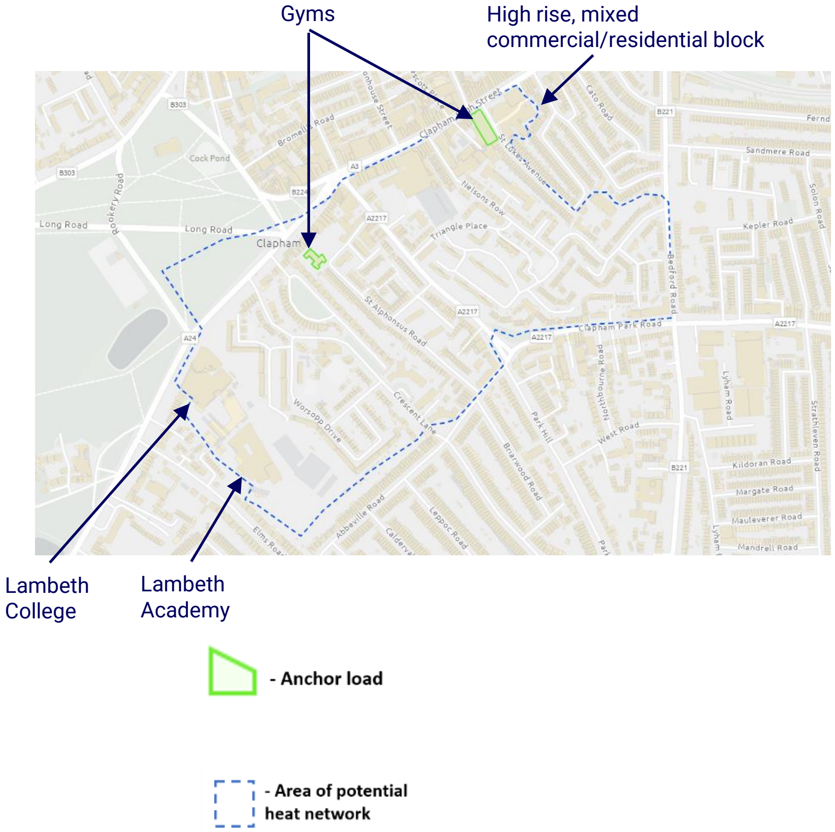
Clapham (north) – anchor loads



Statistics

- Area: 35 ha
- Number of buildings: 731
- Heated floor area: 108,928 m^2
- Thermal demand of buildings: 35,807 MWh
- Two gyms (PureGym & Oncore) totalling 2,200 m^2 and 230 MWh heat demand

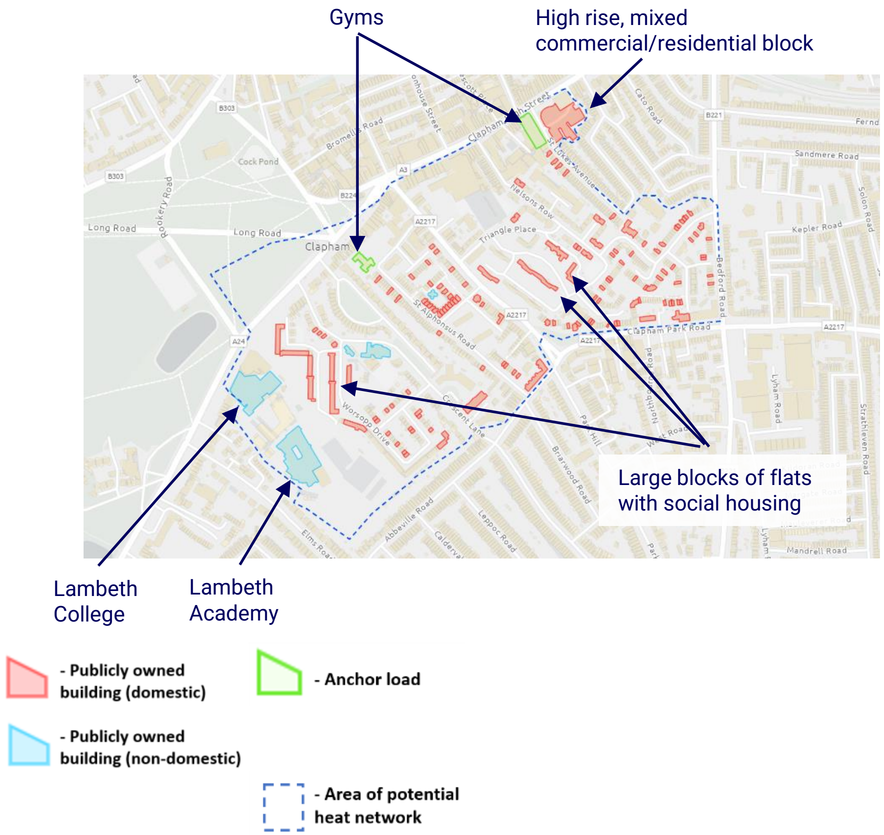
Clapham (north) – thermal removed



Statistics

- Area: 35 ha
- Number of buildings: 731
- Heated floor area: 108,928 m^2
- Thermal demand of buildings: 35,807 MWh
- Two gyms (PureGym & Oncore) totalling 2,200 m^2 and 230 MWh heat demand

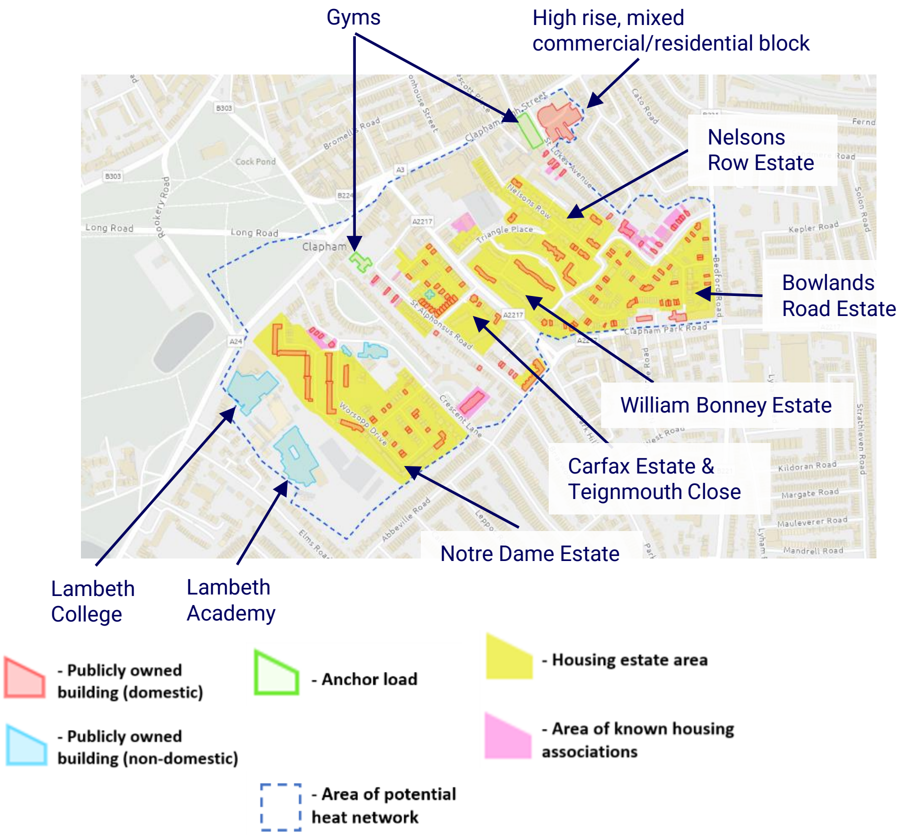
Clapham (north) – public buildings



Statistics

- Area: 35 ha
- Number of buildings: 731
- Heated floor area: 108,928 m^2
- Thermal demand of buildings: 35,807 MWh
- Two gyms (PureGym & Oncore) totalling 2,200 m^2 and 230 MWh heat demand
- 140 public buildings consisting of:
  - 14 large blocks of flats (5,350 MWh)
  - 12 medium-sized blocks of flats (960 MWh)
  - 47 converted flats (1,000 MWh)
  - 54 single houses (900 MWh)
  - 7 mixed commercial/residential blocks (2,900 MWh)
  - 5 school/college buildings (2,400 MWh)

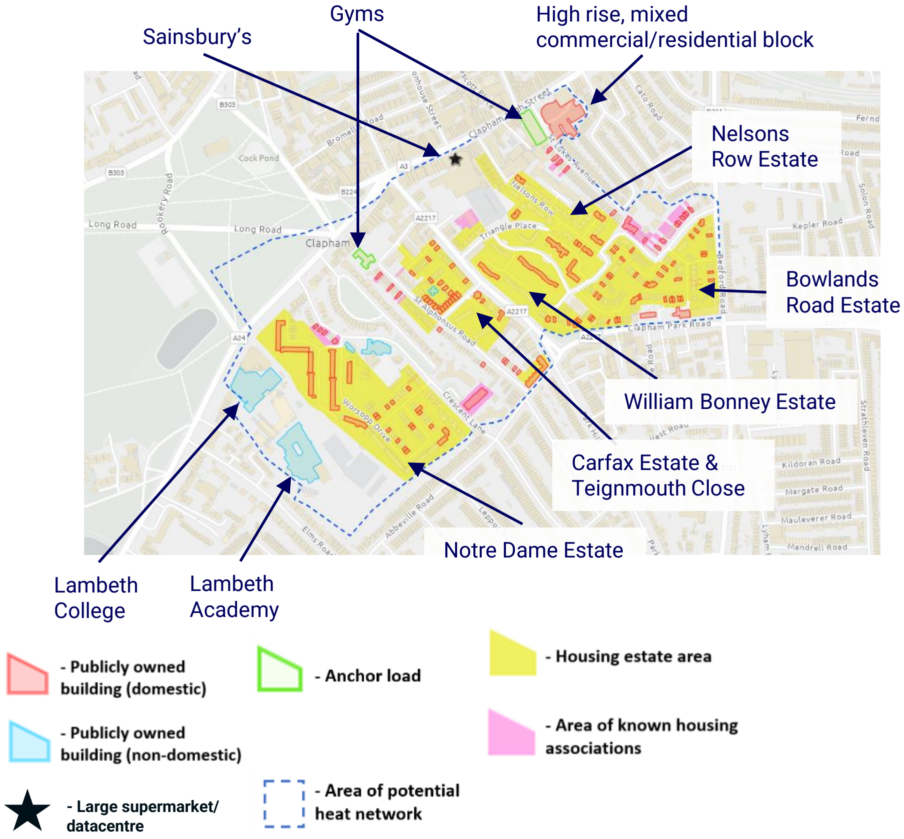
Clapham (north) – housing



Statistics

- Area: 35 ha
- Number of buildings: 731
- Heated floor area: 108,928 m^2
- Thermal demand of buildings: 35,807 MWh
- Two gyms (PureGym & Oncore) totalling 2,200 m^2 and 230 MWh heat demand
- 140 public buildings consisting of:
  - 14 large blocks of flats (5,350 MWh)
  - 12 medium-sized blocks of flats (960 MWh)
  - 47 converted flats (1,000 MWh)
  - 54 single houses (900 MWh)
  - 7 mixed commercial/residential blocks (2,900 MWh)
  - 5 school/college buildings (2,400 MWh)
- 374 buildings in housing estate areas, totalling 17,600 MWh thermal demand
- 37 buildings owned/managed by known housing associations, totalling 1,400 MWh

Clapham (north) – waste heat



Statistics

- Area: 35 ha
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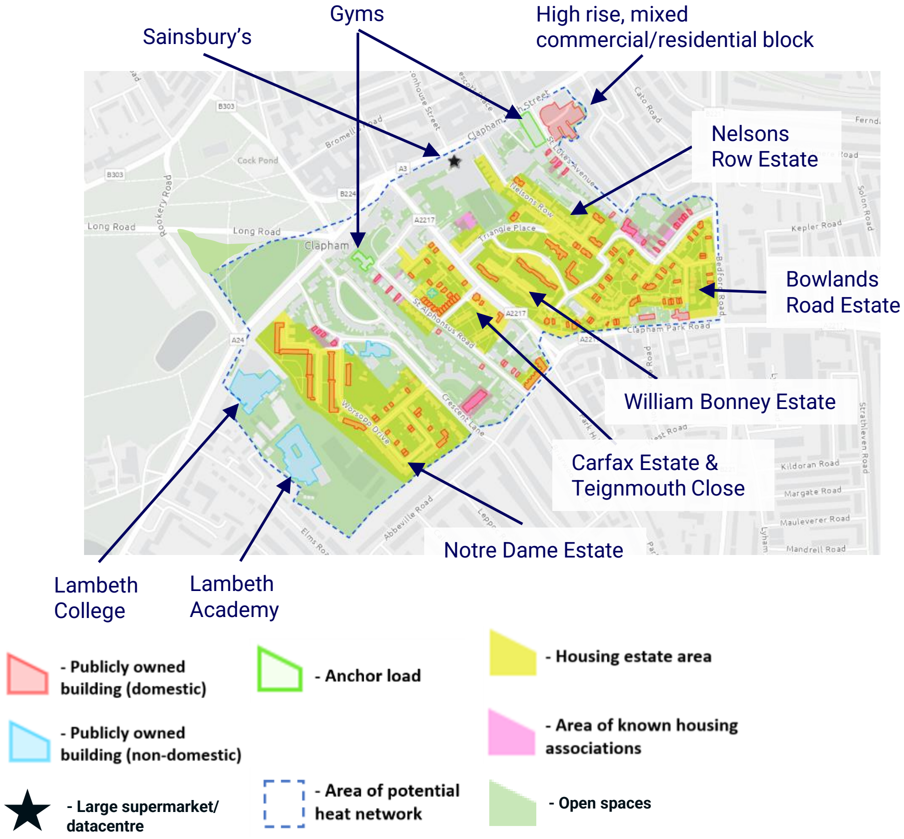
- Thermal demand of buildings: 35,807 MWh
- Two gyms (PureGym & Oncore) totalling 2,200 m^2 and 230 MWh heat demand
- 140 public buildings consisting of:
  - 14 large blocks of flats (5,350 MWh)
  - 12 medium-sized blocks of flats (960 MWh)
  - 47 converted flats (1,000 MWh)
  - 54 single houses (900 MWh)
  - 7 mixed commercial/residential blocks (2,900 MWh)
  - 5 school/college buildings (2,400 MWh)
- 374 buildings in housing estate areas, totalling 17,600 MWh thermal demand
- 37 buildings owned/managed by known housing associations, totalling 1,400 MWh
- One large supermarket, 1,800 m^2 floor area

Clapham (north) – open space



Statistics

- Area: 35 ha
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  - 54 single houses (900 MWh)
  - 7 mixed commercial/residential blocks (2,900 MWh)
  - 5 school/college buildings (2,400 MWh)
- 374 buildings in housing estate areas, totalling 17,600 MWh thermal demand
- 37 buildings owned/managed by known housing associations, totalling 1,400 MWh
- One large supermarket, 1,800 m^2 floor area
- 17 ha of open space (50% of area)

Heat network zone statistics

Waterloo

HEAT NETWORK ZONE 1

Waterloo

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Summary

With an area of 48 ha, Waterloo is the largest of the eight zones, featuring a high concentration of large commercial buildings with a very high heat demand density. This area also has access to many sources of secondary heat e.g. the Thames, sewer pipes, and waste heat from commercial buildings with a cooling demand.

Pros:

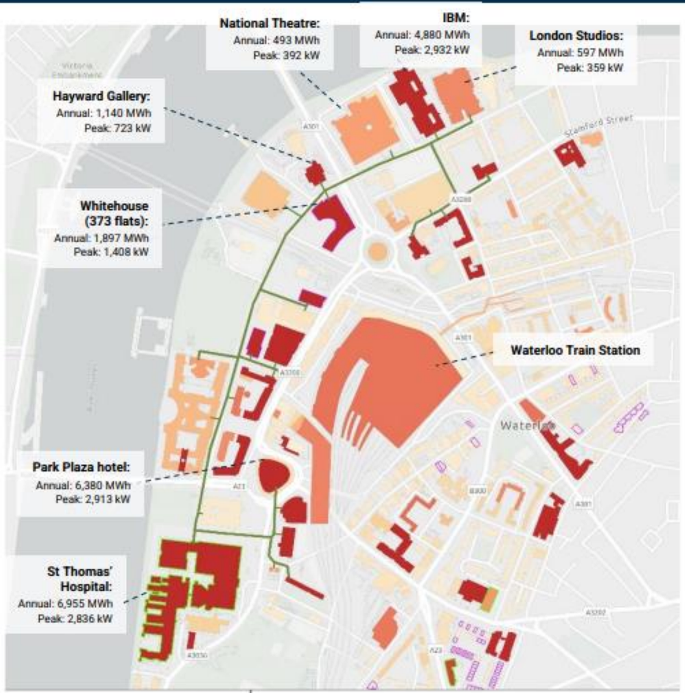
- Very high heat demand density by trench length (38 GWh/km)
- Connects a large number of hard-to-decarbonise commercial high-rises
- St Thomas' Hospital in the south of the zone provides a potential anchor load
- High river water and sewer heat abstraction potential (see map)
- Lots of waste heat from commercial buildings (120 MWh per annum)

Cons:

- In a built-up busy area where construction costs may be higher
- Low number of 'core scheme' properties i.e. not much council-owned land/buildings
- High proportion of tarmac area
- High proportion of privately-owned buildings (99% domestic & 90% non-domestic)

Area attributes

FULL NETWORK	Buildings #	194
	Zone area	48 hectares
	Trench length	2.35 km
	Peak demand	48.04 MWp
	Annual thermal demand	90,145 MWh (23% domestic)
	Heat demand density (by trench length)	38,311 MWh/km
	% residential demand on communal heating	59% (11,993 MWh)
	% total demand with consistent heat load (anchor loads)	8% (7,554 MWh)
	Domestic heat demand social rented (mixed landlords)	1%
	Domestic heat demand privately owned	99%
	Public sector non-domestic heat demand	10%
	Private sector non-domestic heat demand	90%
	Indicative scheme CAPEX	£98.8m
	Indicative cost / kW	£2,057
	Indicative cost / flat (assume 1 flat = 5kW)	£10,286



Waterloo district heating network

a) Thermal properties

0.2 Kilometers

N

Legend

Annual thermal demand (MWh)

<1

>1,000

Proposed heat network pipe length

Potential anchor loads

Communal heat systems

The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems.

Pros:

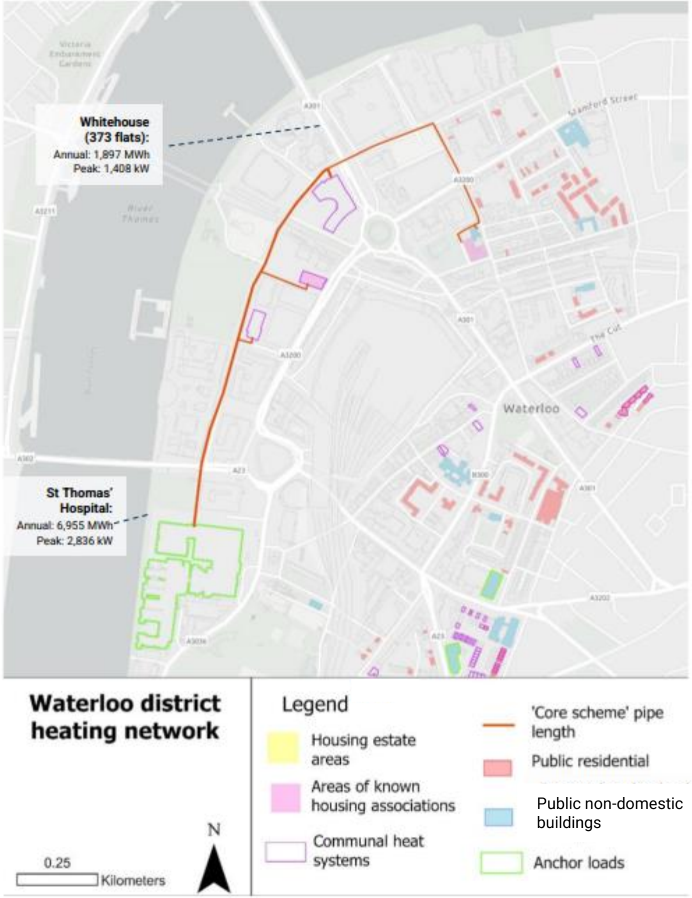
- Lower heat demand density (by trench length) than the full scheme, but still considered within industry benchmarks for viability.
- High heat demand from only eight buildings (just under 2,000 MWh annual load per building)
- St Thomas' Hospital provides a good, stable anchor load
- Very high sewer heat abstraction potential (see heat sources map below)
- Possible heat abstraction from Thames

Cons:

- In a built-up busy area where construction costs may be higher
- Low number of 'core scheme' properties i.e. not much council-owned land/buildings
  High proportion of tarmac area

Core scheme attributes

CORE SCHEME		
	Buildings #	8
	Trench length	1.38 km
	Annual thermal demand	15,662 MWh (75% domestic)
	Heat demand density (by trench length)	11,325 MWh/km
	% residential demand on communal heating	100% (11,993 MWh)
	% total demand with consistent heat load (anchor loads)	48% (7,554 MWh)
	Domestic heat demand (social rented)	4%
	Domestic heat demand (privately owned)	96%
	Non-domestic heat demand (public sector buildings)	95%
	Non-domestic heat demand (private sector buildings)	5%
	Indicative scheme CAPEX	£14.3m
	Indicative cost / kW	£2,631
	Indicative cost / flat (assume 1 flat = 5kW)	£13,155



CARBON TRUST

Sources of heat

HEAT SOURCES		
	Cooling demand (building heat rejection)	120,034 kWh
	Greenspace	15.58 ha (32%)
	Roads, tracks and paths	11.55 ha (24%)
	Length of nearby sewer pipes above 900mm	0.48 km; 8 manholes
	Other potential sources of heat	River Thames
		Waterloo station and underground

Heat network zone statistics

Lambeth Bridge

HEAT NETWORK ZONE 2

Lambeth Bridge

CARBON TRUST

Pros & cons

Similar to Waterloo but with less availability of sewer heat but a greater proportion of anchor loads and council-owned buildings.

Pros:

- Connects a large number of hard-to-decarbonise commercial high-rises
- Council-owned police and fire station could provide good anchor loads
- Lots of waste heat from commercial buildings (41 MWh per annum)
- High proportion of communal heat systems in residences (75%)
- Possible heat abstraction from Thames
- Possible source of secondary heat from data centre

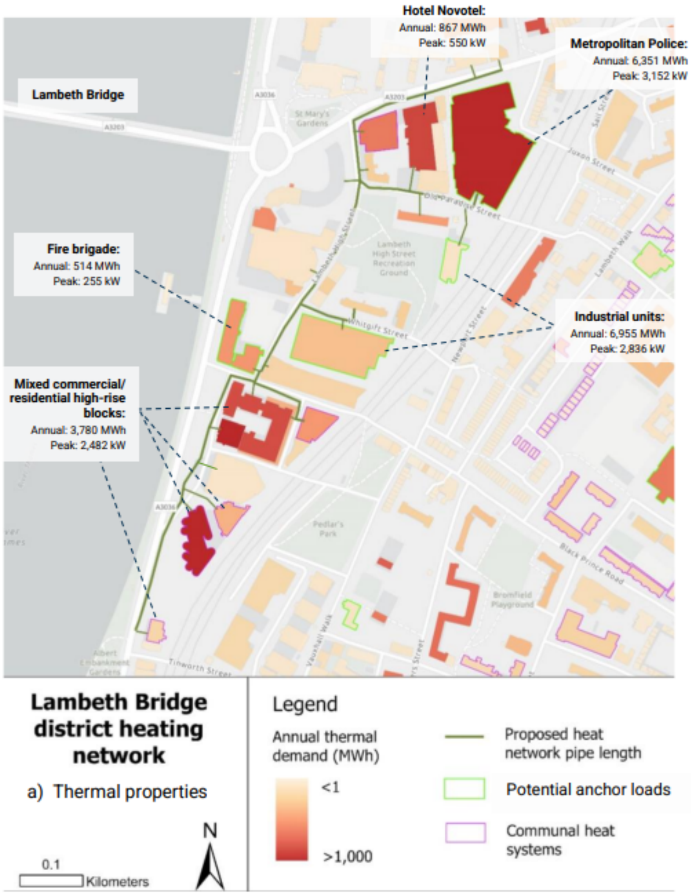
Cons:

- Heat demand density by trench length may be viable but not optimal (8 GWh/km)
- In a built-up busy area where construction costs may be higher
- High proportion of tarmac area
- High proportion of private residences (86%)

Area attributes

FULL NETWORK

Buildings #	49
Zone area	9 hectares
Trench length	2.24 km
Peak demand	10.78 MWp
Annual thermal demand	18,658 MWh (27% domestic)
Heat demand density (by trench length)	8,325 MWh/km
% residential demand on communal heating	75% (3,844 MWh)
% total demand with consistent heat load (anchor loads)	41% (7,624 MWh)
Domestic heat demand social rented (mixed landlords)	14% of domestic
Domestic heat demand privately owned	86% of domestic
Public sector non-domestic heat demand	51% of non-domestic
Private sector non-domestic heat demand	49% of non-domestic
Indicative scheme CAPEX	£27.0m
Indicative cost / kW	£2,502
Indicative cost / flat (assume 1 flat = 5kW)	£12,510



The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems.

Pros:

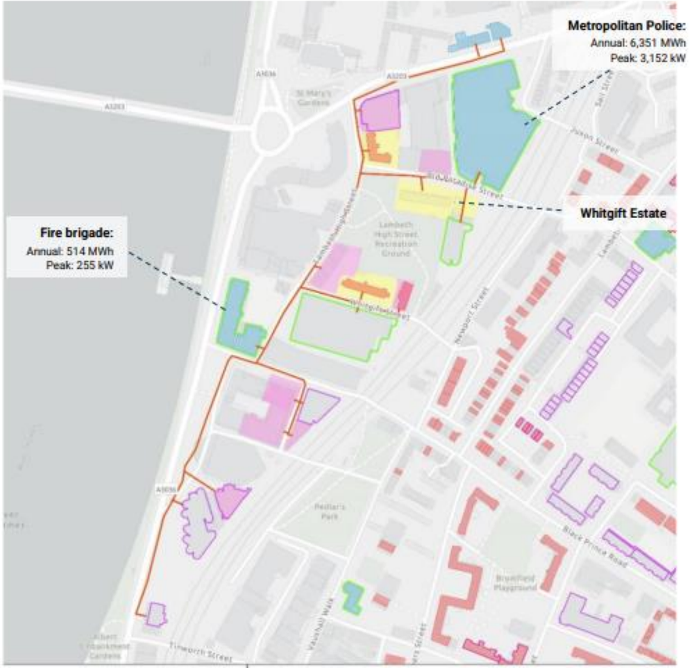
- Connects a large number of hard-to-decarbonise commercial high-rises
- Council-owned police and fire station provide good anchor loads
- High proportion of communal heat systems in residences (88%)
- Possible heat abstraction from Thames
- Possible source of secondary heat from data centre

Cons:

- Potentially viable heat demand density but close to the threshold level of 5,000 MWh per km trench length.
- In a built-up busy area where construction costs may be higher
- High proportion of tarmac area
- High proportion of private residences (83%)

Core scheme attributes

CORE SCHEME		
	Buildings #	21
	Trench length	2.09 km
	Annual thermal demand	12,920 MWh (34% domestic)
	Heat demand density (by trench length)	6,177 MWh/km
	% residential demand on communal heating	88% (3,844 MWh)
	% total demand with consistent heat load (anchor loads)	59% (7,624 MWh)
	Domestic social rented (mixed landlords)	17% of domestic
	Domestic privately owned	83% of domestic
	Public non-domestic heat demand	80% of non-domestic
	Private non-domestic heat demand	20% of non-domestic
	Indicative scheme CAPEX	£18.8m
	Indicative cost / kW	£2,786
	Indicative cost / flat (assume 1 flat = 5kW)	£13,928



Lambeth Bridge district heating network

b) Core scheme

0.1 Kilometers

N

Legend

- Housing estate areas (LBL)
- Areas of known housing associations
- Communal heat systems
- 'Core scheme' pipe length
- Public residential buildings
- Public non-domestic buildings
- Potential anchor loads

CARBON TRUST

Sources of heat

HEAT SOURCES		
	Cooling demand (heat rejection)	40,628 kWh
	Greenspace	3.55 ha (39%)
	Roads, tracks and paths	4.31 ha (48%)
	Length of nearby sewer pipes above 900mm	No sewer heat abstraction potential
	Other potential sources of heat	River Thames
		Data centre

Heat network zone statistics

Vauxhall

HEAT NETWORK ZONE 3

Vauxhall

CARBON TRUST

Pros & cons

The proposed heat network route in Vauxhall connects mixed use, communally heated high-rises in the north of the zone to a couple of large housing estates in the south.

Pros:

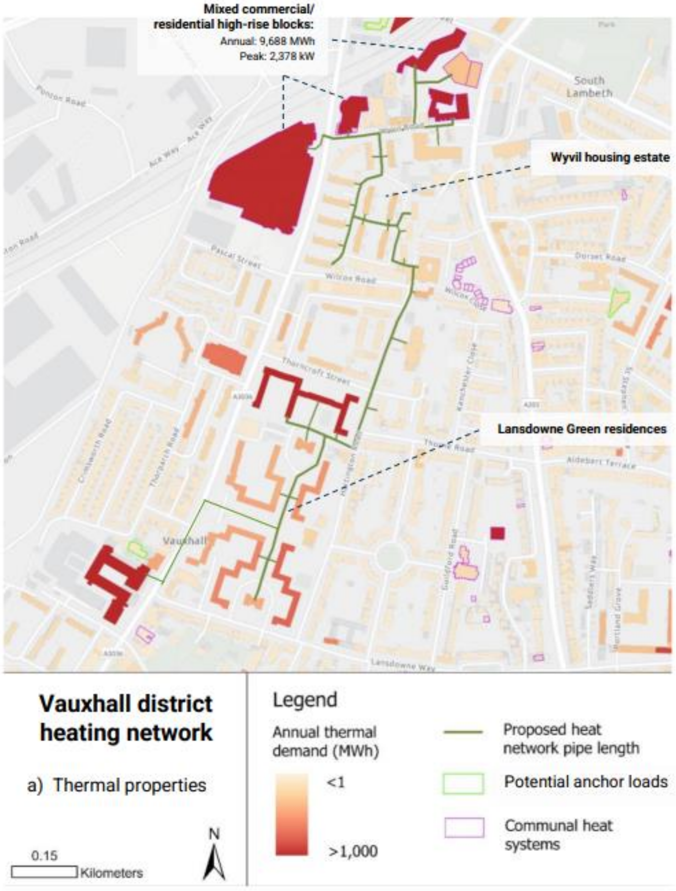
- High heat demand density (by trench length) in both the full scheme and the core scheme (~14 GWh/km)
- Connects to five communally heated high-rises in the north of the zone, all in close proximity
- High proportion of land owned by Lambeth Council (Wyvil Estate) and Optivo housing association (Lansdowne Green)
- Significant cooling load from commercial buildings (69 MWh per annum)

Cons:

- High proportion of buildings are privately owned (58% domestic, 87% non-domestic)

Area attributes

FULL NETWORK		
	Buildings #	91
	Zone area	16 hectares
	Trench length	2.02 km
	Peak demand	10.09 MWp
	Annual thermal demand	26,755 MWh (77% domestic)
	Heat demand density (by trench length)	14,167 MWh/km
	% residential demand on communal heating	73% (14,387 MWh)
	% total demand with consistent heat load (anchor loads)	<1% (70 MWh)
	Domestic heat demand social rented (mixed landlords)	42% of domestic
	Domestic heat demand privately owned	58% of domestic
	Public sector non-domestic heat demand	13% of non-domestic
	Private sector non-domestic heat demand	87% of non-domestic
	Indicative scheme CAPEX	£25.0m
	Indicative cost / kW	£2,480
	Indicative cost / flat (assume 1 flat = 5kW)	£12,400



The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems.

Pros:

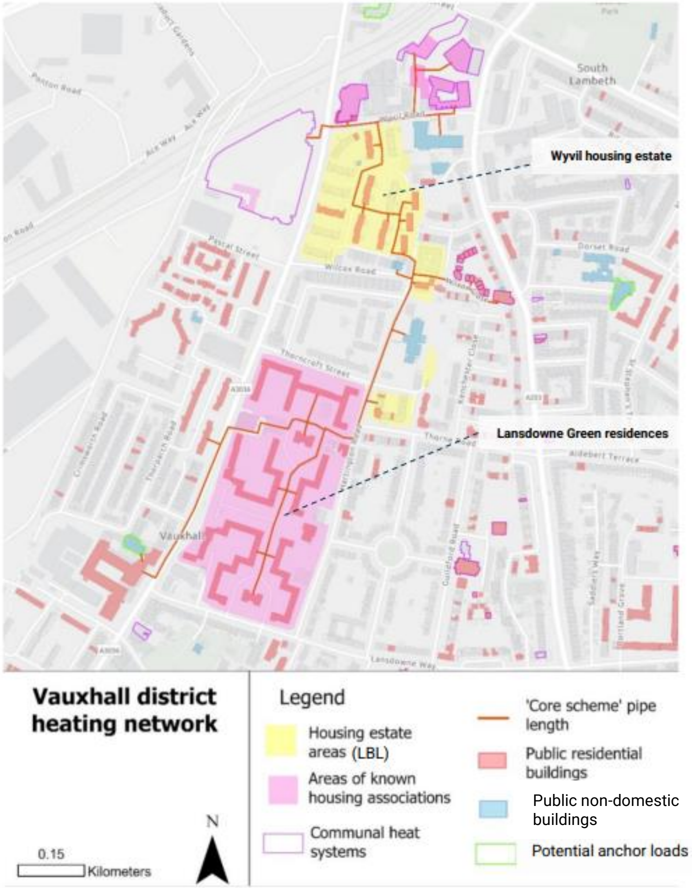
- Heat demand density of core scheme is higher than full network. This is because there is similar heat demand and a shorter trench length
- Connects to five communally heated high-rises in the north of the zone, all in close proximity
- High proportion of land owned by Lambeth Council (Wyvil Estate) and Optivo housing association (Lansdowne Green)
- Significant cooling load from commercial buildings (69 MWh per annum)

Cons:

- High proportion of buildings are privately owned (57% domestic, 83% non-domestic)

Core scheme attributes

CORE SCHEME	
Buildings #	73
Trench length	1.93 km
Annual thermal demand	24,719 MWh (79% domestic)
Heat demand density (by trench length)	14,322 MWh/km
% residential demand on communal heating	74% (14,387 MWh)
% total demand with consistent heat load (anchor loads)	<1% (70 MWh)
Domestic social rented (mixed landlords)	43% of domestic
Domestic privately owned	57% of domestic
Public non-domestic heat demand	17% of non-domestic
Private non-domestic heat demand	83% of non-domestic
Indicative scheme CAPEX	£23.6m
Indicative cost / kW	£2,488
Indicative cost / flat (assume 1 flat = 5kW)	£12,440



Vauxhall district heating network

Sources of heat

HEAT SOURCES	
Cooling demand (heat rejection)	68,888 kWh
Greenspace	7.14 ha (46%)
Roads, tracks and paths	3.16 ha (20%)
Length of nearby sewer pipes above 900mm	No sewer heat abstraction potential
Other potential sources of heat	Data centre

Heat network zone statistics

Clapham (north)

HEAT NETWORK ZONE 4

Clapham (north)

CARBON TRUST

Pros & cons

The Clapham (north) proposed heat network route would connect Lambeth College and Lambeth Academy to the surrounding housing estates, most of which have communal heat systems already installed. However, a lack of a direct route to connect these buildings means that the trench length is very high resulting in a low heat demand density for the zone.

Pros:

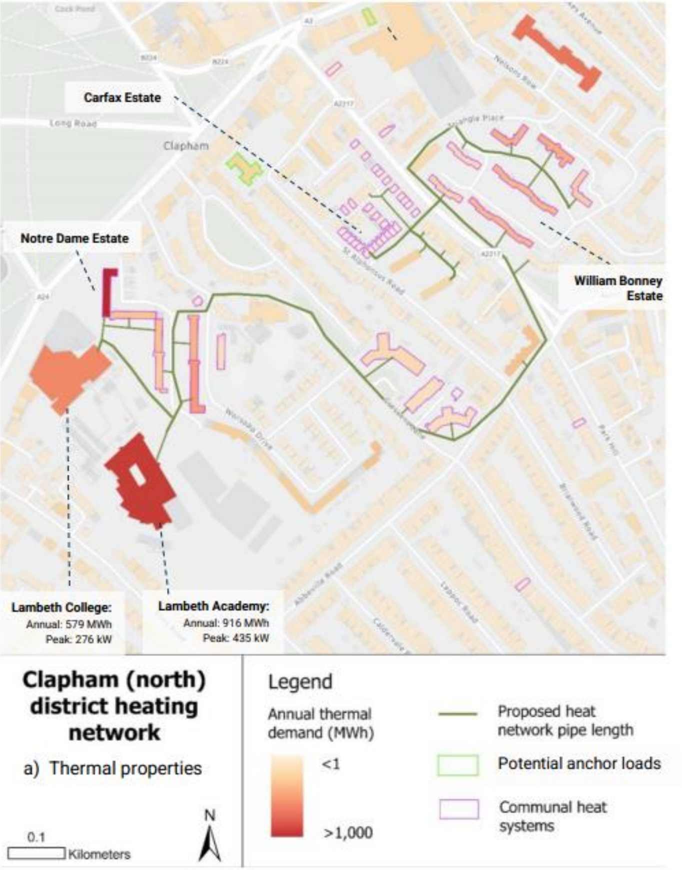
- Connects several housing estates to Lambeth College and Lambeth Academy
- Very high proportion of council-owned land from the various housing estate areas and schools, with lots of greenspace suitable for 'soft dig'
- High public ownership of buildings (67% domestic, 63% non-domestic)
- High proportion of communally heated residences (78%)
- High heat abstraction potential from surrounding sewer systems

Cons:

- Very low heat demand density per unit trench length (as no direct route to key buildings)
- Relatively low total heat demand worsening the business case
- No non-domestic anchor loads
- Relatively high price per kW of heat network (£2,965)

Area attributes

FULL NETWORK		
	Buildings #	148
	Zone area	13 hectares
	Trench length	1.97 km
	Peak demand	5.28 MWp
	Annual thermal demand	9,841 MWh (73% domestic)
	Heat demand density (by trench length)	4,995 MWh/km
	% residential demand on communal heating	78% (5,555 MWh)
	% total demand with consistent heat load (anchor loads)	No anchor loads
	Domestic heat demand social rented (mixed landlords)	67% of domestic
	Domestic heat demand privately owned	33% of domestic
	Public sector non-domestic heat demand	63% of non-domestic
	Private sector non-domestic heat demand	37% of non-domestic
	Indicative scheme CAPEX	£15.7m
	Indicative cost / kW	£2,965
	Indicative cost / flat (assume 1 flat = 5kW)	£14,824



The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems.

Pros:

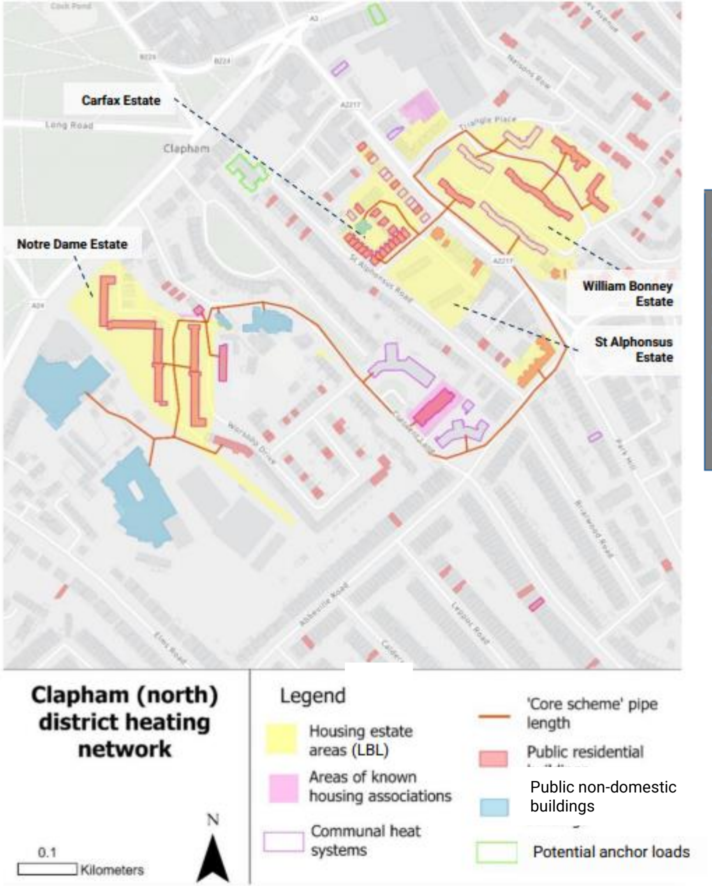
- Core scheme is very similar to the full scheme
- Connects several housing estates to Lambeth College and Lambeth Academy
- Very high proportion of council-owned land from the various housing estate areas and schools, with lots of greenspace suitable for 'soft dig'
- High public ownership of buildings (71% domestic, 71% non-domestic)
- High proportion of communally heated residences (82%)
- High heat abstraction potential from surrounding sewer systems

Cons:

- Very low heat demand density per unit trench length (as no direct route to key buildings)
- Relatively low total heat demand worsening the business case (9.1 GWh)
- No non-domestic anchor loads
- Relatively high estimated price per kW of heat network (£3,038)

Core scheme attributes

CORE SCHEME		
	Buildings #	106
	Trench length	1.93 km
	Annual thermal demand	9,108 MWh (74% domestic)
	Heat demand density (by trench length)	4,744 MWh/km
	% residential demand on communal heating	82% (5,555 MWh)
	% total demand with consistent heat load (anchor loads)	No anchor loads
	Domestic social rented (mixed landlords)	71% of domestic
	Domestic privately owned	29% of domestic
	Public non-domestic heat demand	71% of non-domestic
	Private non-domestic heat demand	29% of non-domestic
	Indicative scheme CAPEX	£14.6m
	Indicative cost / kW	£3,038
	Indicative cost / flat (assume 1 flat = 5kW)	£15,189



CARBON TRUST

Sources of heat

HEAT SOURCES		
	Cooling demand (heat rejection)	431 kWh
	Greenspace	6.07 ha (47%)
	Roads, tracks and paths	3.08 ha (24%)
	Length of nearby sewer pipes above 900mm	0.1 km; 2 manholes
	Other potential sources of heat	n/a

Heat network zone statistics

Clapham (south)

HEAT NETWORK ZONE 5

Clapham (south)

CARBON TRUST

Pros & cons

The Clapham (south) proposed heat network route connects three housing estate areas. The largest is the Clapham Park Estate in the east of the zone which accounts for 60% of the zone's demand and contains buildings with communal heat systems already installed.

Pros:

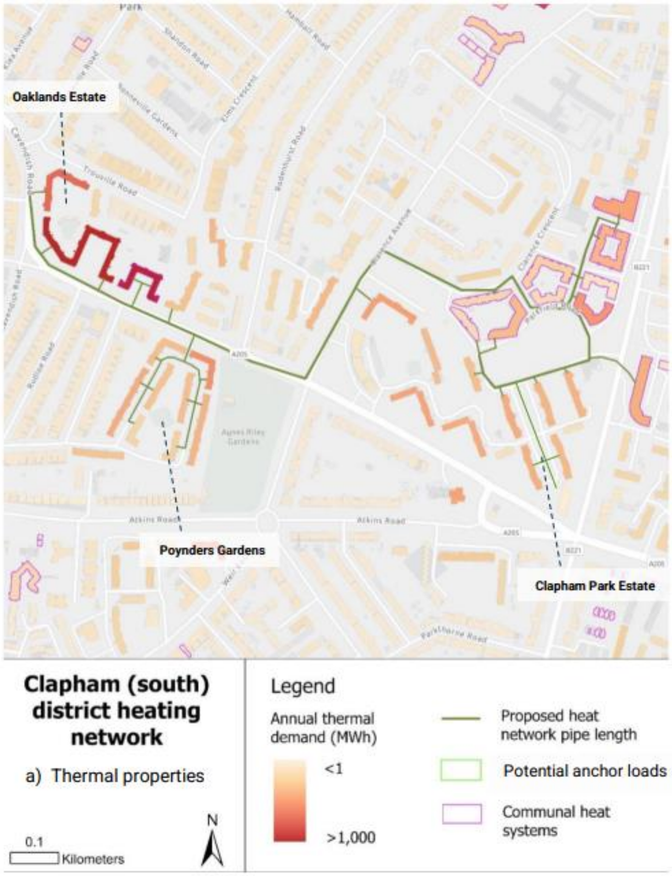
- Connects three large housing estates in close proximity
- High proportion of land owned by Lambeth Council (Oaklands Estate) and Metropolitan housing trust (Clapham Park Estate)
- High public ownership of domestic buildings (68%)

Cons:

- Heat demand density is viable but not optimal
- Low proportion of communal heating in residences (24%)
- No non-domestic anchor loads
- Relatively high estimated price per kW of heat network (£2,819)

Area attributes

FULL NETWORK		
	Buildings #	98
	Zone area	21 hectares
	Trench length	2.45 km
	Peak demand	7.64 MWp
	Annual thermal demand	18,526 MWh (91% domestic)
	Heat demand density (by trench length)	7,549 MWh/km
	% residential demand on communal heating	24% (4,129 MWh)
	% total demand with consistent heat load (anchor loads)	No anchor loads
	Domestic heat demand social rented (mixed landlords)	68% of domestic
	Domestic heat demand privately owned	32% of domestic
	Public sector non-domestic heat demand	8% of non-domestic
	Private sector non-domestic heat demand	92% of non-domestic
	Indicative scheme CAPEX	£21.5m
	Indicative cost / kW	£2,819
	Indicative cost / flat (assume 1 flat = 5kW)	£14,097



The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems.

Pros:

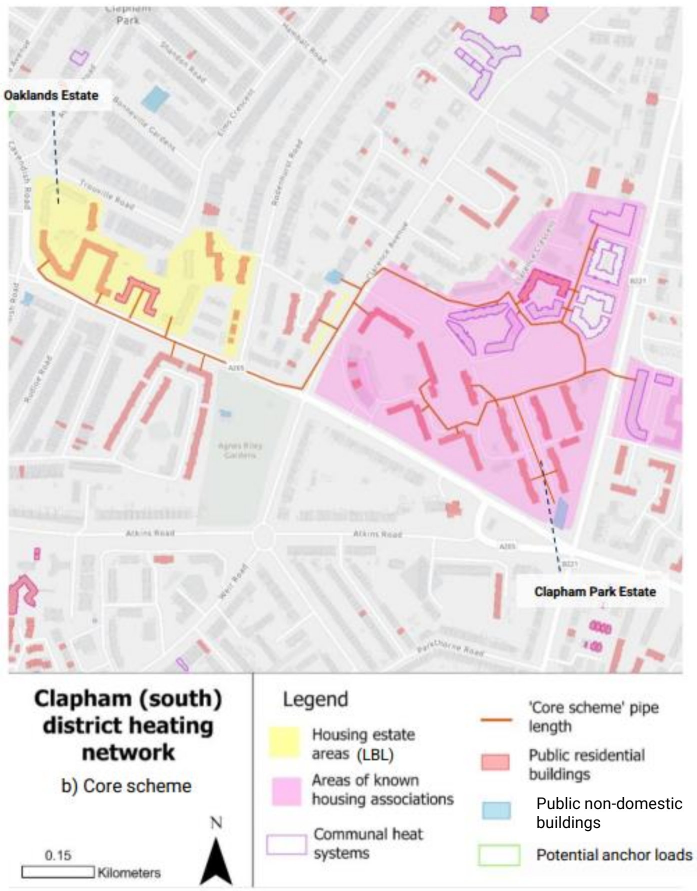
- Connects two large housing estates in close proximity
- High proportion of land owned by Lambeth Council (Oaklands Estate) and Metropolitan housing trust (Clapham Park Estate)
- Very high public ownership of domestic buildings (86%)

Cons:

- Heat demand density is viable but not ideal
- Low proportion of communal heating in residences (24%)
- No non-domestic anchor loads
- Relatively high estimated price per kW of heat network (£2,834)

Core scheme attributes

CORE SCHEME		
	Buildings #	71
	Trench length	2.36 km
	Annual thermal demand	14,162 MWh (92% domestic)
	Heat demand density (by trench length)	6,218 MWh/km
	% residential demand on communal heating	32% (4,129 MWh)
	% total demand with consistent heat load (anchor loads)	No anchor loads
	Domestic social rented (mixed landlords)	86% of domestic
	Domestic privately owned	14% of domestic
	Public non-domestic heat demand	13% of non-domestic
	Private non-domestic heat demand	87% of non-domestic
	Indicative scheme CAPEX	£20.6m
	Indicative cost / kW	£2,834
	Indicative cost / flat (assume 1 flat = 5kW)	£14,168



Clapham (south) district heating network

b) Core scheme

CARBON TRUST

Sources of heat

HEAT SOURCES		
	Cooling demand (heat rejection)	326 kWh
	Greenspace	9.77 ha (46%)
	Roads, tracks and paths	5.26 ha (25%)
	Length of nearby sewer pipes above 900mm	0.1 km; 2 manholes
	Other potential sources of heat	n/a

Heat network zone statistics

Brixton

HEAT NETWORK ZONE 6

Brixton

CARBON TRUST

Pros & cons

The Brixton proposed heat network route follows a similar route to that identified in a 2019 feasibility study delivered by Arup. The network connects a mixture of council-owned non-domestic in the north of the zone (e.g. Brixton Police Station, Recreation Centre, Lambeth Town Hall) to various housing estates in the east and south of the zone.

Pros:

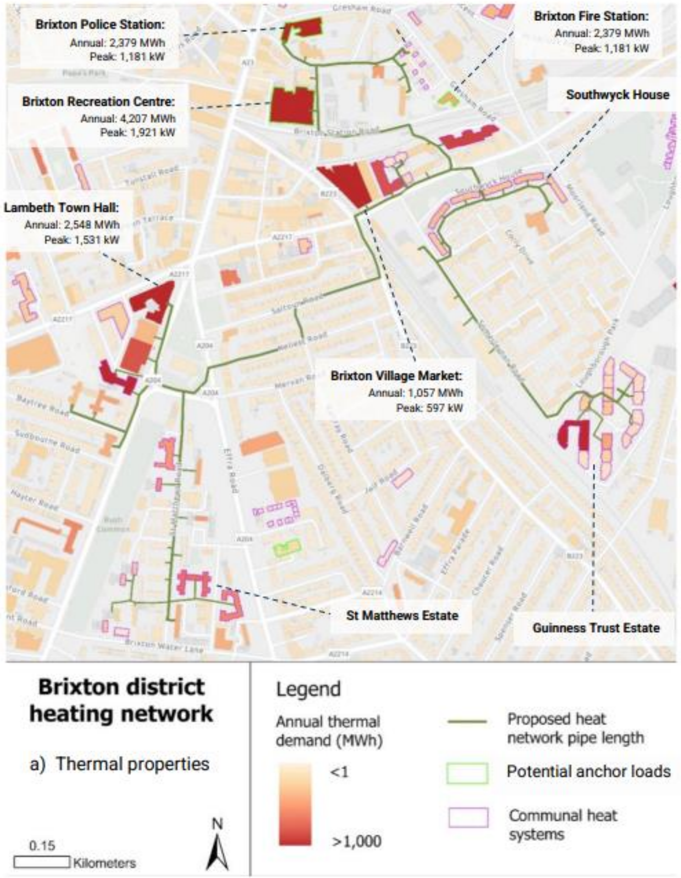
- This is the second largest of the eight zones and connects to almost 300 buildings
- The scheme has relatively high rates of public ownership which is improved on in the core scheme
- The Guinness Trust Estate and Southwyck House are both large residential areas with communal heat systems already installed
- Significant anchor load demand from non-domestic buildings (23% of demand)
- Very high sewer heat abstraction potential (see map)

Cons:

- Despite having a very large heat demand, the long trench length makes the heat demand density at the lower end of feasibility according to industry benchmarks (8.5 GWh/km)

Area attributes

FULL NETWORK		
	Buildings #	265
	Zone area	30 hectares
	Trench length	4.46 km
	Peak demand	19.47 MWp
	Annual thermal demand	38,075 MWh (47% domestic)
	Heat demand density (by trench length)	8,539 MWh/km
	% residential demand on communal heating	64% (11,450 MWh)
	% total demand with consistent heat load (anchor loads)	23% (8,556 MWh)
	Domestic heat demand social rented (mixed landlords)	33% of domestic
	Domestic heat demand privately owned	67% of domestic
	Public sector non-domestic heat demand	39% of non-domestic
	Private sector non-domestic heat demand	61% of non-domestic
	Indicative scheme CAPEX	£49.9m
	Indicative cost / kW	£2,561
	Indicative cost / flat (assume 1 flat = 5kW)	£12,806



The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems.

Pros:

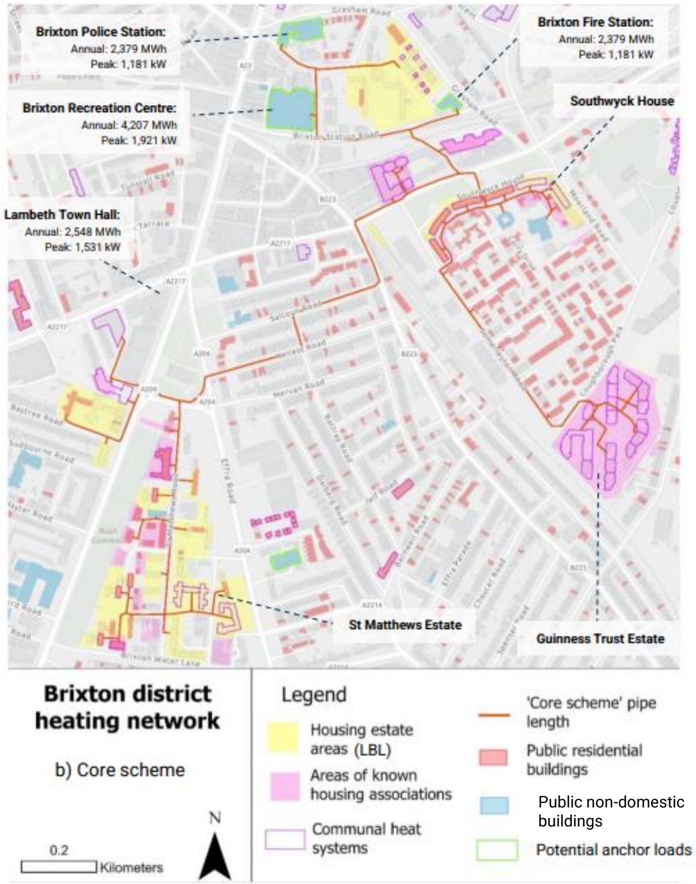
- The core scheme is the second largest of the eight zones and connects to almost 200 buildings (26.3 GWh per annum)
- The scheme has very high rates of public ownership of non-domestic buildings (77%)
- The Guinness Trust Estate and Southwyck House are both large residential areas with communal heat systems already installed
- Significant anchor load demand from non-domestic buildings (32% of demand)
- Very high sewer heat abstraction potential (see map)

Cons:

- Despite having a very large heat demand, the long trench length makes the heat demand density on the lower end of feasible (6.8 GWh/km)

Core scheme attributes

CORE SCHEME	
Buildings #	170
Trench length	3.87 km
Thermal demand	26,304 MWh (61% domestic)
Heat demand density (by trench length)	6,793 MWh/km
% residential demand on communal heating	71% (11,450 MWh)
% total demand with consistent heat load (anchor loads)	32% (8,526 MWh)
Domestic social rented (mixed landlords)	37% of domestic
Domestic privately owned	63% of domestic
Public non-domestic heat demand	77% of non-domestic
Private non-domestic heat demand	23% of non-domestic
Indicative scheme CAPEX	£35.1m
Indicative cost / kW	£2,778
Indicative cost / flat (assume 1 flat = 5kW)	£13,888



Sources of heat

HEAT SOURCES	
Cooling demand (heat rejection)	5,004 kWh
Greenspace	13.10 ha (44%)
Roads, tracks and paths	7.84 ha (26%)
Length of nearby sewer pipes above 900mm	0.36 km; 3 manholes
Other potential sources of heat	n/a

Heat network zone statistics

Tulse Hill

HEAT NETWORK ZONE 7

Tulse Hill

CARBON TRUST

Pros & cons

The Tulse Hill proposed heat network route connects City Heights E-ACT Academy to the neighbouring housing estate (Palace Rd). This housing estate consists of multiple low-rise blocks of communally heated flats.

Pros:

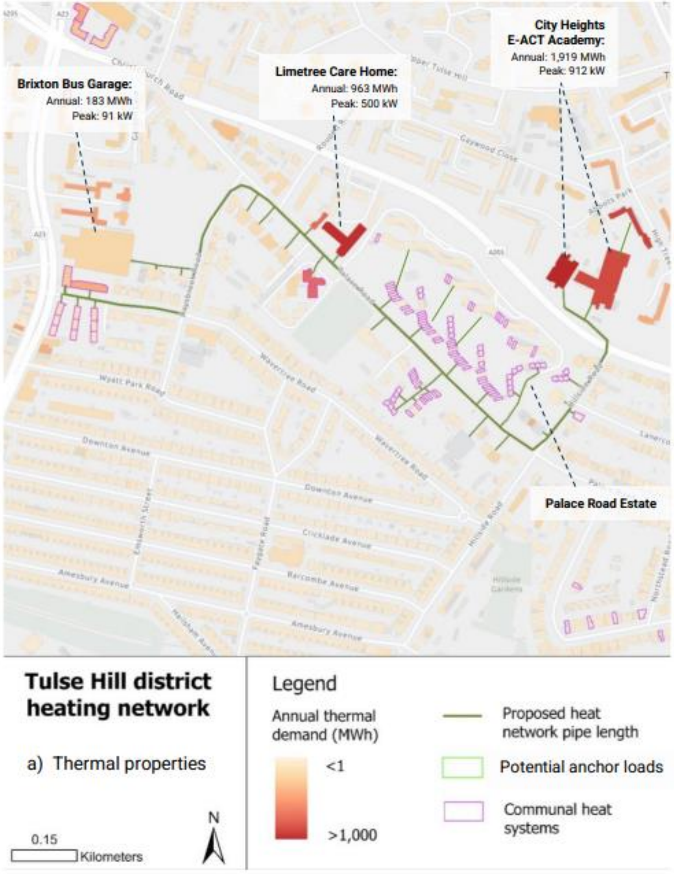
- Connects Park Rd Estate to City Heights E-ACT Academy and a few other buildings
- Very high proportion of council-owned land from the various housing estate area and school, with lots of greenspace suitable for 'soft dig'

Cons:

- Heat demand density per unit trench length is at the lower end of feasibility according to industry benchmarks (6.2 GWh/km)
- Although most of the Park Rd Estate is communally heated, 63% of residences in the zone are not
- No non-domestic anchor loads
- Low rates of public ownership (38% domestic, 43% non-domestic)
- Relatively high price per kW of heat network (£2,785)

Area attributes

FULL NETWORK		
	Buildings #	262 *multiple flats registered as individual buildings
	Zone area	20 hectares
	Trench length	2.48 km
	Peak demand	7.94 MWp
	Annual thermal demand	15,168 MWh (67% domestic)
	Heat demand density (by trench length)	6,263 MWh/km
	% residential demand on communal heating	37% (3,643 MWh)
	% total demand with consistent heat load (anchor loads)	No anchor loads
	Domestic heat demand social rented (mixed landlords)	38% of domestic
	Domestic heat demand privately owned	62% of domestic
	Public sector non-domestic heat demand	43% of non-domestic
	Private sector non-domestic heat demand	57% of non-domestic
	Indicative scheme CAPEX	£22.1m
	Indicative cost / kW	£2,785
	Indicative cost / flat (assume 1 flat = 5kW)	£13,927



The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems.

Pros:

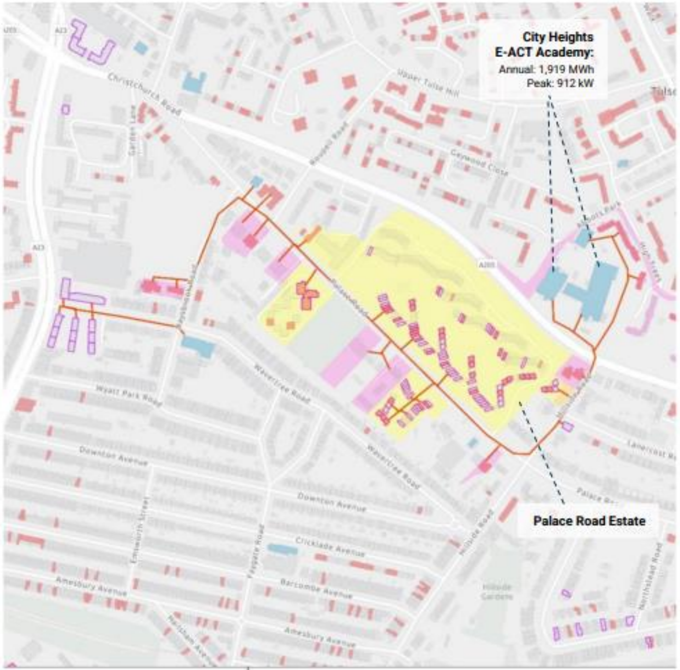
- Connects Park Rd Estate to City Heights E-ACT Academy and a few other buildings
- Very high proportion of council-owned land from the various housing estate area and school, with lots of greenspace suitable for 'soft dig'

Cons:

- Less than optimal heat demand density per unit trench length (5.5 GWh/km)
- Although most of the Park Rd Estate is communally heated, 59% of residences in the zone are not
- Relatively high price per kW of heat network (£2,785)

Core scheme attributes

CORE SCHEME		
	Buildings #	208 *multiple flats registered as individual buildings
	Trench length	2.40 km
	Annual thermal demand	13,086 MWh (71% domestic)
	Heat demand density (by trench length)	5,455 MWh/km
	% residential demand on communal heating	41% (3,843 MWh)
	% total demand with consistent heat load (anchor loads)	No anchor loads
	Domestic social rented (mixed landlords)	42% of domestic
	Domestic privately owned	58% of domestic
	Public non-domestic heat demand	57% of non-domestic
	Private non-domestic heat demand	43% of non-domestic
	Indicative scheme CAPEX	£19.6m
	Indicative cost / kW	£2,919
	Indicative cost / flat (assume 1 flat = 5kW)	£14,596



Tulse Hill district heating network

b) Core scheme

0.15 Kilometers

N

Legend

- Housing estate areas (LBL)
- Areas of known housing associations
- Communal heat systems
- 'Core scheme' pipe length
- Public residential buildings
- Public non-domestic buildings
- Potential anchor loads

CARBON TRUST

Sources of heat

HEAT SOURCES		
	Cooling demand (heat rejection)	1,014 kWh
	Greenspace	12.37 ha (61%)
	Roads, tracks and paths	4.01 ha (20%)
	Length of nearby sewer pipes above 900mm	No sewer heat abstraction potential
	Other potential sources of heat	n/a

Heat network zone statistics

Streatham

HEAT NETWORK ZONE 8

Streatham

The proposed heat network in Streatham is relatively small, with a trench length under a kilometre and a total area of 8 ha. The network connects a few heat intensive non-domestic buildings on the High Street to a housing estate in the south.

Pros:

- Very high heat demand density by trench length (19.5 GWh/km)
- Council-owned Streatham Ice & Leisure Centre makes up almost 40% of commercial heat demand and provides a good anchor load. This is also a possible source of secondary heat
- Lots of waste heat from commercial buildings (24 MWh per annum)
- Relatively low price per kW heat network (£2,185)

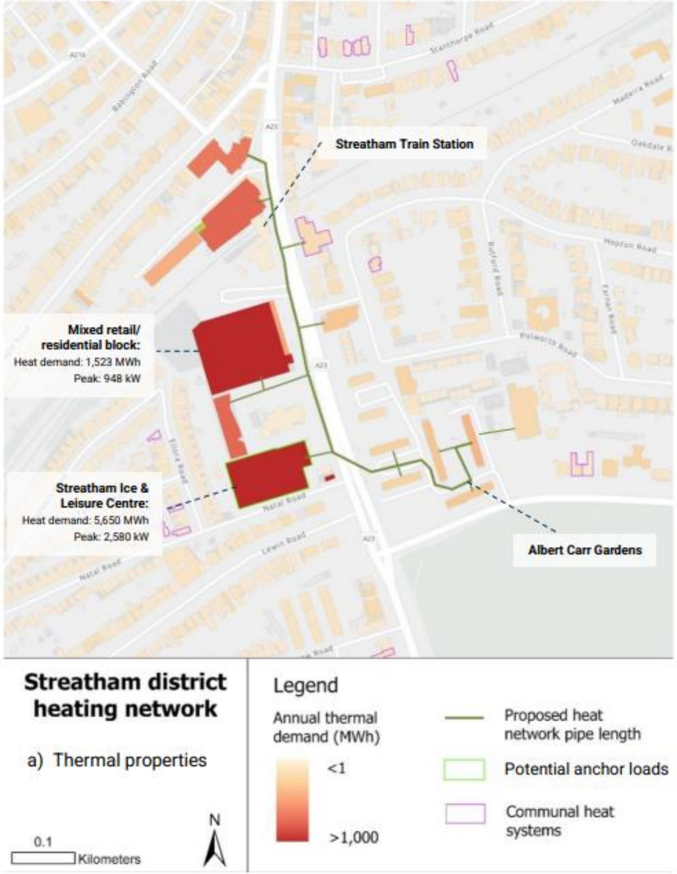
Cons:

- Communal heat systems make up a very small chunk of the domestic heat demand (3%)
- High proportion of private residences (78%)

Area attributes

FULL NETWORK

Buildings #	55
Zone area	8 hectares
Trench length	0.77 km
Peak demand	8.18 MWp
Annual thermal demand	15,153 MWh (36% domestic)
Heat demand density (by trench length)	19,577 MWh/km
% residential demand on communal heating	3% (148 MWh)
% total demand with consistent heat load (anchor loads)	40% (6,072 MWh)
Domestic heat demand social rented (mixed landlords)	22% of domestic
Domestic heat demand privately owned	78% of domestic
Public sector non-domestic heat demand	58% of non-domestic
Private sector non-domestic heat demand	42% of non-domestic
Indicative scheme CAPEX	£17.9m
Indicative cost / kW	£2,185
Indicative cost / flat (assume 1 flat = 5kW)	£10,925



CARBON TRUST

The following attributes are measured against industry benchmarks using a RAG system:

Annual thermal demand (MWh)	< 8,000
	8,000 – 12,000
	> 12,000
Heat demand density (by trench length, MWh/km)	< 5,000
	5,000 – 10,000
	> 10,000

CARBON TRUST

Pros & cons

The 'core scheme' assesses what a start-up heat network might look like by connecting to key buildings only. This includes public buildings, anchor loads (non-domestic buildings with a consistent heat demand) and buildings with communal heat systems already installed.

Pros:

- High heat demand density by trench length (12.6 GWh/km)
- Council-owned Streatham Ice & Leisure Centre makes up over 50% of commercial heat demand and provides a good anchor load. This is also a possible source of secondary heat
- Lots of waste heat from commercial buildings (24 MWh per annum)
- Relatively low price per kW heat network (£2,357)

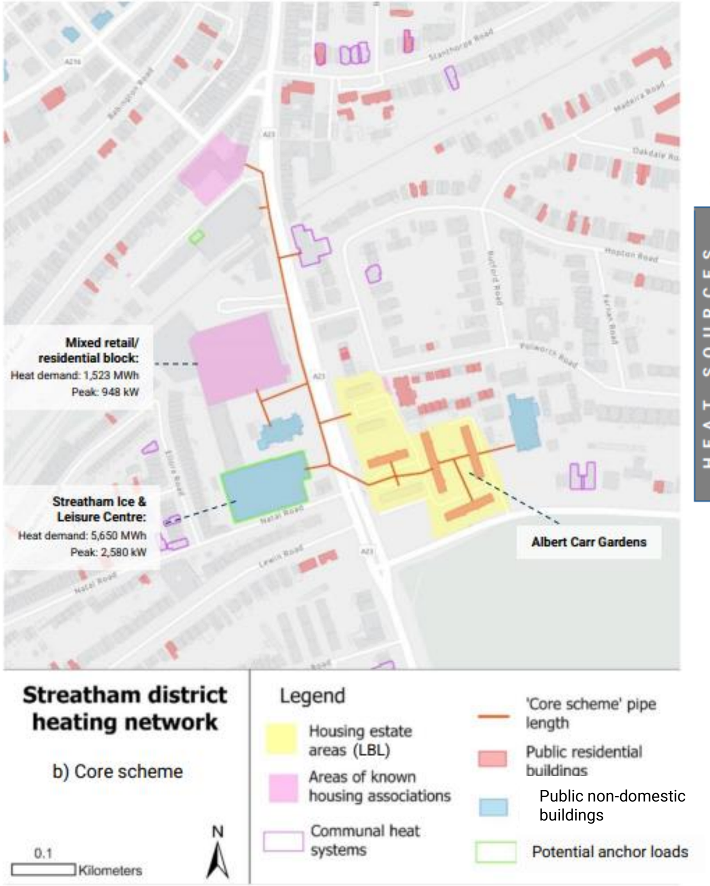
Cons:

- Communal heat systems make up a very small chunk of the domestic heat demand (5%)
- High proportion of private residences (64%)
- Relatively low total heat demand worsening the business case (9.1 GWh)

Core scheme attributes

CORE SCHEME

Buildings #	14
Trench length	0.72 km
Annual thermal demand	9,146 MWh (36% domestic)
Heat demand density (by trench length)	12,632 MWh/km
% residential demand on communal heating	5% (148 MWh)
% total demand with consistent heat load (anchor loads)	66% (6,072 MWh)
Domestic social rented (mixed landlords)	36% of domestic
Domestic privately owned	64% of domestic
Public non-domestic heat demand	99% of non-domestic
Private non-domestic heat demand	1% of non-domestic
Indicative scheme CAPEX	£10.9m
Indicative cost / kW	£2,357
Indicative cost / flat (assume 1 flat = 5kW)	£11,783



Sources of heat

HEAT SOURCES

Cooling demand (heat rejection)	23,859 kWh
Greenspace	2.34 ha (30%)
Roads, tracks and paths	2.63 ha (33%)
Length of nearby sewer pipes above 900mm	No sewer heat abstraction potential
Other potential sources of heat	n/a