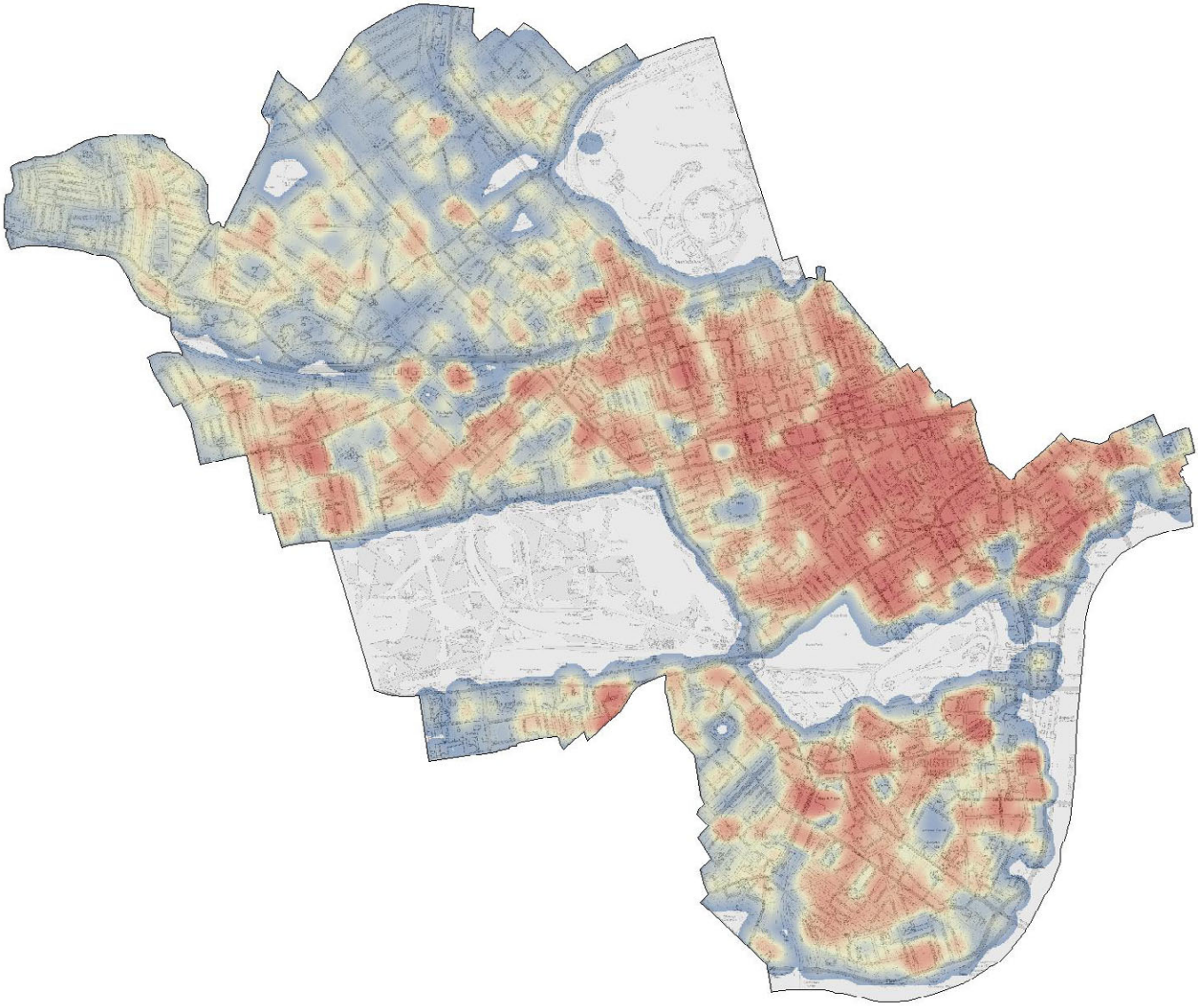
Westminster Heat Mapping Methodology Report



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Contents

Introduction

Following the successful launch of the London Heat Map in 2009, CSE was commissioned by the Greater London Authority to test an enhanced approach to heat mapping, in support of the pilot Westminster Energy Masterplanning process.

The new approach consists of modelling space and water heating demand for each individual building in the City of Westminster – this is in contrast with the London Heat Map, which modelled demand on a 50m x 50m grid (itself an improvement on earlier methods). However it is buildings, rather than abstract grid squares, which must be connected to heat distribution networks, and the new approach is therefore the logical next step the development of spatial heat demand modelling.

The advantages of the new methodology are that it allows:

- the creation of significantly more geographically detailed local heat maps (grid based approaches break down as the map resolution approaches the scale of the grid squares).
- a much finer sectoral breakdown of heat demand than was employed in the original London heat map
- incorporation of locally collected energy demand data within the a single address-level data structure
- analysis of the dataset in which lists of addresses in any given area can be selected, sorted in order of heat demand, and used as shortlists for contacting potential high users of heat.
- initial but detailed assessment of potential heat distribution routes, including identification of network connections, to be done using GIS – and given the appropriate tools, calculation of linear heat demand densities undertaken for candidate networks

This report summarises the process by which the address-level dataset was created, and includes a brief discussion of the results, and the ways in which the methodology could be further developed.

Methodology

Summary

The building-level heat demand modelling methodology starts with a dataset representing the addresses and locations of premises (and hence the buildings that contain them). It combines this dataset with information from numerous sources representing characteristics of these premises which can be used to estimate their heat demand. It then performs this estimate for every premise individually, running a set of benchmarks against these characteristics. Finally this premise-level dataset is aggregated to building level to preserve agreement with the real-world population of buildings. The result of the modelling process is a spatial relational database storing the address text, geographic coordinates, and estimated heat demand of all buildings in the study area as defined by the master address list used - in this case the National Land and Property Gazetteer (NLPG). This database is then used to generate maps for analytical and reporting purposes.

Inputs

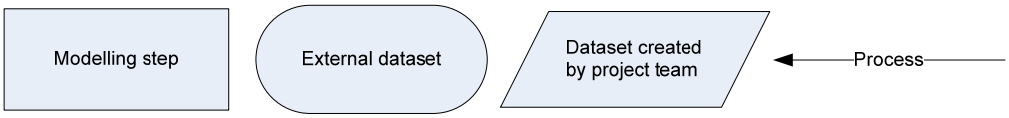
The model uses takes a wide range of official datasets as inputs. The table below lists these datasets, and their uses in the model.

Table 1: Data inputs (see Appendix 1 for further detail).

Dataset	Use in model
National Land and Property Gazetteer	Definition of building geography, classification of all address types
VOA commercial floorspace database	Classification of rateable address types, quantification of floorspace
Town Centre Intelligence	Classification of commercial address types
Residata	Classification of residential address types
ONS Annual Business Inquiry	Geographic Employee and Site count data by SIC code
Derived from DECC statistics	Per-site and per-employee heat demand benchmarks by SIC code
CIBSE Guide F	Floorspace heat demand benchmarks
English House Condition Survey	As input to derivation of residential benchmarks
Expenditure and Food Survey	As input to derivation of residential benchmarks

Processes

There are two stages to the modelling process. These are summarised in the diagrams below. The symbols used in the diagrams have the following meanings:



Stage 1: Address definition and classification

Here the underlying address (premises and buildings) database is established, with each premise being assigned a classification and further attribute data required for estimating heat demand – for example:

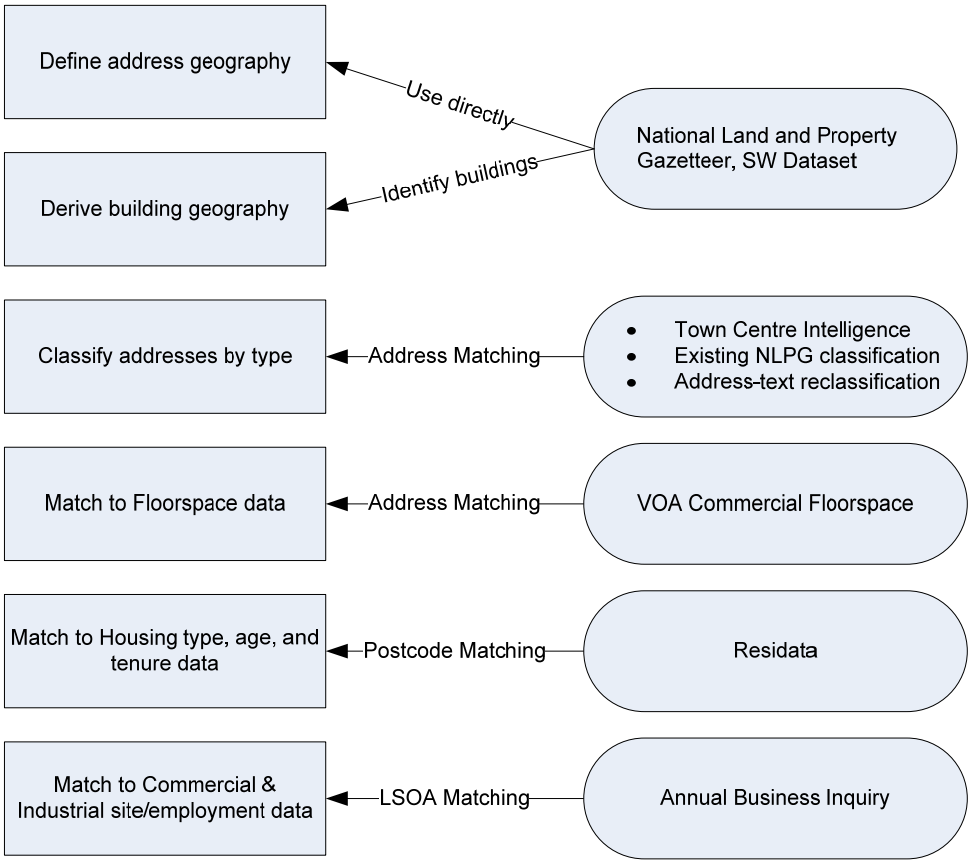
- Residential: ConvertedFlats/3 bedrooms/1980+/owner-occupied
- Office: 5000m^2 floorspace
- School: 40 employees
- Factory: 1 site

This is achieved by matching the various address-descriptor datasets to the NLPG master address dataset, using advanced record-linkage techniques. Where a positive match is identified, the

addresses in the two datasets are assumed to be the same, and attribute data is transferred from the various descriptor datasets to the NLPG address dataset. In this way the NLPG address dataset is enhanced with additional information on the detailed characteristics of the addresses.
For residential premises, the Residata database (2005) was used: this describes the typical built form, tenure, age and size of housing for every unit postcode. As a result, postcode level information is assumed to be representative of the population of residential premises sharing that postcode. To improve on this the project team created additional classification routines which detect multiple premises at the same location, and reclassified these as either converted or purpose built flats, depending on the number of premises.

The classification information available on non-residential premises comes from multiple sources – the richest and most reliable of these is the Valuation Office Agency's rateable floorspace database, which gives detailed information both on the activity (office, retail, workshop etc), and total floor area. Other sources, such as Town Centre Intelligence, or the NLPG's own classification schema, only provided classification data (office, school, hospital etc), making estimation of heat demand a more complex task.

Figure 1: Model stage 1 - define and classify addresses



Output from Stage 1: a spatial relational database representing all premises and their buildings, across Westminster. Addresses are classified into one of approximately forty categories, and information required to model heat demand integrated into single data structure.

Stage 2: Heat Demand Modelling.
Here the estimated heat demand is calculated for each premise in the database. As noted above, more information is available for some premises/types of premise than others. The model uses the best available information in each case. For a small proportion of addresses, classification data are unavailable (the NLPG lists these premises as unclassified, and record-linkage on address text does not yield further information). In these cases, the heat demand is spatially imputed by taking the modal average of all neighbours within a fixed radius.

Residential
For residential properties, heat demand is estimated using a set of constant values developed by the project team, using the English House Condition Survey and the Expenditure and Food Survey. This contains a distinct annual heat demand value for each combination of housing tenure, age, built form and size (number of bedrooms). A sample of the list (which contains over 5,000 unique values) is shown in Table X).

Non-residential with floorspace data
Where address records were successfully matched to the VOA floorspace dataset, the combination of floorspace and activity type were used to estimate heat demand, based on the appropriate CIBSE Guide F floorspace benchmark ("Typical" values were used).

Non-residential without floorspace data
Where premise records were not matched to the VOA floorspace dataset (either because the premise category was not within the scope of the VOA dataset, or because a positive match was not obtained in the record-linkage process), a secondary approach was taken to estimating heat demand. This involved the use of ONS area-based statistics on employment and site counts grouped by Standard Industrial Classification (SIC) code.

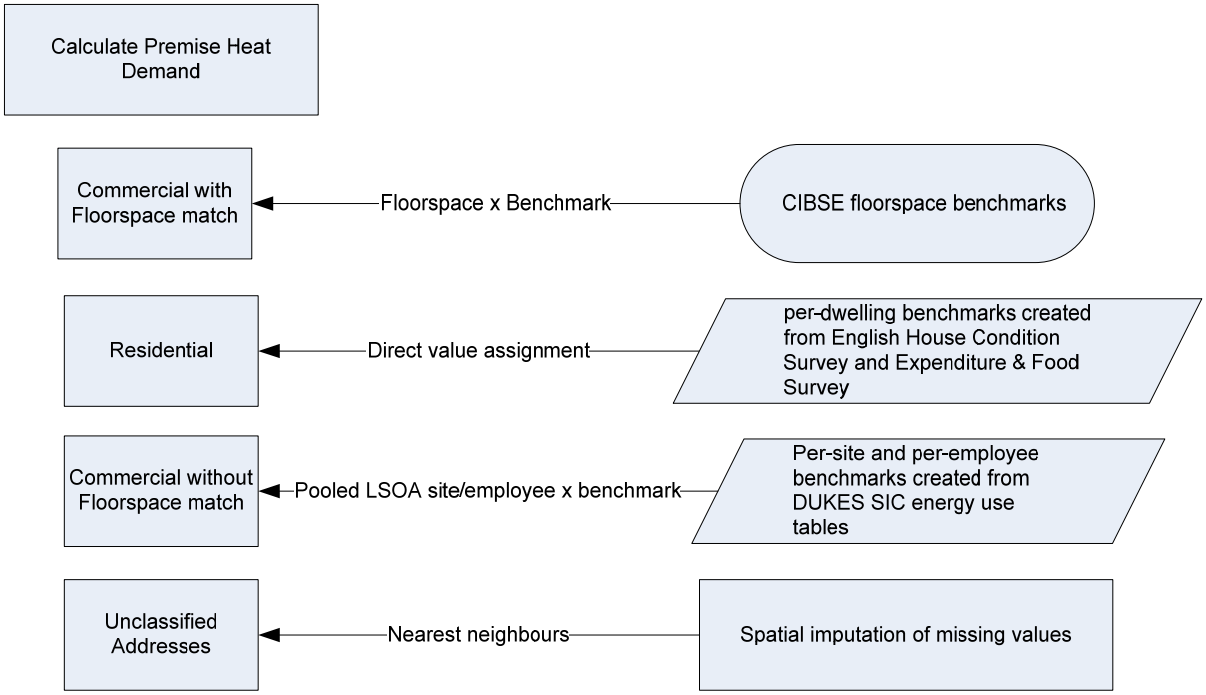
For each LSOA (Lower-level super output area), the total number of sites and employees in the premise's activity category was taken from the Annual Business Inquiry dataset 2008. The LSOA total heat demand in that category was then calculated from per-site and per-employee benchmarks developed by the project team. These were based on national energy use, employment and site data split by SIC code, and obtained from DECC. Once the overall category heat demand was calculated for that LSOA, the total was split pro-rata among the premises in that category and LSOA.

Unclassified premises
There are two categories of unclassified premise. The first is where the overall category is known (e.g. Residential or Commercial), but nothing else. In these cases a spatial imputation is performed using only the appropriate subset of neighbouring addresses as known datapoints. Hence heat demand for "Commercial-Unclassified" premises was calculated as the modal average of the non-residential neighbouring premises. Conversely for "Residential-Unclassified" premises, the filter excludes non-residential premises.

For a very small number of addresses there were insufficient neighbours within the defined radius to perform the imputation. In these cases, the average value was calculated for addresses in the same category across the dataset. This is referred to as "Table imputed" in Table X.

The second category of unclassified address is where nothing is known about the address, other than the address itself and its location. In these cases the spatial imputation criterion was relaxed so as to take into account all neighbouring addresses for which there was a known heat demand.

Figure 2: Model stage 2 - estimate heat demand



Benchmarks

Residential

In total 593 distinct domestic heat demand values were created from the EHCS and EFS for London dwellings. Of these, 308 were used in the modelling for Westminster, as a result of the distribution of combinations of built form, tenure, age and number of bedrooms in the Westminster subset of the Residata dataset. The table below gives a small number of examples. The full list of values is available on request. The description of a residential address is split into six parts, as follows:

1. Sector: RESIDENTIAL
2. Region: LONDON
3. Built form: P_FLATS (purpose built flats)
4. Tenure: SR (social rented)
5. Period of construction: 1946-1979
6. Number of bedrooms: 1

Residential Type	**kwh/premise**
RESIDENTIAL_LONDON_P_FLATS_SR_1946-1979_1	8154.722
RESIDENTIAL_LONDON_DETACHED_SR_<1920_5	47894.6
RESIDENTIAL_LONDON_DETACHED_PR_<1920_5	44734.28
RESIDENTIAL_LONDON_DETACHED_OO_<1920_5	42292.28
RESIDENTIAL_LONDON_DETACHED_SR_<1920_4	40122.11
RESIDENTIAL_LONDON_DETACHED_SR_<1920_5	47894.6
RESIDENTIAL_LONDON_DETACHED_MIXED_1946-1979_3	19099.42
RESIDENTIAL_LONDON_DETACHED_SR_1980+_2	19660.18

Non-residential

As discussed previously, various benchmarks have been used to estimate non residential heat demand, depending on the amount of information available for each address. Where floorspace data was available, "Typical" values from CIBSE Guide F were used, as shown in Table 1 below. Where floorspace data was not available, the Office of National Statistics Annual Business Inquiry (ABI) small-area dataset was used, in conjunction with per-site and per-employee SIC-code heat demand coefficients. These were calculated by the project team and are shown in Table 2 (below).

Table 2: Floorspace heat demand benchmarks (source: CIBSE Guide F).

Classification	**Annual space and water heating per m^2**
Arts and Entertainment	142
Banking	98.0
Bars	257.0
Care Homes	426.5
Community Hall	173.3
Courts	181.3
Factory	325.0
Government Office	205.0
Halls of Residence	290.0
High Street Agency	230.0
Hospital	482.8
Hotel	406.7
Laundry	202.0
Library	185.0
Light Manufacturing	325.0
Museums and Art Galleries	142.0
Office	174.1
Police Station	339.8
Post Office	210.0
Primary Education	203.8
Primary Health	270.0
Residential	240.0
Restaurants	538.3
Retail_Commercial	192.0
Retail_Department Store	248.0
Retail_High Street	92.3
Science Laboratory	132.0
Secondary Education	132.0
Social Club	329.0
Sport and Leisure	364.6
Supermarket	261.0
Theatre	625.0
University	148.8
Warehouse	136.0
Workshop	136.0

Table 3: Site and employee heat demand coefficients by SIC code.

2-digit SIC code	2-digit SIC code description	Annual space and water heating demand per site (national average)	Annual space and water heating demand per employee (national average)
14	Other mining and quarry	60544	7011
15	Manufacturing of food and beverages	538012	18087
16	Manufacture of tobacco products	1324936	10375
17	Manufacture of textiles	932385	97152
18	Manufacture of wearing apparel; dressing and dyeing of fur	181952	36211
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	241325	24793
20	Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	357083	58459
21	Manufacture of pulp, paper and paper products	1086232	51075
22	Publishing, printing and reproduction of recorded media	23204	3217
23	Manufacture of coke, refined petroleum products and nuclear fuel	57658766	895976
24	Manufacture of chemicals and chemical products	1237885	42805
25	Manufacture of rubber and plastic products	651670	37678
26	Manufacture of other non-metallic mineral products	107245	9038
28	Manufacture of fabricated metal products, except machinery and equipment	143496	17306
29	Manufacture of machinery and equipment not elsewhere classified	210090	14274
30	Manufacture of office machinery and computers	201854	16263
31	Manufacture of electrical machinery and apparatus not elsewhere classified	456360	31765
32	Manufacture of radio, television and communication equipment and apparatus	470080	32235
33	Manufacture of medical, precision and optical instruments, watches and clocks	237516	15351
34	Manufacture of motor vehicles, trailers and semi-trailers	1708522	48460
35	Manufacture of transport equipment	854867	22139
36	Manufacture of furniture; manufacturing not elsewhere classified	100506	15697
37	Recycling	1366740	206151
40	Electricity, gas, steam and hot water supply	957875	45052

2-digit SIC code	2-digit SIC code description	Annual space and water heating demand per site (national average)	Annual space and water heating demand per employee (national average)
45	Construction	24042	4522
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles	157200	22605
52	Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods	109565	15238
55	Hotels and restaurants	131936	17107
60	Land transport; transport via pipelines	36826	3515
61	Water transport	36826	3515
62	Air transport	36826	3515
63	Supporting and auxiliary transport activities; activities of travel agencies	36826	3515
64	Post and telecommunications	36826	3515
65	Financial intermediation, except insurance and pension funding	24042	4522
66	Insurance and pension funding, except compulsory social security	24042	4522
67	Activities auxiliary to financial intermediation	24042	4522
70	Real estate activities	24042	4522
71	Renting of machinery and equipment without operator and of personal and household goods	157200	22605
72	Computer and related activities	24042	4522
73	Research and development	24042	4522
74	Other business activities	24042	4522
75	Public administration and defence; compulsory social security	390174	8760
80	Education	302418	9992
85	Health and social work	76891	4317
91	Activities of membership organisations not elsewhere classified	122940	31254
92	Recreational, cultural and sporting activities	104975	17708
93	Other service activities	122940	31254
631	Cargo handling and storage	157200	22605

Summary Results

Tabular results

Table 4: Estimated heat demand by address category

Classification	Number of premises	Total kwh	Average kwh per premise
RESIDENTIAL	119663	1,456,050,706	12,168
OFFICE	20516	830,934,407	40,502
UNKNOWN	17790	326,182,009	18,335
RETAIL_HIGH STREET	7959	216,963,274	27,260
RESTAURANTS	2123	258,254,018	121,646
PRIMARY HEALTH	510	19,052,150	37,357
RETAIL_COMMERCIAL	477	18,557,862	38,905
HOTEL	396	49,766,238	125,672
BARS	358	42,163,914	117,776
WORKSHOP	347	3,994,226	11,511
BANKING	232	11,077,242	47,747
SECONDARY EDUCATION	89	17,260,227	193,935
SOCIAL CLUB	87	7,172,808	82,446
MUSEUMS AND ART GALLERIES	85	7,953,205	93,567
PRIMARY EDUCATION	67	10,911,063	162,852
ARTS AND ENTERTAINMENT	67	1,470,930	21,954
SPORT AND LEISURE	60	4,821,127	80,352
THEATRE	50	5,140,108	102,802
LIGHT MANUFACTURING	46	2,493,098	54,198
WAREHOUSE	41	3,449,558	84,136
COMMUNITY HALL	37	2,553,644	69,017
HOSPITAL	30	1,874,009	62,467
SCIENCE LABORATORY	30	2,021,629	67,388
LAUNDRY	27	491,534	18,205
POST OFFICE	23	3,413,587	148,417
GOVERNMENT OFFICE	18	3,125,418	173,634
LIBRARY	15	1,131,937	75,462
POLICE STATION	15	4,440,834	296,056
UNIVERSITY	8	2,149,291	268,661
COURTS	7	2,341,044	334,435
RETAIL_DEPARTMENT STORE	6	26,449,815	4,408,303
FIRE STATION	3	1,170,522	390,174
FACTORY	2	193,506	96,753
SWIMMING POOL	1	968,000	968,000
TOTAL	**171,185**	**3,345,992,940**	**8,852,093.078**

Table 5: Estimated heat demand by modelling method

Modelling method	Total kWh	Number of premises	% of demand	% of premises	average kWh per premise
ABI (Employee)	46,873,809	1,196	1.4	0.7	39,192
ABI (Site)	410,612,546	7,848	12.2	4.5	52,321
Residential Benchmarking	1,397,005,616	115,156	41.7	66.0	12,131
Spatially imputed (by category)	61,047,181	4,564	1.8	2.6	13,376
Spatially imputed (all categories)	327,743,403	17,774	9.8	10.2	18,439
Ignored (no heat demand expected)		3,252		1.9	
Floorspace multiplier	1,105,000,975	24,506	33.0	14.0	45,091
Table imputed	4,177,926	72	0.1	0.0	58,027
TOTALS	**3,352,461,454**	**174,437**	**100**	**100**	

Table 6: Validation against DECC small-area statistics (2007)

	DECC Totals 2007 (kWh)	Heat map totals (kWh)	Ratio
Residential	1,287,658,919	1,397,005,616	1.08
Non-residential	2,895,080,351	1,948,987,325	0.67
Total	4,182,739,270	3,345,992,940	0.80

Geographic results

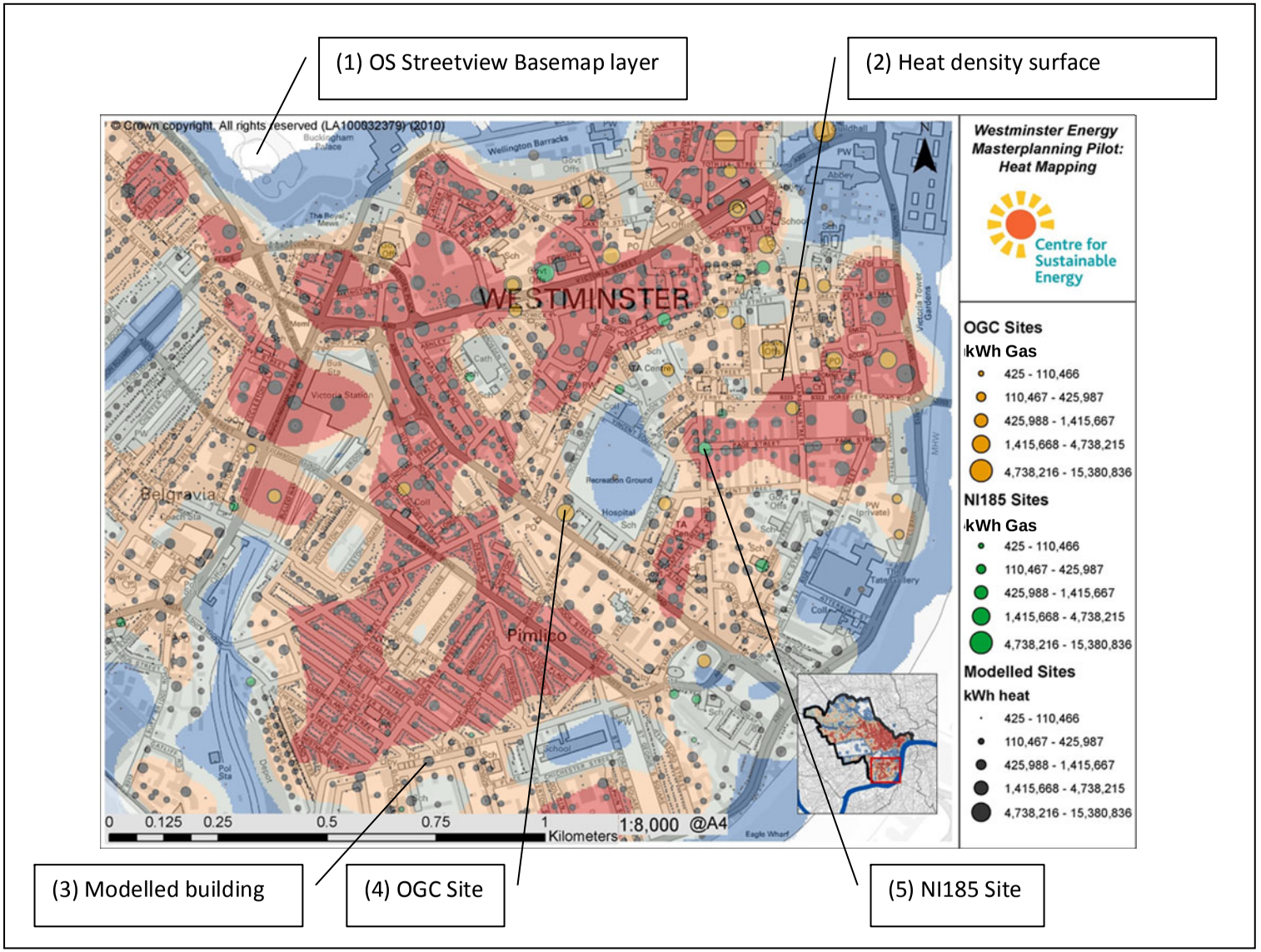
This section of the report presents a set of maps combining various GIS datasets, some of which were produced by CSE as part of the heat mapping projects, and some of which were supplied by Westminster City Council. They are designed to illustrate the different ways in which the data can be displayed, explored and analysed (although note that a technical assessment of specific heat distribution project opportunities is outside the scope of this project).

Table 7 below explains the source, content and relationships between these GIS datasets, while Figure 3 (next page) illustrates how they appear in the maps.

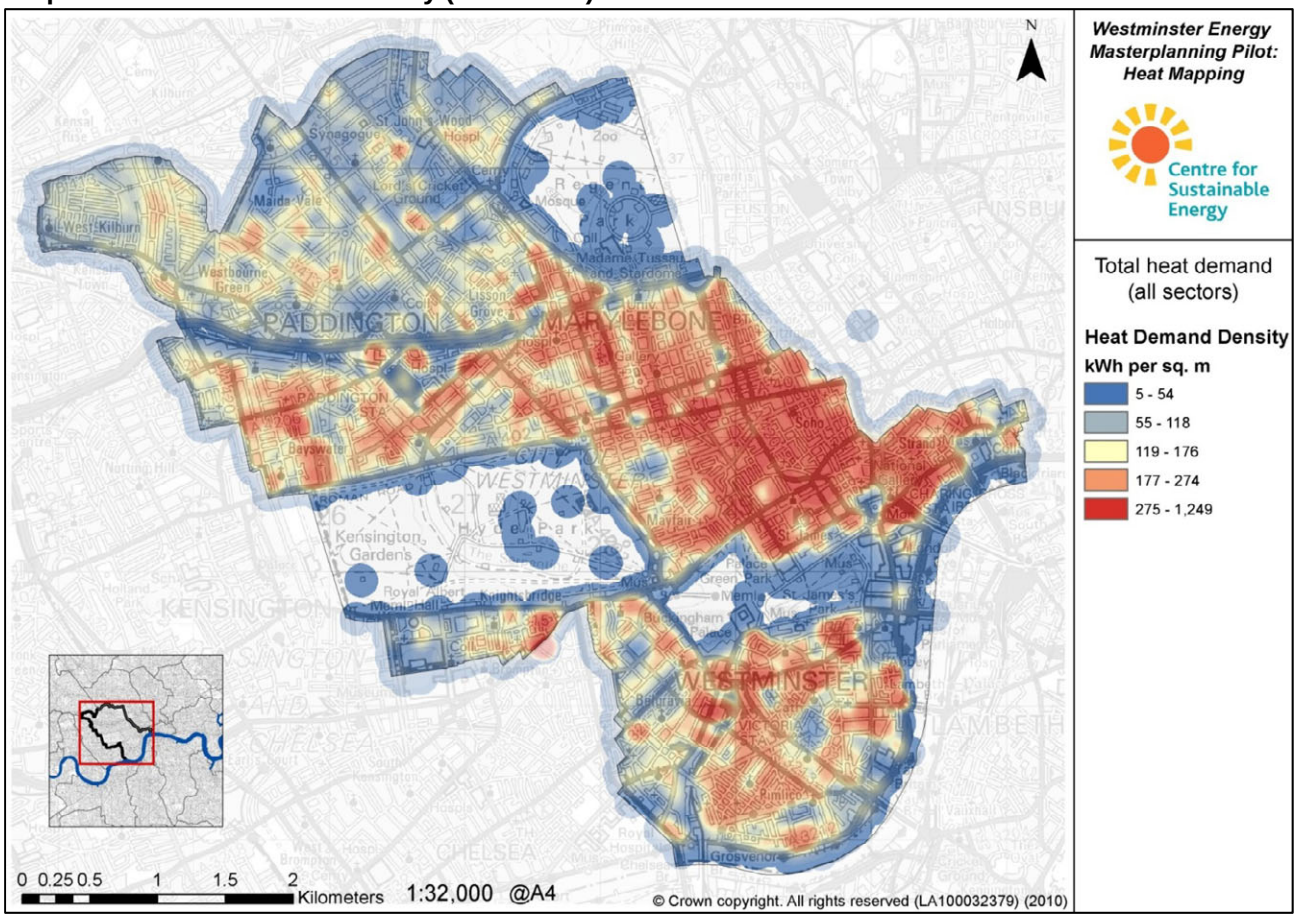
Table 7: Five GIS datasets shown in the Westminster maps

Dataset	Source	Notes
(1) OS Streetview	Ordnance Survey OpenData	This is a simple basemap showing the street network and selected building outlines. The layer is shown in greyscale to avoid colour clashes with the heat density surfaces.
(2) Heat density surfaces	Generated by CSE from Building-level heat demand point data	Heat density surfaces illustrate spatial patterns inherent the modelled heat demand point data. They are static in that if the input point data changes, the surfaces must be re-created to reflect that change. They do not reflect or account for other heat data sources, such as the NI185 dataset. These surfaces can be colour coded according to different criteria, to emphasise different aspects of the underlying dataset. For example, Figures 1 and 4 are displaying identical surface datasets, but with different criteria applied to the colour coding.
(3) Building-level modelled heat demand data	Modelled by CSE	This is a building-level point dataset representing the raw outputs of the heat demand modelling work
(4) NI185	Provided by Westminster City Council	Address-level point dataset showing local authority energy consumption. This layer does not feed into the creation of the heat demand density surfaces.
(5) OGC	Provided via Westminster City Council	Address-level point dataset showing energy consumption from central government estate. This layer does not feed into the creation of the heat demand density surfaces.

Figure 3: Diagram showing the five different GIS datasets displayed in the Westminster maps

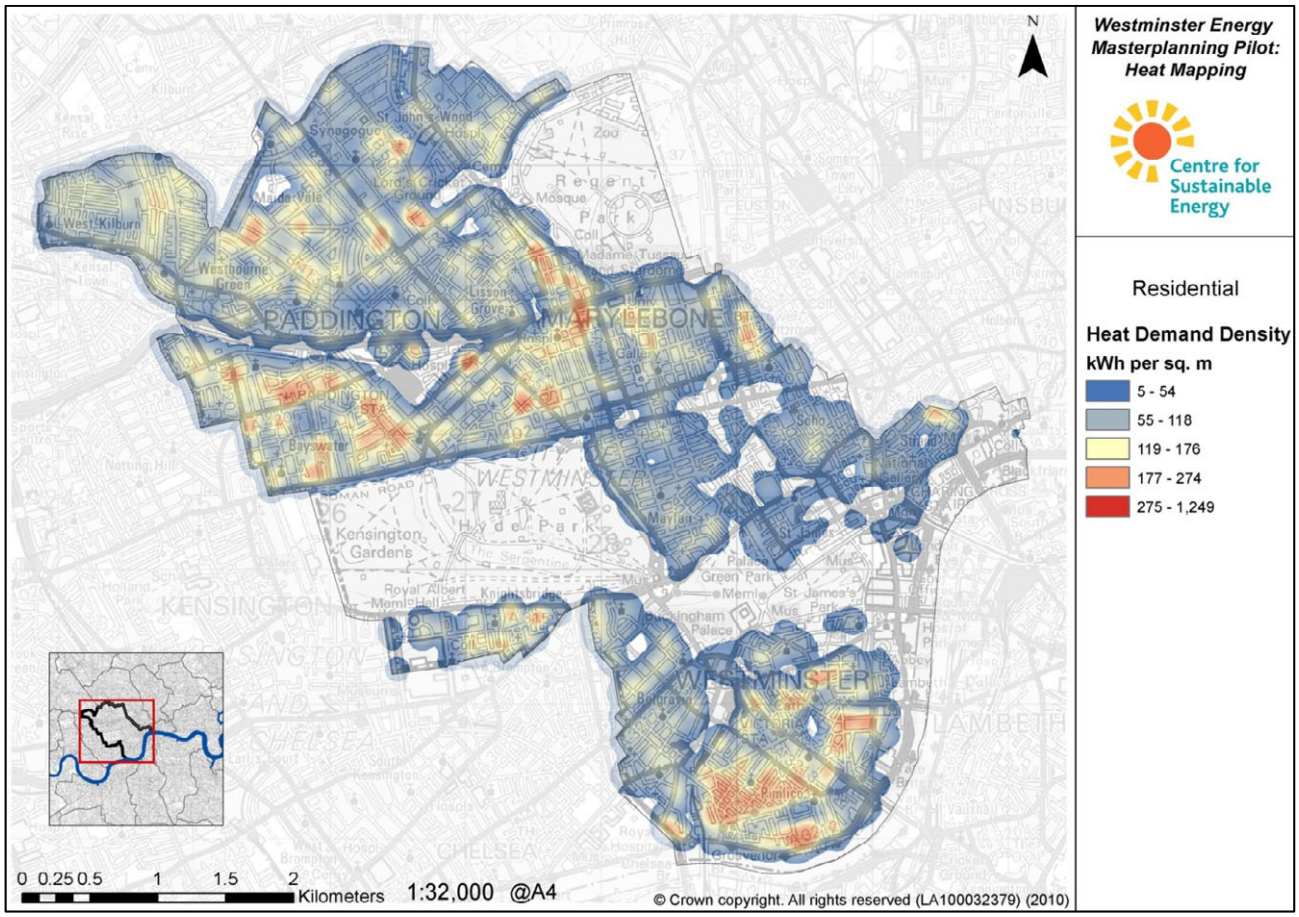


Map 1: Total heat demand density (all sectors)



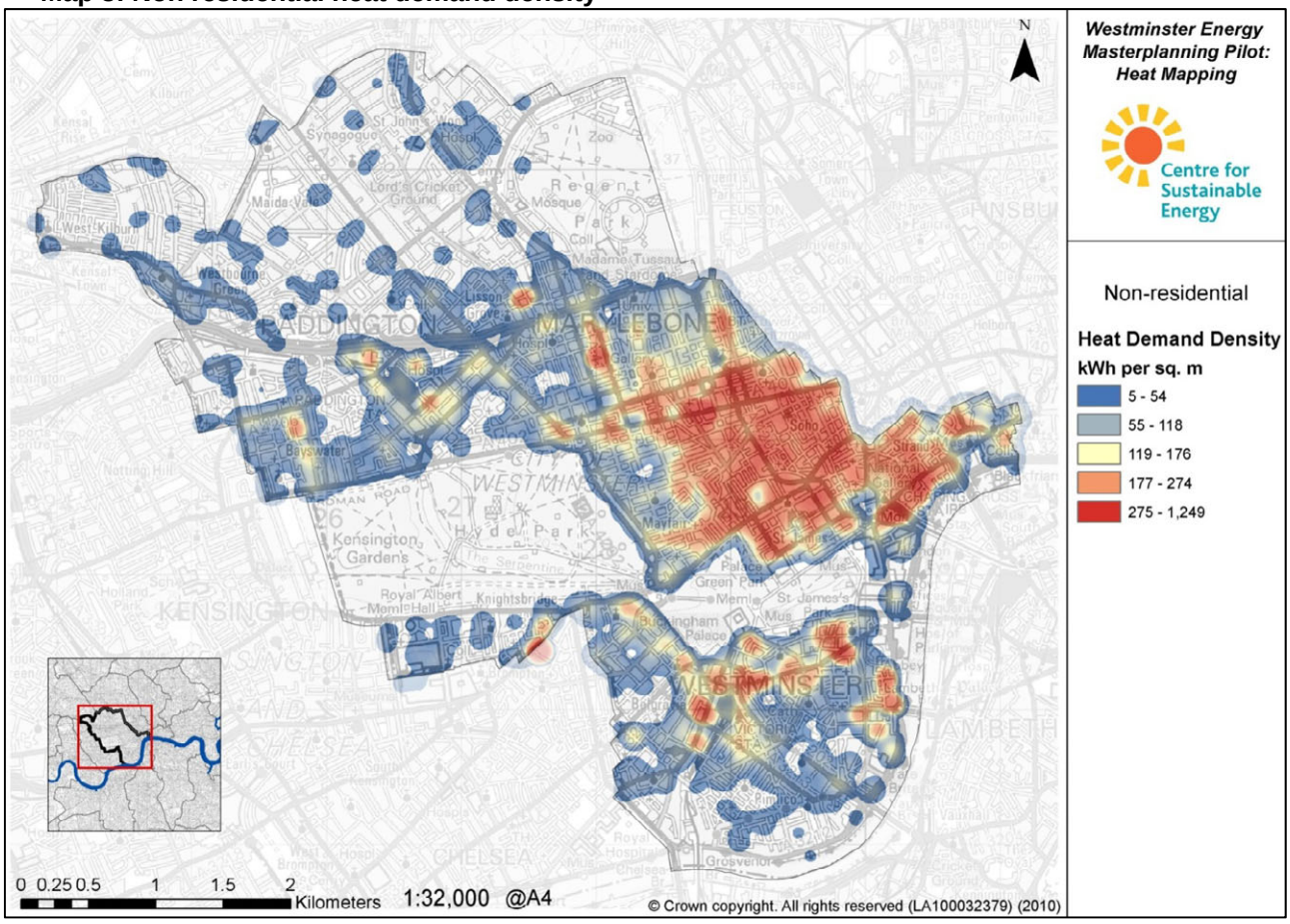
Map 1 shows total heat demand per square metre across Westminster. The colour coding shows areas of low heat demand density in blue, fading through yellow to red as heat demand density increases. This map demonstrates that heat demand density is correlated with building density, with the areas around Soho and Oxford street forming the largest block of high density heat demand.

Map 2: Residential Heat demand density



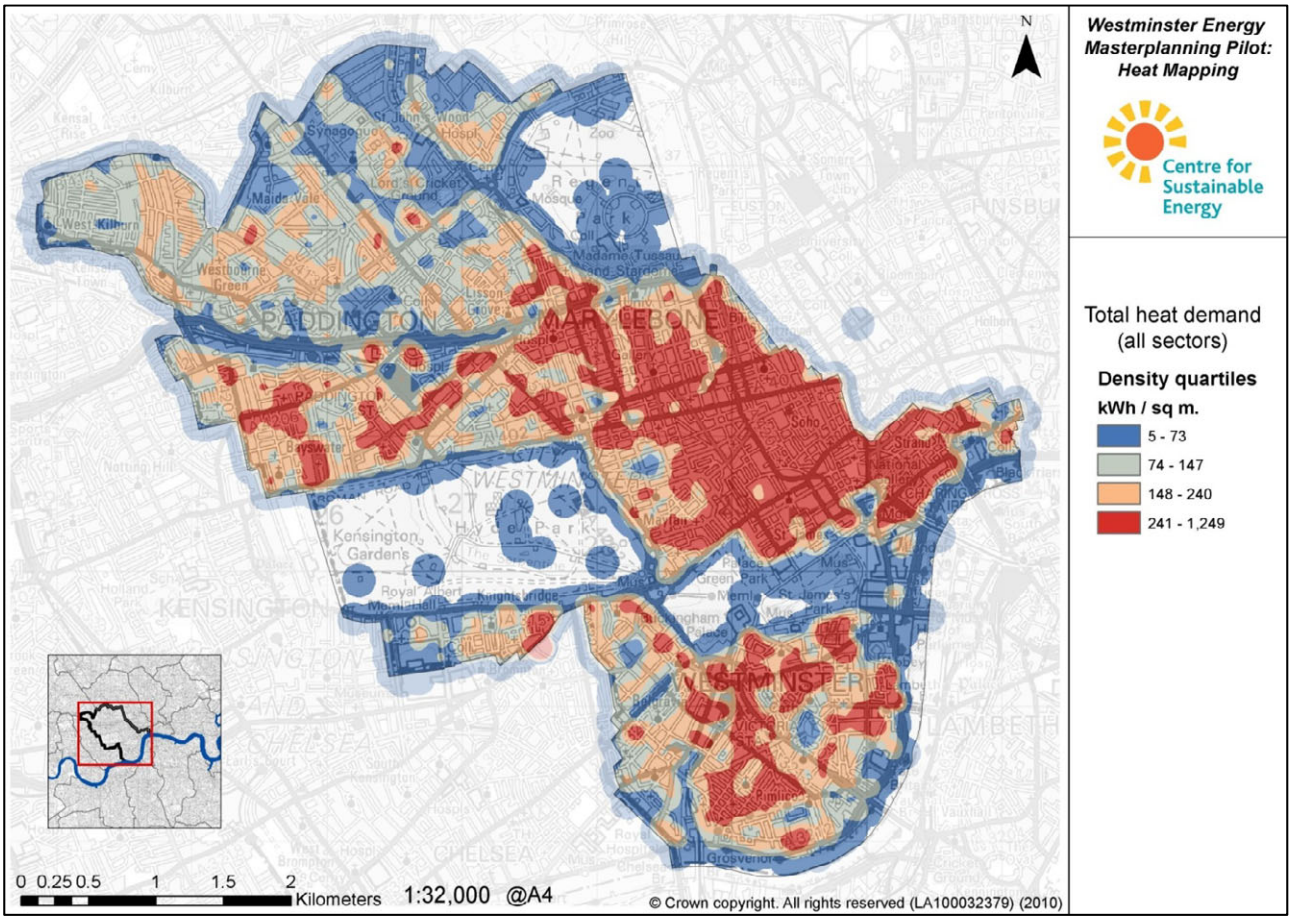
Map 2 shows the residential contribution to total heat density in Westminster. Here it can be seen that the areas of Pimlico, Marylebone, Paddington and Westbourne Park have the highest densities of residential heat demand. This contrasts with Map 3, which shows the non-residential contributions.

Map 3: Non residential heat demand density



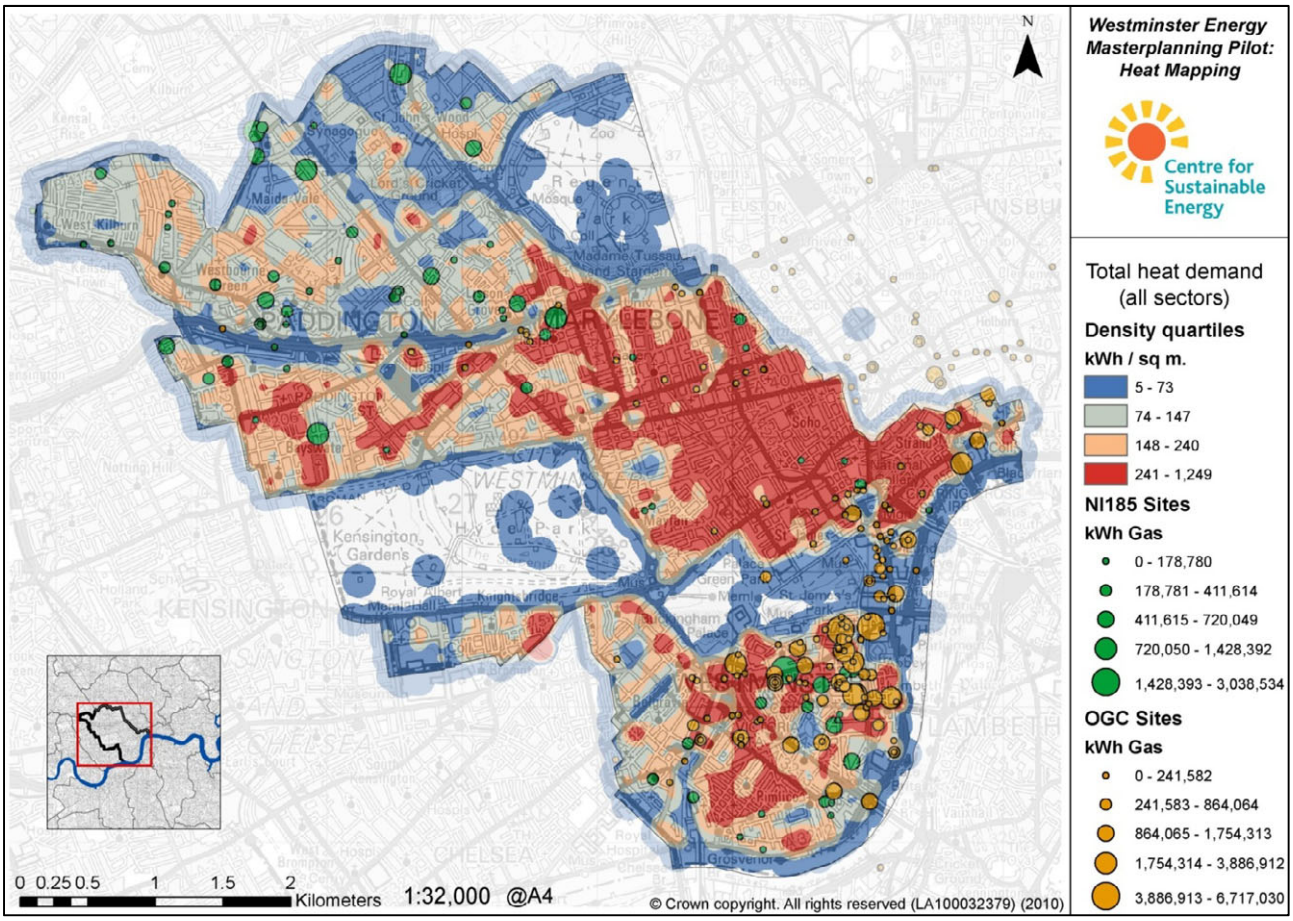
Map 3 shows the non-residential contribution to total heat density in Westminster. This is dominated by Office and Retail land uses.

Map 4: Total heat density quartiles



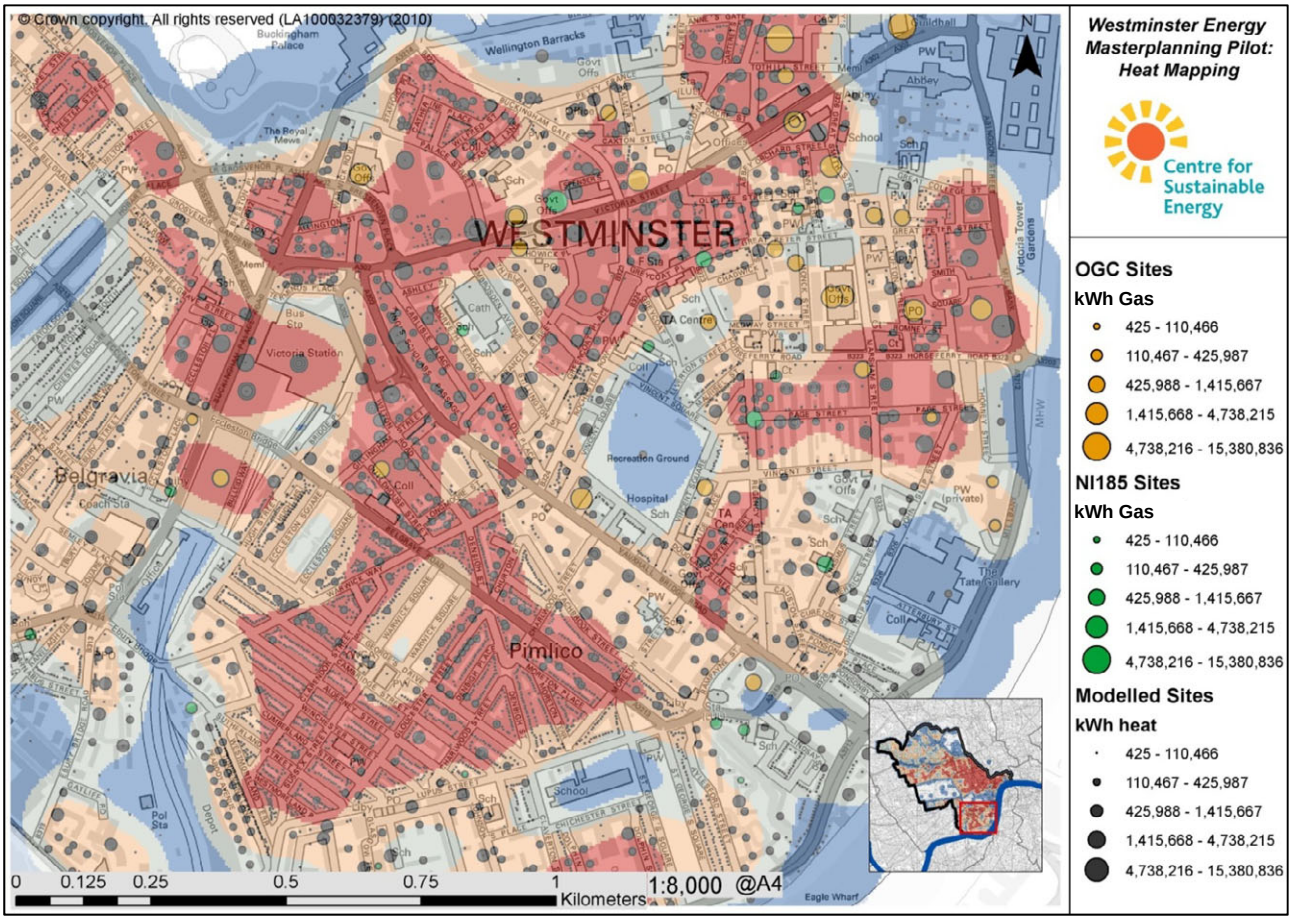
Map 4 shows total heat demand density, and is based on the same dataset as Map 1. However here the colour thresholds have been designed to create a simple 4-colour map, dividing the City of Westminster in four quartile areas based on heat demand density. This visualisation of the data makes it easier to identify the highest density areas, which can then be investigated in more detail.

Map 5: Heat density quartiles with NI185 and OGC site data



Map 5 shows the same heat density surface as Map 4, but overlays gas consumption data from local authority sites (NI185), and central government estate (Office of Government Commerce). This combination of data could be used to identify areas in which public sector heat demand could be used to initiate new heat distribution projects which would then potentially connect neighbouring buildings.

Map 6: Detail - South Westminster

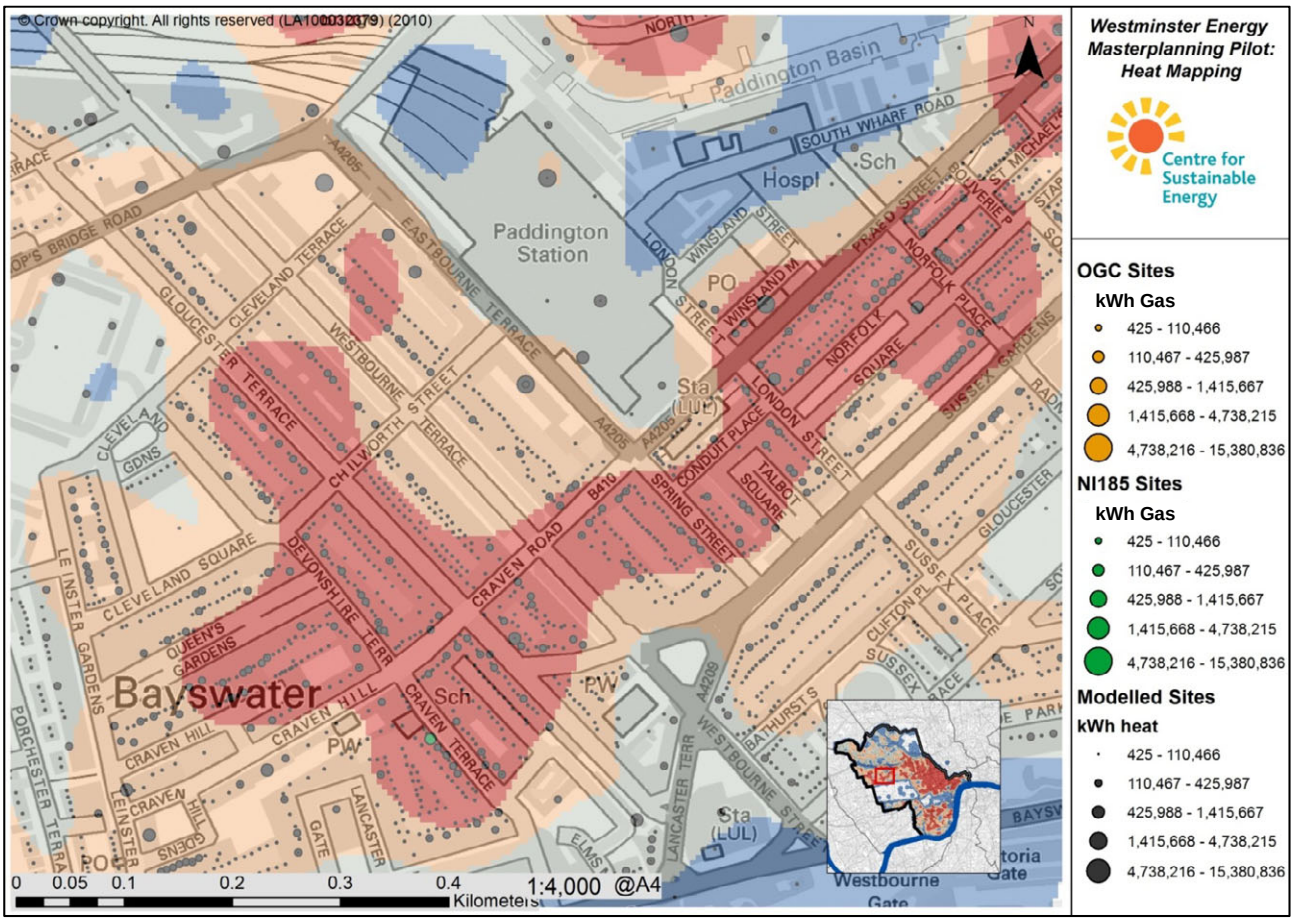


Map 6 shows the heat density quartiles in the area of Pimlico, and again overlays NI185 and OGC gas consumption. It also displays modelled heat demand for all other buildings, shown as grey circles.

Map 7: Detail - Bayswater

Maps 7 and 8 show the same information at smaller scales, for the Bayswater and Paddington areas.

Map 8: - Detail - Paddington

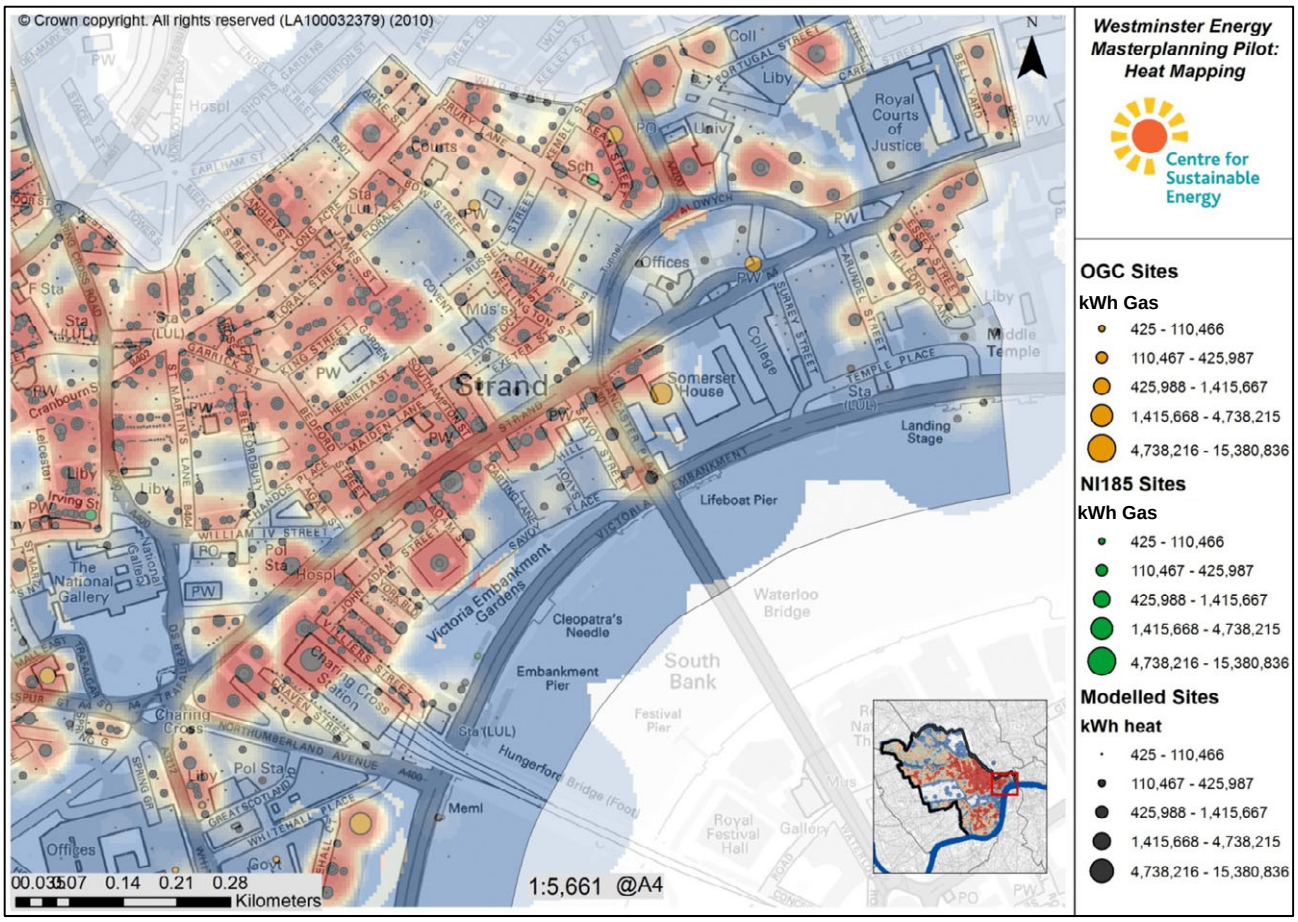


Maps 7 and 8 show the same information as Map 6 at smaller scales, for the Bayswater and Paddington areas.

Map 9: Detail -: Maida Vale (small area)

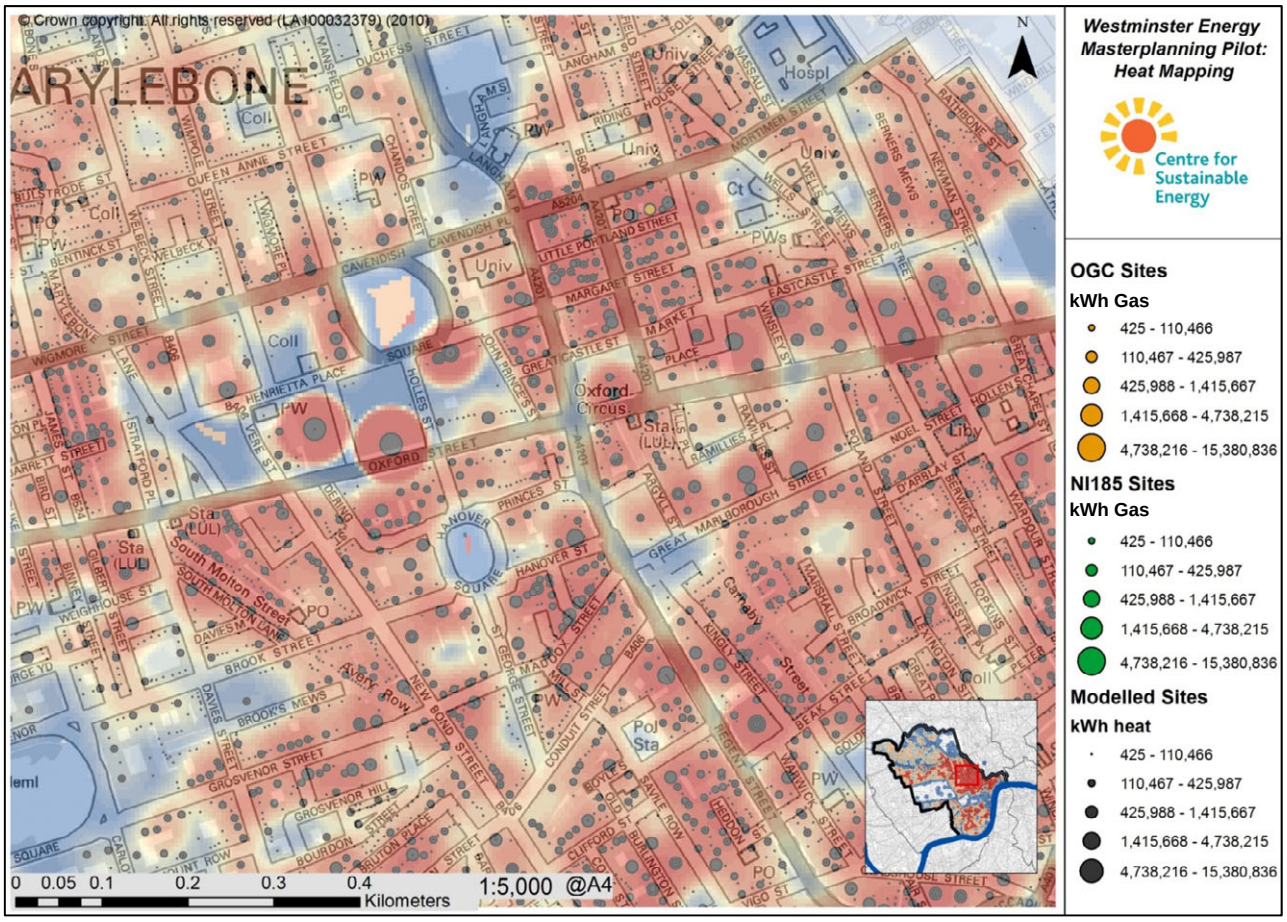
Map 9 is a very small scale (1:1,500@A4) map which illustrates the level of detail available from address-level heat mapping. This shows a very small area of Maida Vale in which the heat demand density is estimated to be in the top quartile of the whole of Westminster. This is due to the presence of high-density housing, which would appear worthy of further investigation as a potential heat distribution project opportunity.

Map 10: Detail - The Strand



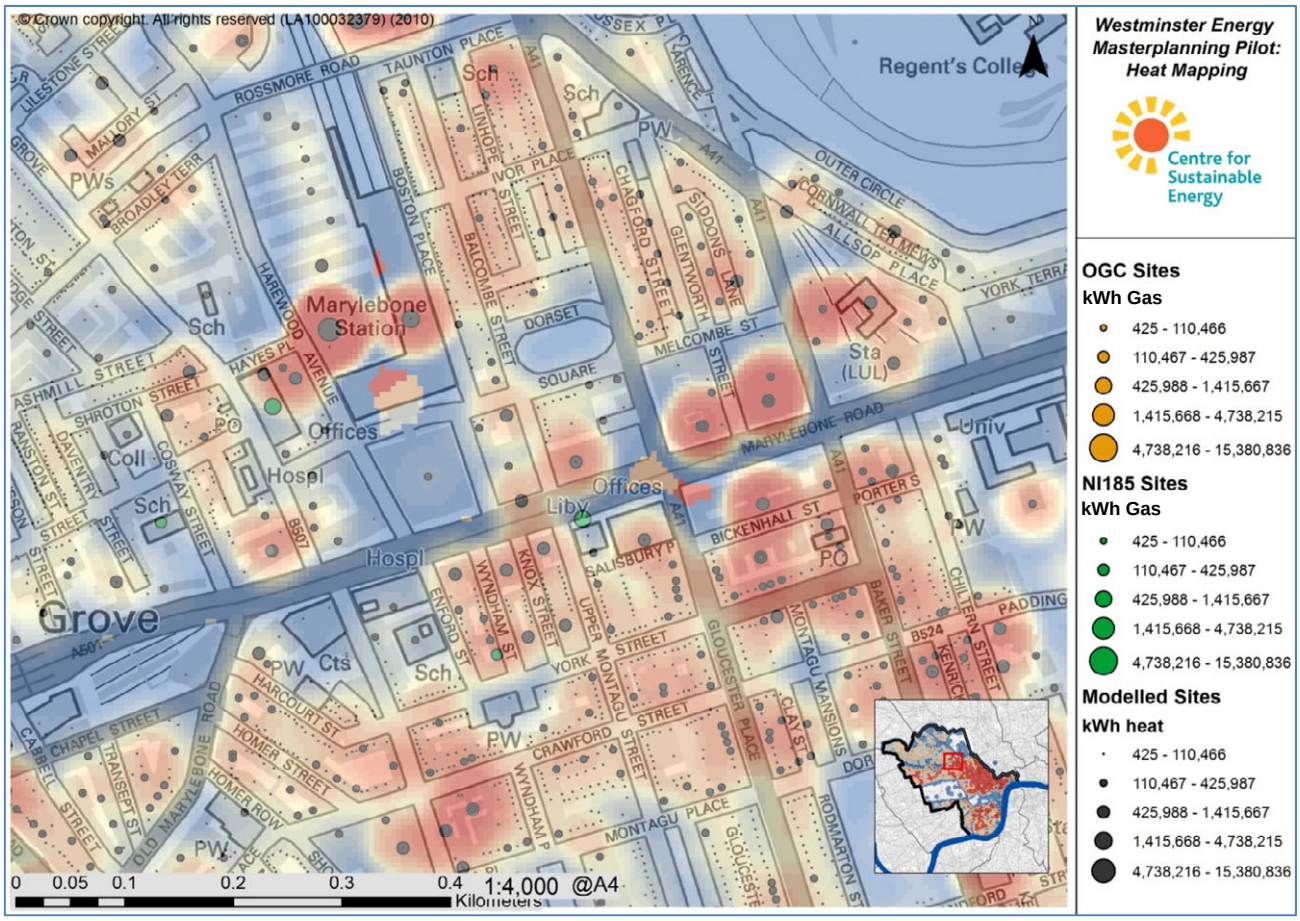
In contrast, Map 10 shows a wider area along the Victoria Embankment. This shows several clusters of high heat demand density, along with a number of government buildings (yellow circles). Investigation of this map in GIS software would allow further interrogation and identification of specific addresses. The heat density surface displayed in this map is similar to that in Map 1, and shows a more continuous scale than the quartiles used in Map 4.

Map 11: Detail - Oxford Circus



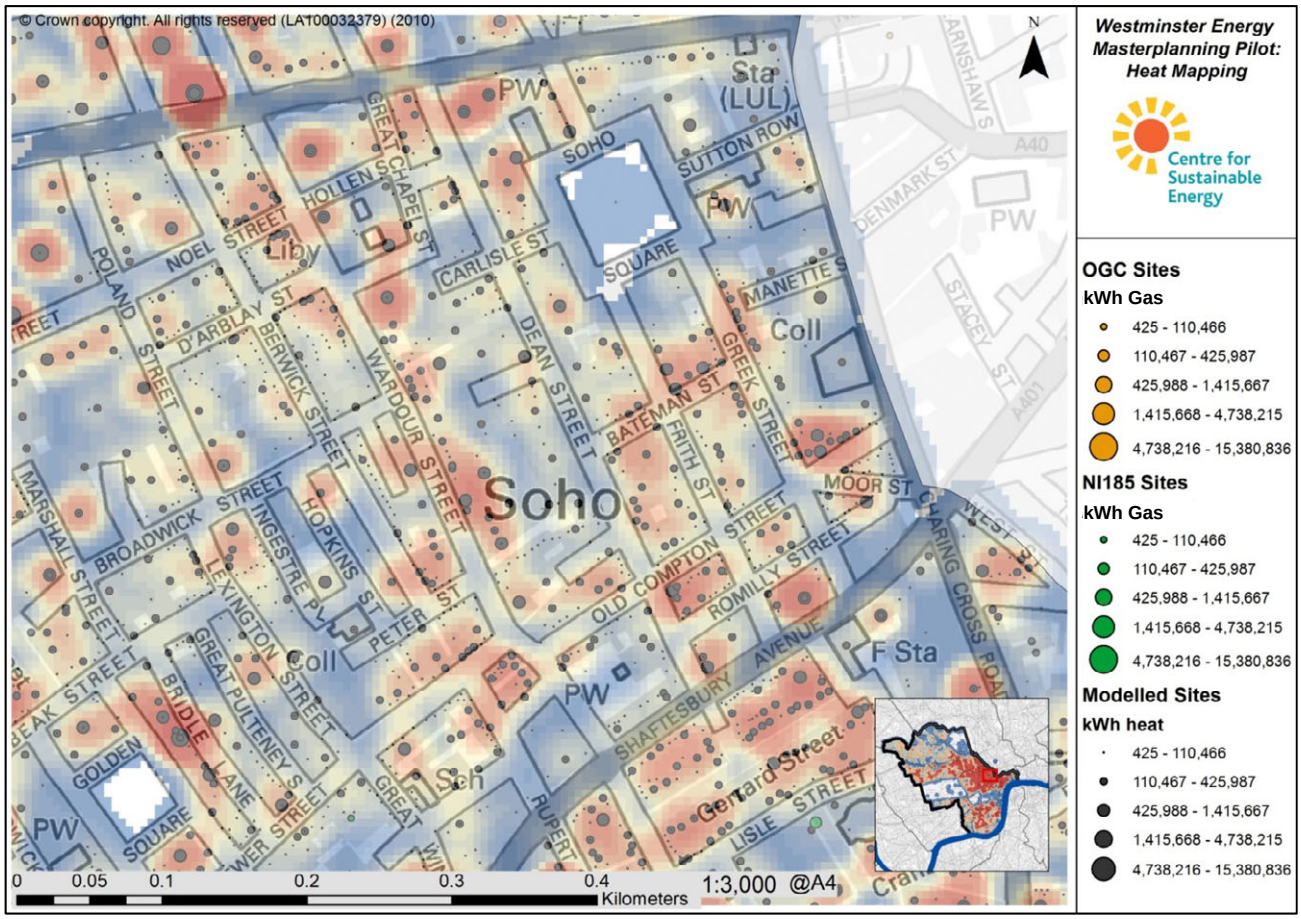
Map 11 shows an area of about one square kilometre with Oxford Circus at its centre. It is clear from this map that there are large number of buildings in the area which would be expected to have high heat demand, probably dominated by retail and office uses. Further investigation of this area could be undertaken to indentify the most promising opportunities. Again, the heat density surface displayed in this map is similar to that in Map 1, and shows a more continuous scale than the quartiles used in Map 4.

Map 12: Detail – Marylebone



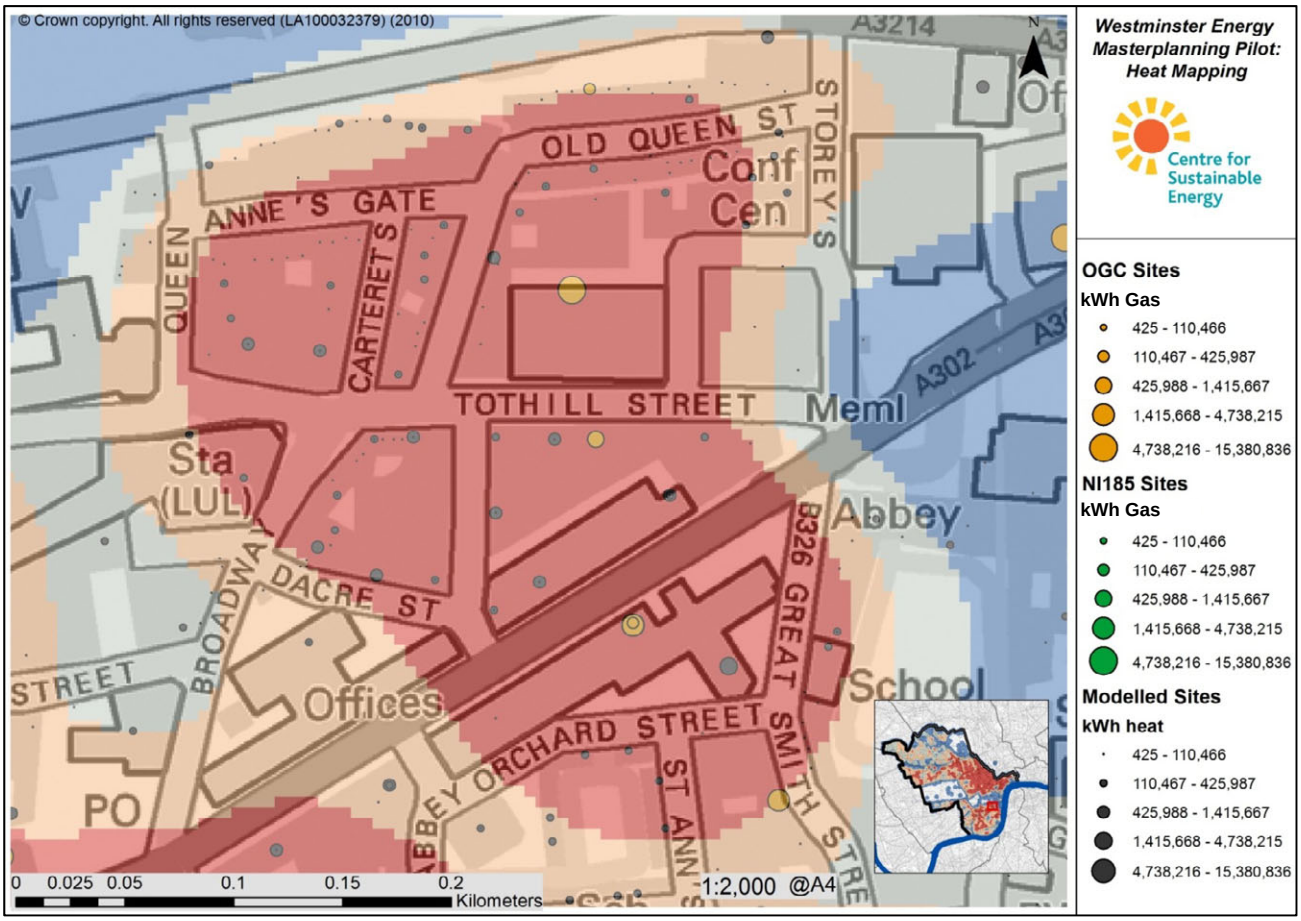
Map 12 also shows an area of about one square kilometre, this time centred on the intersection of Marylebone Road and Gloucester Place. This area is less densely built-up, and consequently easier to interpret at the displayed scale than Map 11.

Map 13: Detail – Soho



Map 13 also shows a heat demand density map of Soho. The map suggests several linear heat density patterns which warrant further investigation – for example, Wardour Street North West of Peter Street, Bateman Street, and Bridle Lane.

Map 14: Detail – Tothill Street



Map 14 is a small scale view of a cluster of buildings south of St. James's Park, just East of the Tube station. The central area of the map is in the top quartile of heat demand density for Westminster as a whole, and includes several government estate buildings.

Conclusions

The Westminster Energy Masterplanning pilot heat mapping study has established the feasibility of wide-area heat mapping at address-level based on publicly available datasets.

It has further demonstrated that an address-level heat demand geodataset can be used effectively to identify heat distribution potential at a range of scales - the same underlying dataset permits area-wide analysis (e.g. Maps 1-5), extremely detailed local analysis (e.g. Maps 9 and 14), and investigation at levels between these (e.g. Maps 6-8 and Maps 10-13).

This process can be enhanced by overlaying a range of other geographic data, such as:

- Locations of buildings with known heat loads (such as the NI185 and OGC datasets shown in the Maps above)
- expected locations for new development (e.g. SHLAA or non-residential pipeline data)
- locations of existing / proposed heat sources
- existing / proposed heat distribution routes

These and other datasets can be combined with the underlying heat density surfaces and address-level point modelled demand data to support the achievement of several objectives:

1. In the planning system:
    a. Supporting planning policy development at all scales, by providing spatial evidence in support of policy objectives and targets
    b. Supporting development control officers in negotiations with developers where the surrounding heat demand 'context' of the proposal is relevant to conditions being sought by planners

2. In the development of decentralised energy systems:
    a. 'Prospecting' for heat distribution project opportunities
    b. Identifying target areas of high potential
    c. Identifying specific addresses for further contact and data collection
    d. Shortlisting potential distribution routes for further investigation

In applying the data to these questions, it is important to note that the heat map is a set of *modelled estimates* of heat demand. It is not a replacement for collecting actual heat demand data where these are required for the detailed assessment of local projects, but rather as a tool for optimising the considerable effort required to collect such data, and for allowing assessment of the distribution of heat demand in its absence.

We believe that the address-level mapping heat demand modelling and mapping presented here adds significant value compared with previous approaches (i.e. those based on arbitrary geographies such as grid squares or census output areas). Nevertheless there are ways in which the methodology which can be improved.

In the short term, adjustments should be made to the site and employment based calculation of heat demand, which would mitigate the current underestimation of non-residential heat demand (see page 15), which affects hospitals in particular. This could be done as a relatively straightforward adjustment to the existing model.

There is also a range of more significant enhancements that could be introduced. As set out in Section 5, different approaches are taken to estimating the heat demand of a given address,

depending on the information available to describe it. The types of information available to the model include:

1. address-specific data (floorspace and usage)
2. postcode-level data (predominant age, built form, size and tenure of housing)
3. Lower Super Output Area level data (SIC-based site and employment data)

The model combines the best (most specific) available information on an address with benchmarks which are used to convert that information into kWh of heat demand (see Section 5 for more detail on this process).

There are therefore two ways to improve the output dataset:

1. increase the geographic resolution of the input data – that is, maximise the proportion of addresses modelled using address-specific information, and minimise the proportion of addresses relying on LSOA-level data.
2. improve the quality of the benchmark data used to convert address characteristics into kWh of heat

We would recommend pursuing both these strategies. Specifically, the following steps are feasible, and would improve the accuracy output dataset:

Increasing spatial resolution of input data

1. Move from postcode to address-specific information describing the characteristics of residential premises

2. Increase the proportion of rateable premises modelled using floorspace data by improving the address-matching between the VOA floorspace database and the NLPG address database. The match rate is currently 70%, and could probably be increased to around 85% (or higher if using the 2010 VOA database). Currently rateable premises for which a match has not been found are modelled using LSOA-level site and employment data.

3. Further reduce the number of non-rateable premises modelled using LSOA-level site or employment data, by undertaking a systematic actual heat demand data collection exercise covering the public sector premises (which are generally non-rateable). This would cover key address types including swimming pools, schools, hospitals, police and fire stations, social housing, and central and local government estate (these latter two were mapped for the current project, but were not integrated into the modelling process). Ultimately, the LSOA-level modelling would then be used only where no other data sources were available.

4. Build the collection of actual site heat demand data into a web interface to share the mapped results, and support the development of a community of users around the project. Over time this would allow actual heat demand data to supersede modelled data – the collected data would be integrated into the main results dataset, feeding into updated heat density surfaces reflecting the collected data.

Improving benchmarks

5. Review and refine the approach taken to creating residential heat demand benchmarks from the English Housing Condition Survey and the Expenditure and Food Survey (see Section 5

for more detail). This currently uses classification based lookups – however more sophisticated approaches could be deployed, such as regression or multiple imputation modelling. In addition, new datasets could be introduced, such as the Energy Demand Research Project domestic gas and electricity consumption database.

6. Over time, use local heat demand data to develop new benchmarks which can then be applied to similar premises, but for which heat demand data is not known.

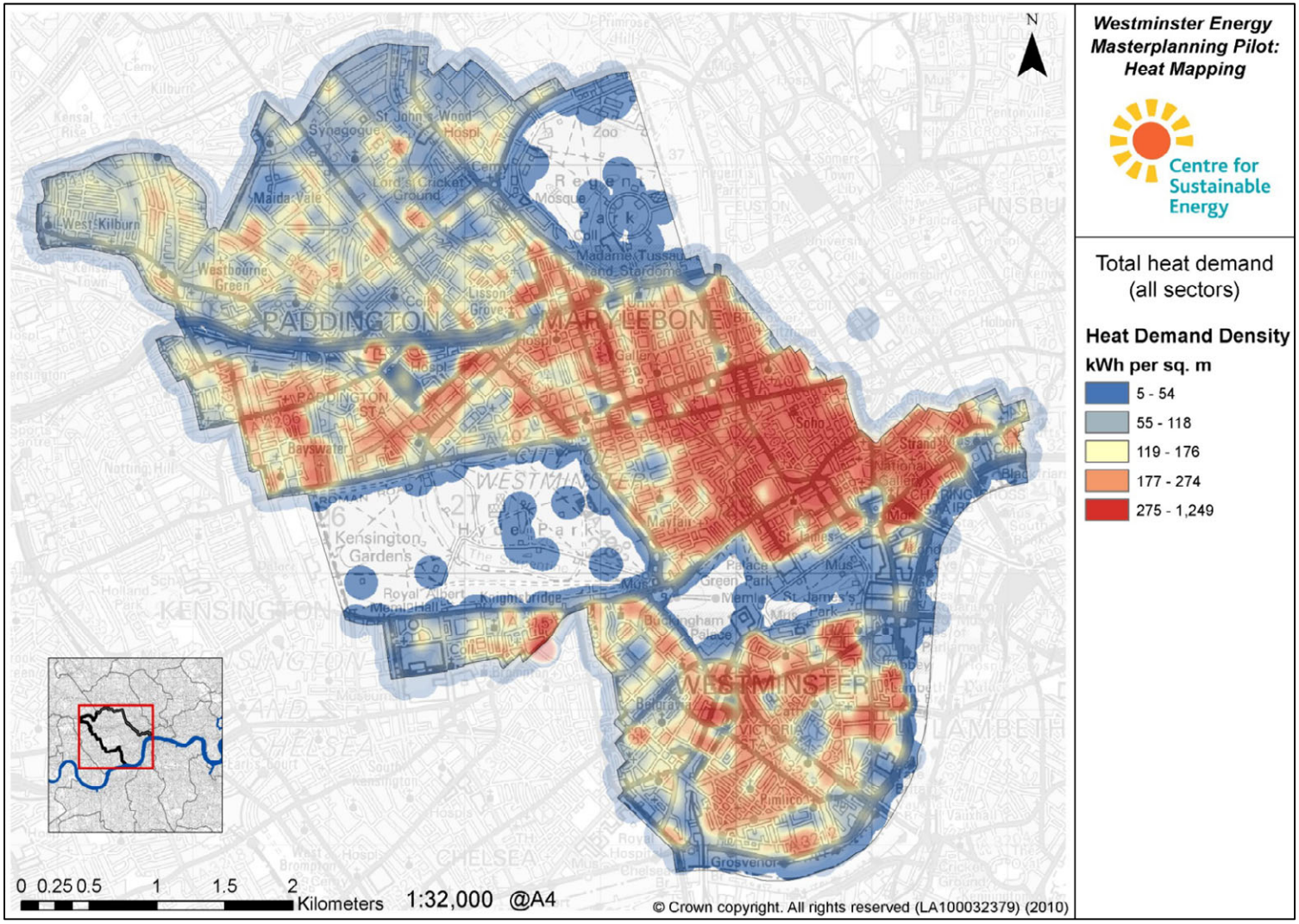
Load profile analysis

7. Finally, it is also possible to introduce load profile information at address-level, by applying a set of standard load profiles based on address-categories (e.g. 'Office', 'School', 'Hospital', etc). We have demonstrated this approach in recent work in the South West (see www.southwestheatmap.co.uk); it permits area-wide identification of zones with relatively flat profiles, as well as allowing the assessment of load profile across a specific set of selected addresses.

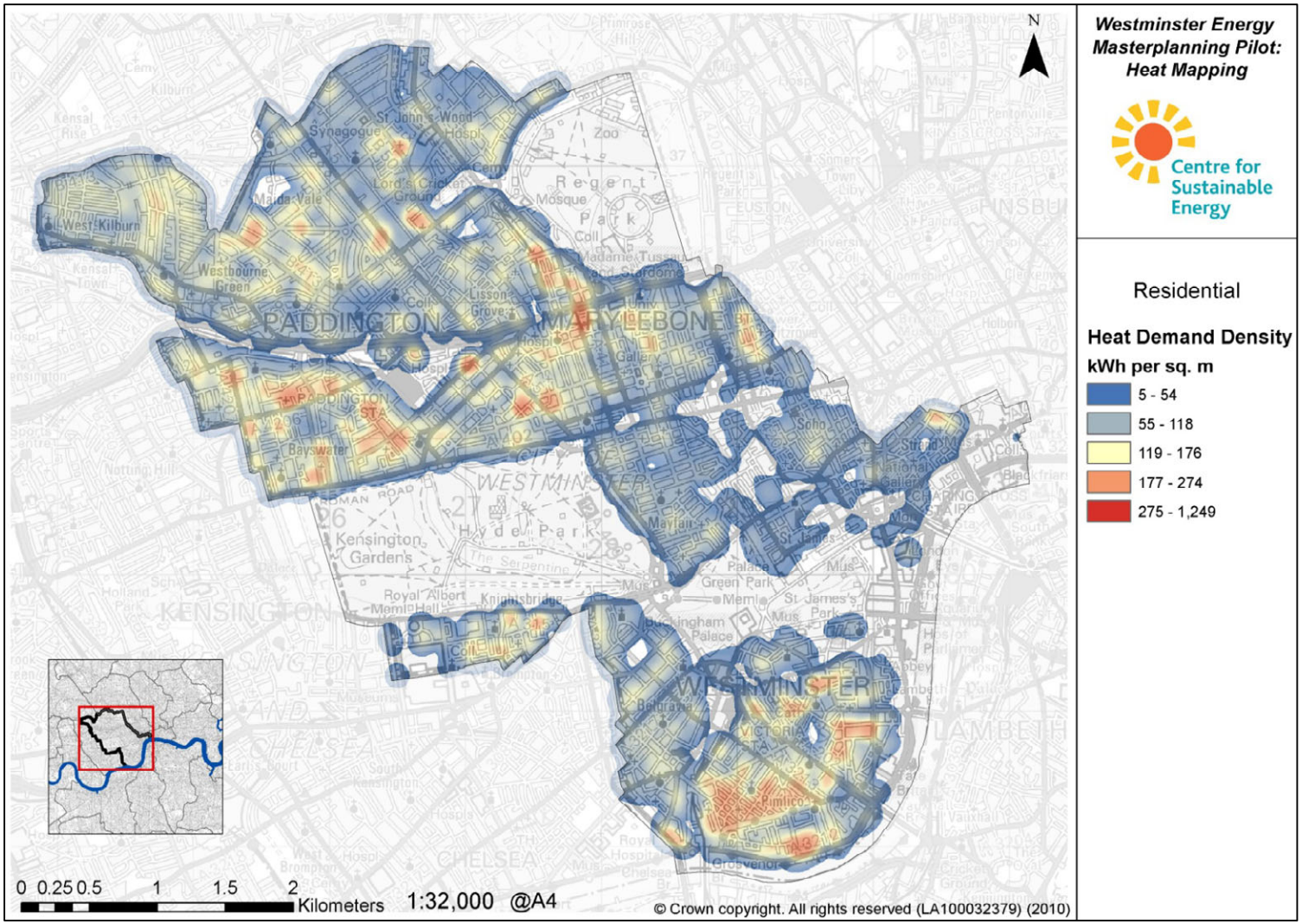
Annex 1: Data inputs, vintages, and update frequencies

Dataset	Use in model	Vintage	Update Frequency
National Land and Property Gazetteer	Definition of building geography, classification of all address types	H1 2009	6 monthly
VOA commercial floorspace database	Classification of rateable address types, quantification of floorspace	2005	5 yearly
Town Centre Intelligence	Classification of commercial address types	W1 February 2010	Weekly
Residata	Classification of residential address types	2004	Annual (1 year lag)
ONS Annual Business Inquiry	Geographic Employee and Site count data by SIC code	2008	Annual (2 year lag)
Derived from DECC statistics	Per-site and per-employee heat demand benchmarks by SIC code	2007	Annual (2 year lag)
CIBSE Guide F	Floorspace heat demand benchmarks	tbc	tbc
English House Condition Survey	As input to derivation of residential benchmarks	2004-2006	Two-yearly (two year lag)
Expenditure and Food Survey	As input to derivation of residential benchmarks	2007	Annual (2 year lag)

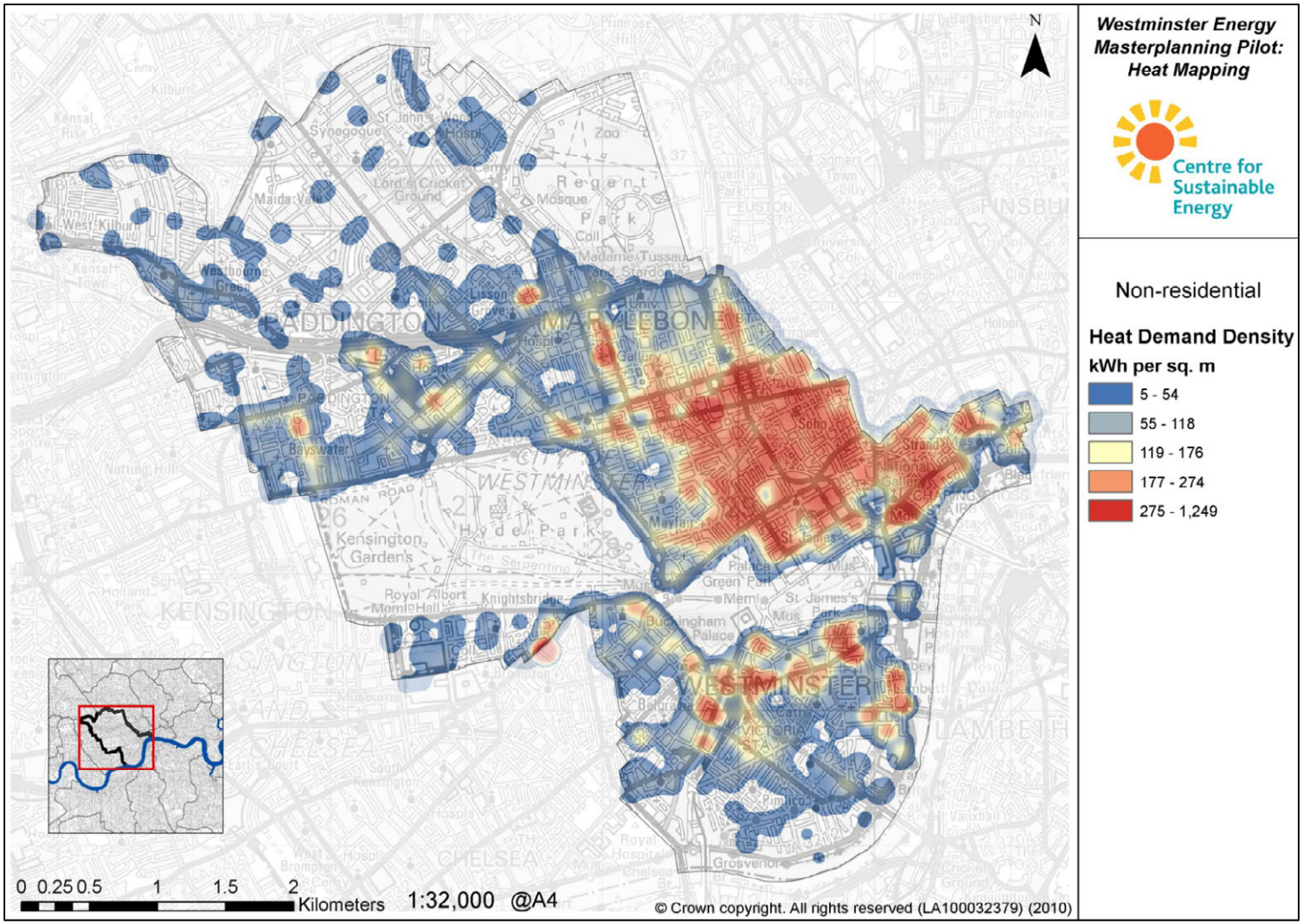
Annex 2: Full page maps



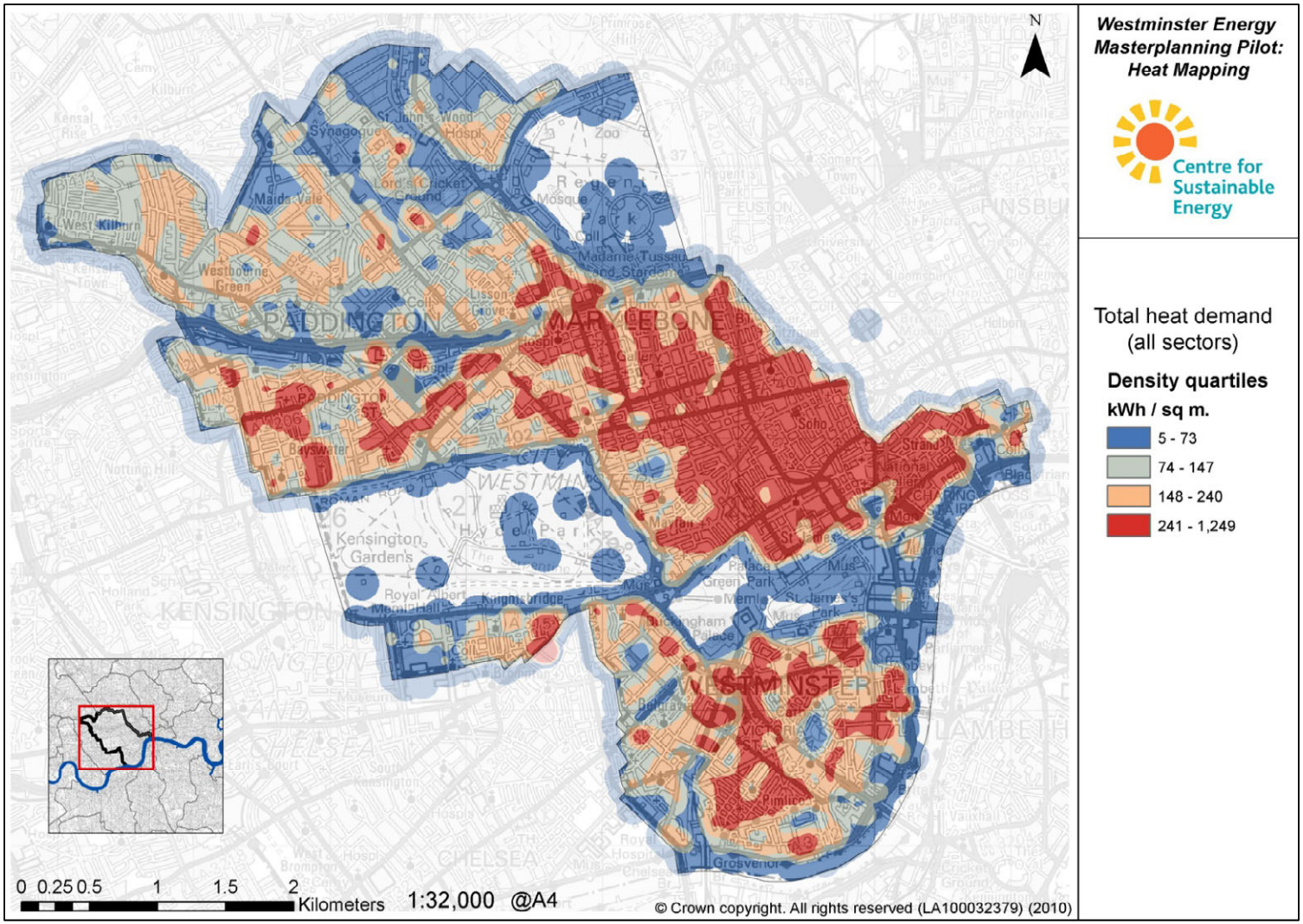
Full size map 1: Total heat demand density



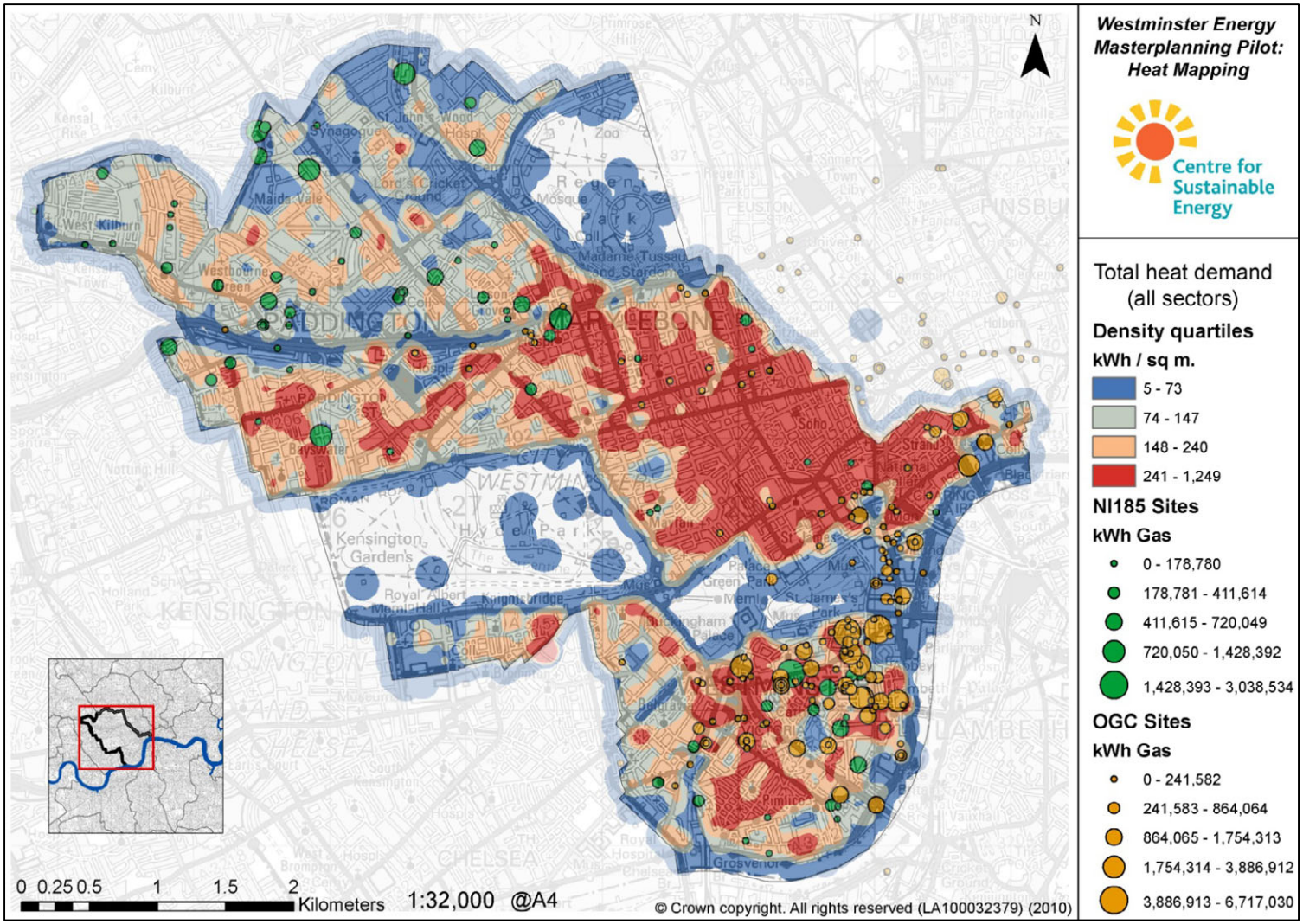
Full size map 2: Residential heat demand density



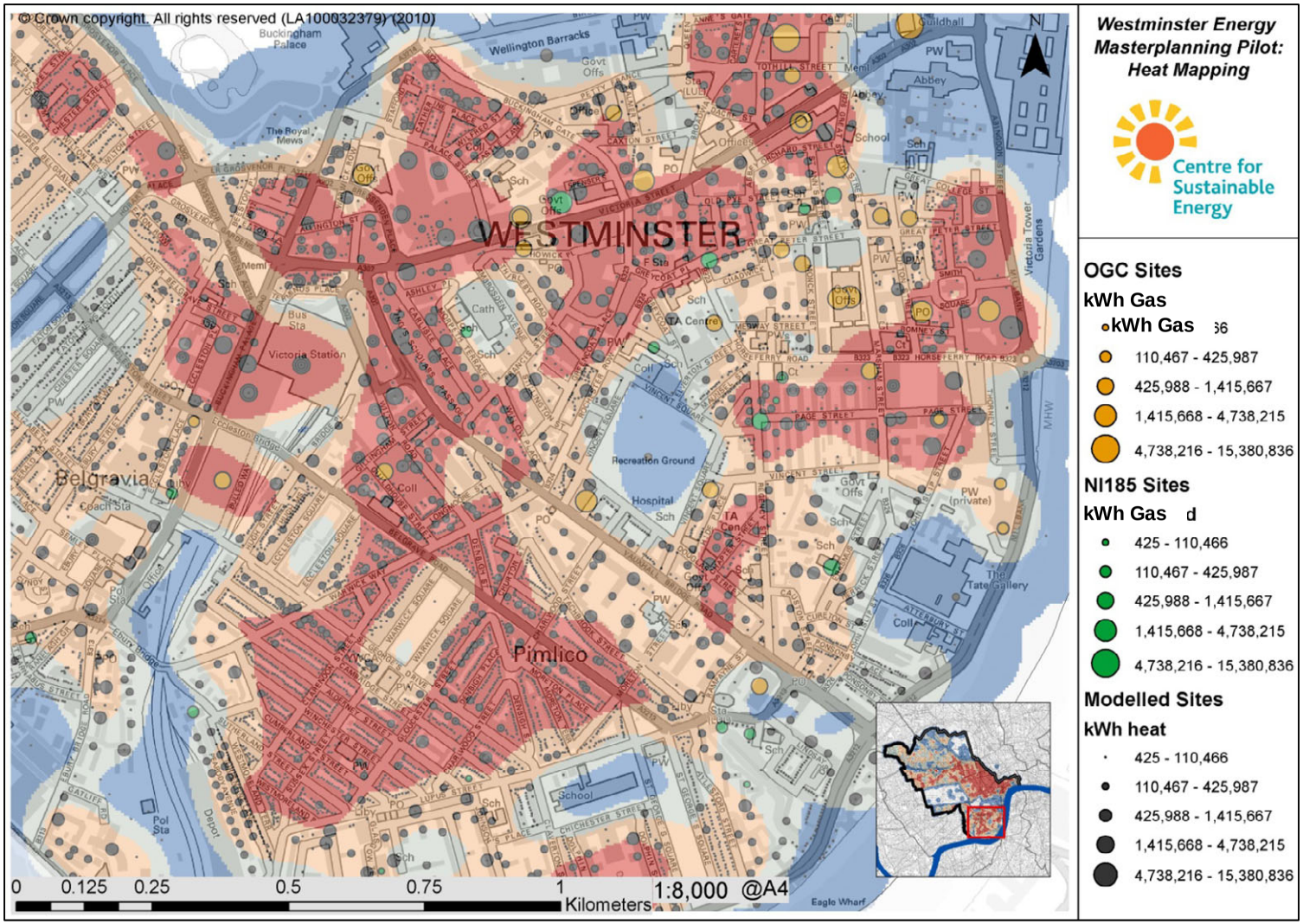
Full size map 3: Non-residential heat demand density



Full size map 4: Total heat demand density - Quartiles

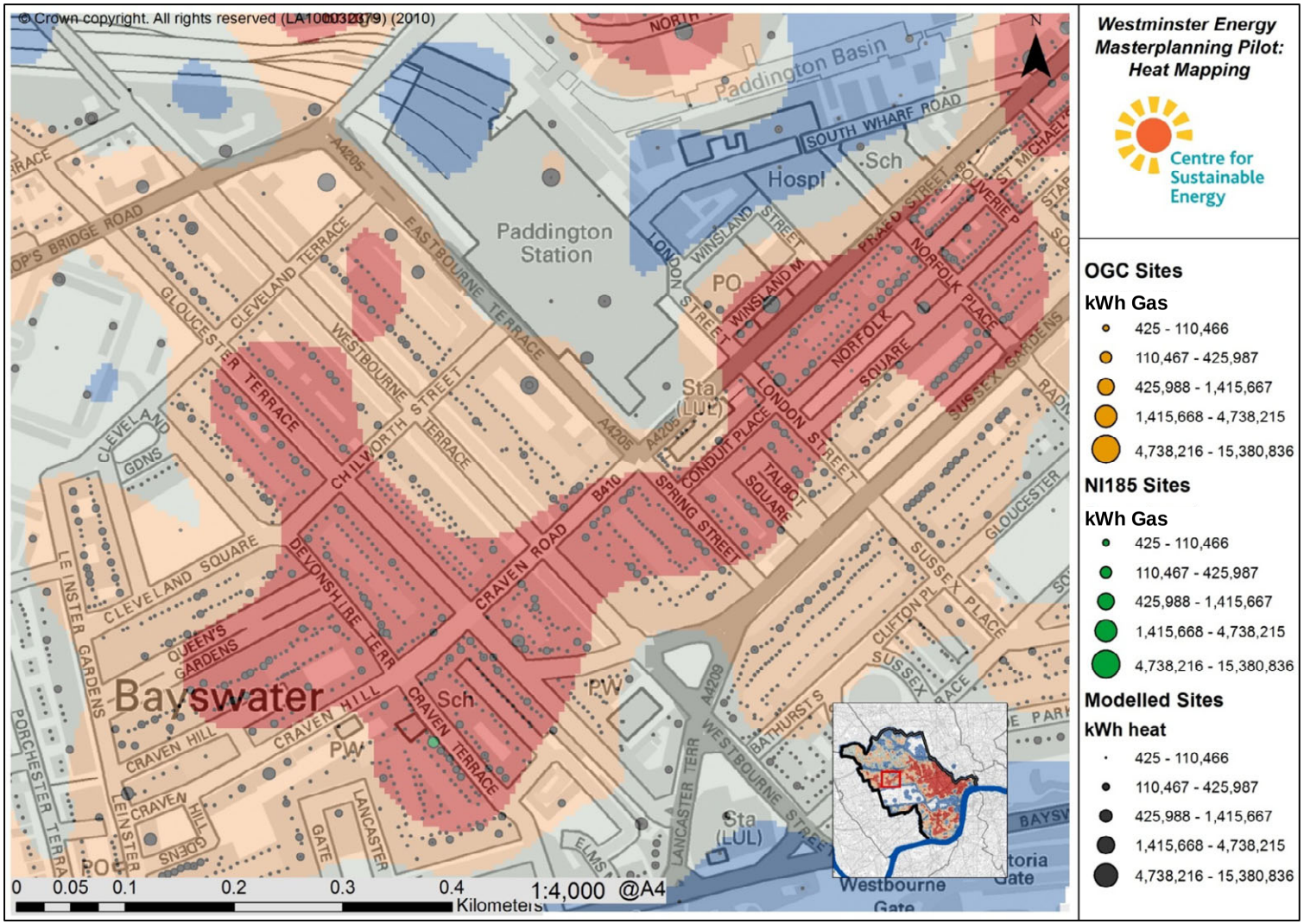


Full size map 5: Total heat demand density - Quartiles with local data

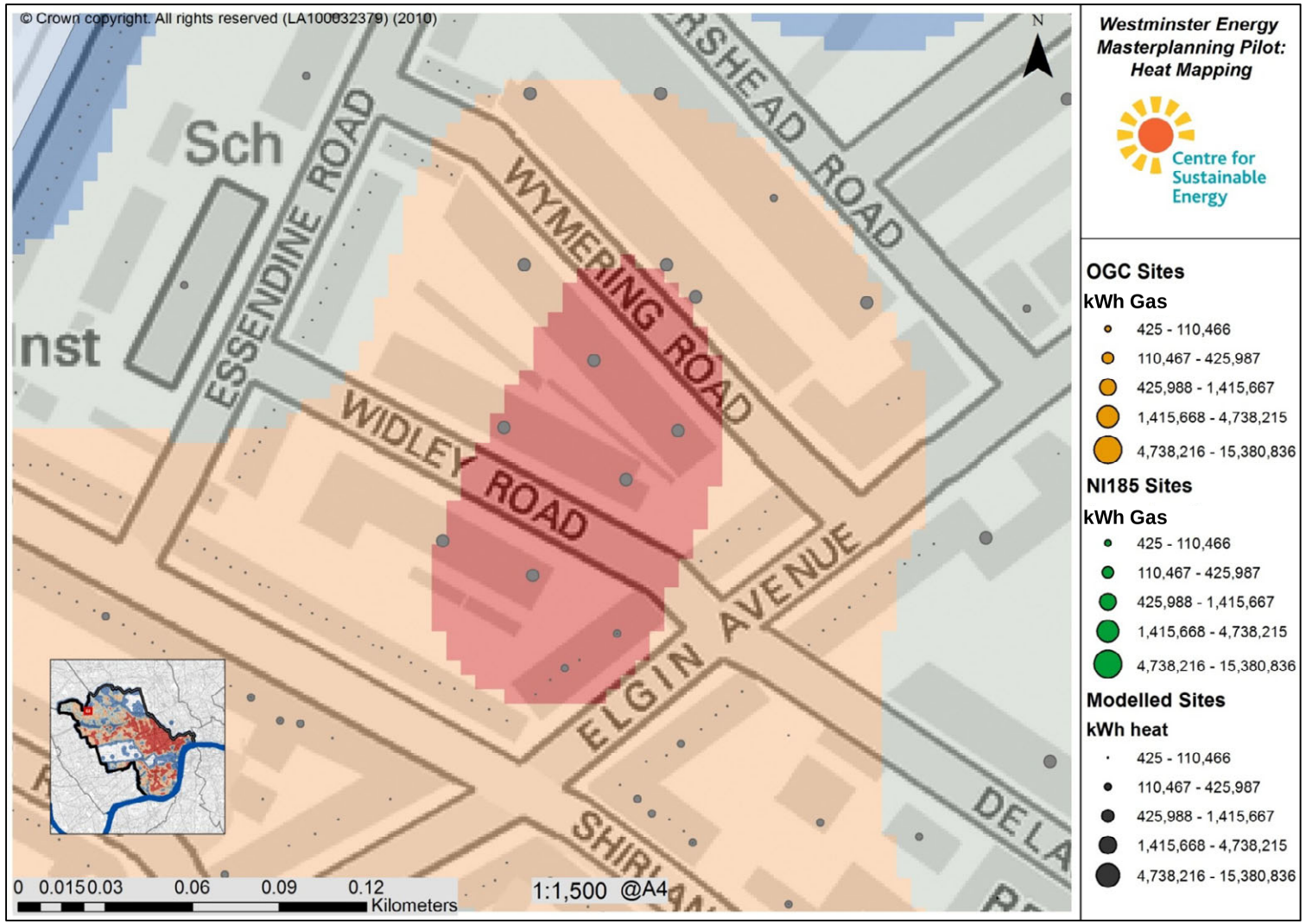


Full size map 6: Detail - South Westminster

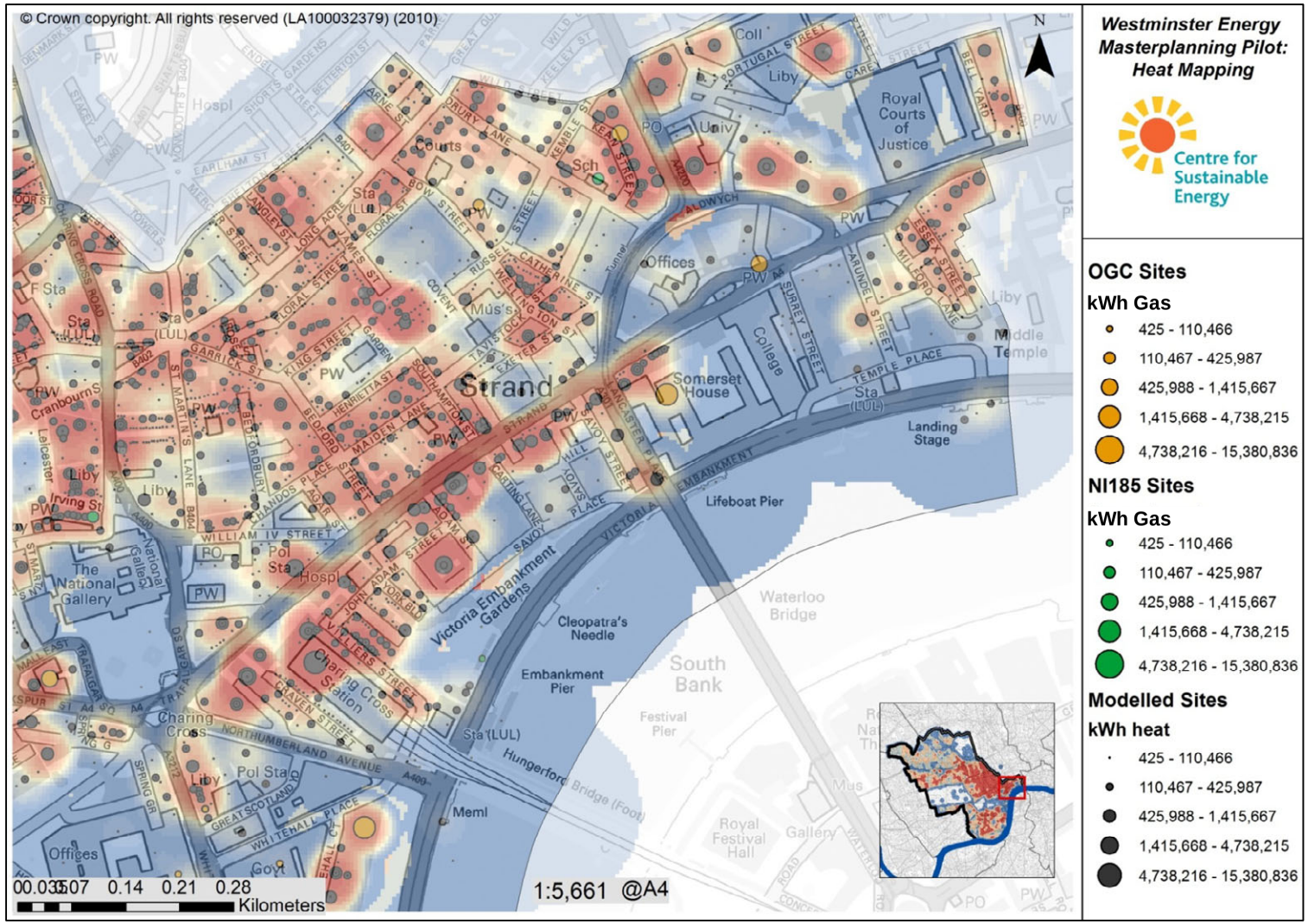
Full size map 7: Detail - Bayswater



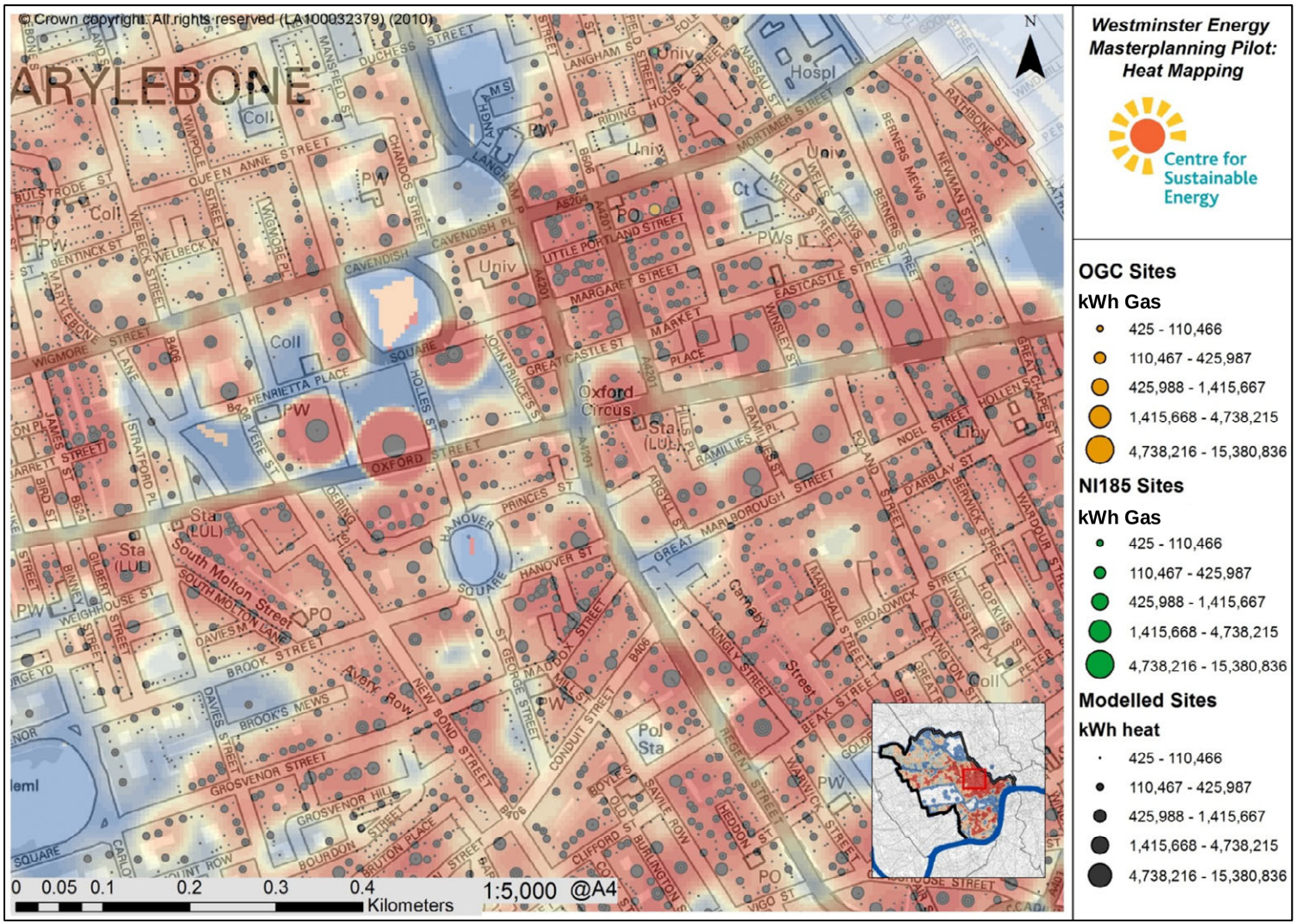
Full size map 8: Detail - Paddington



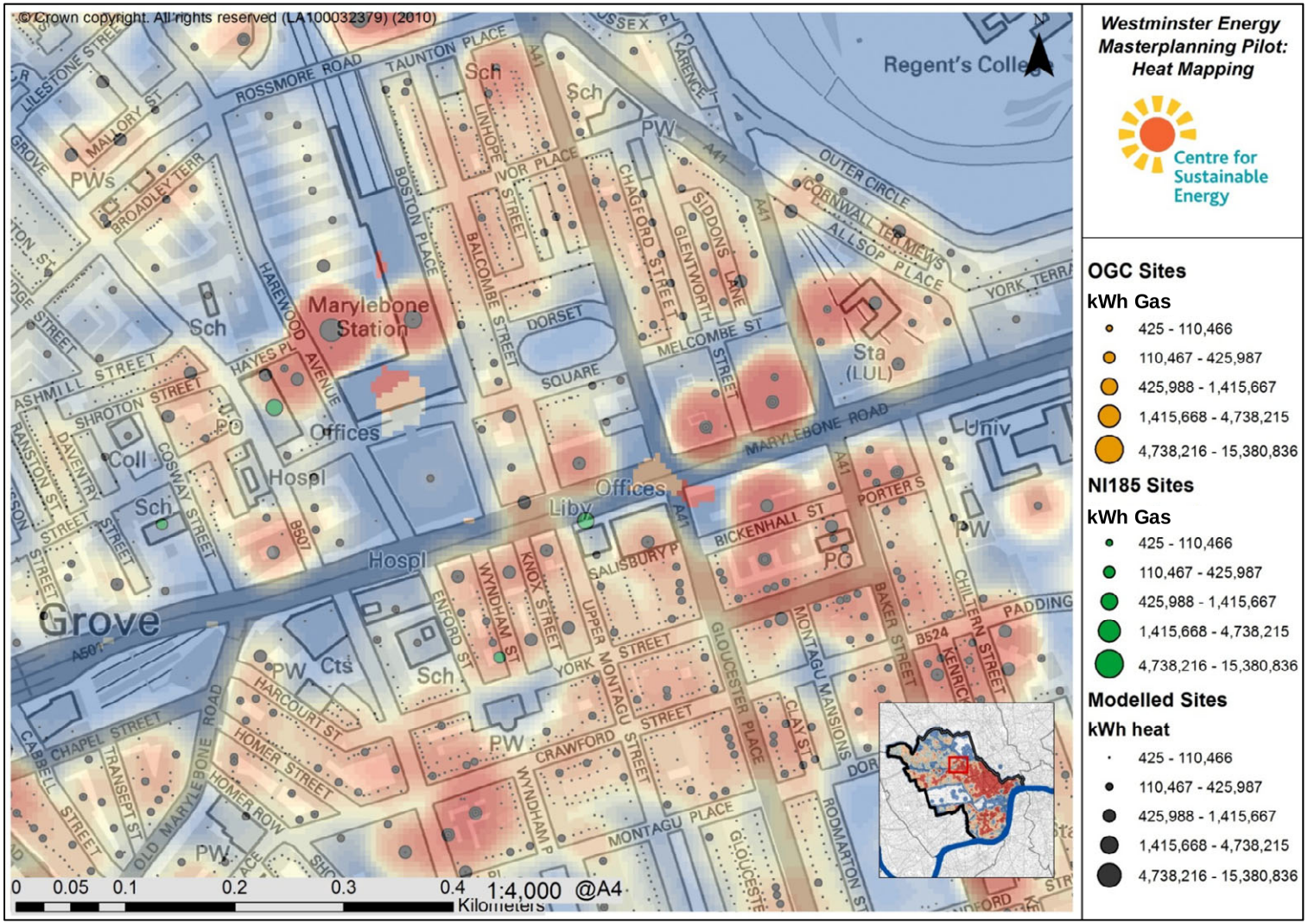
Full size map 9: Detail - Maida Vale (small area)



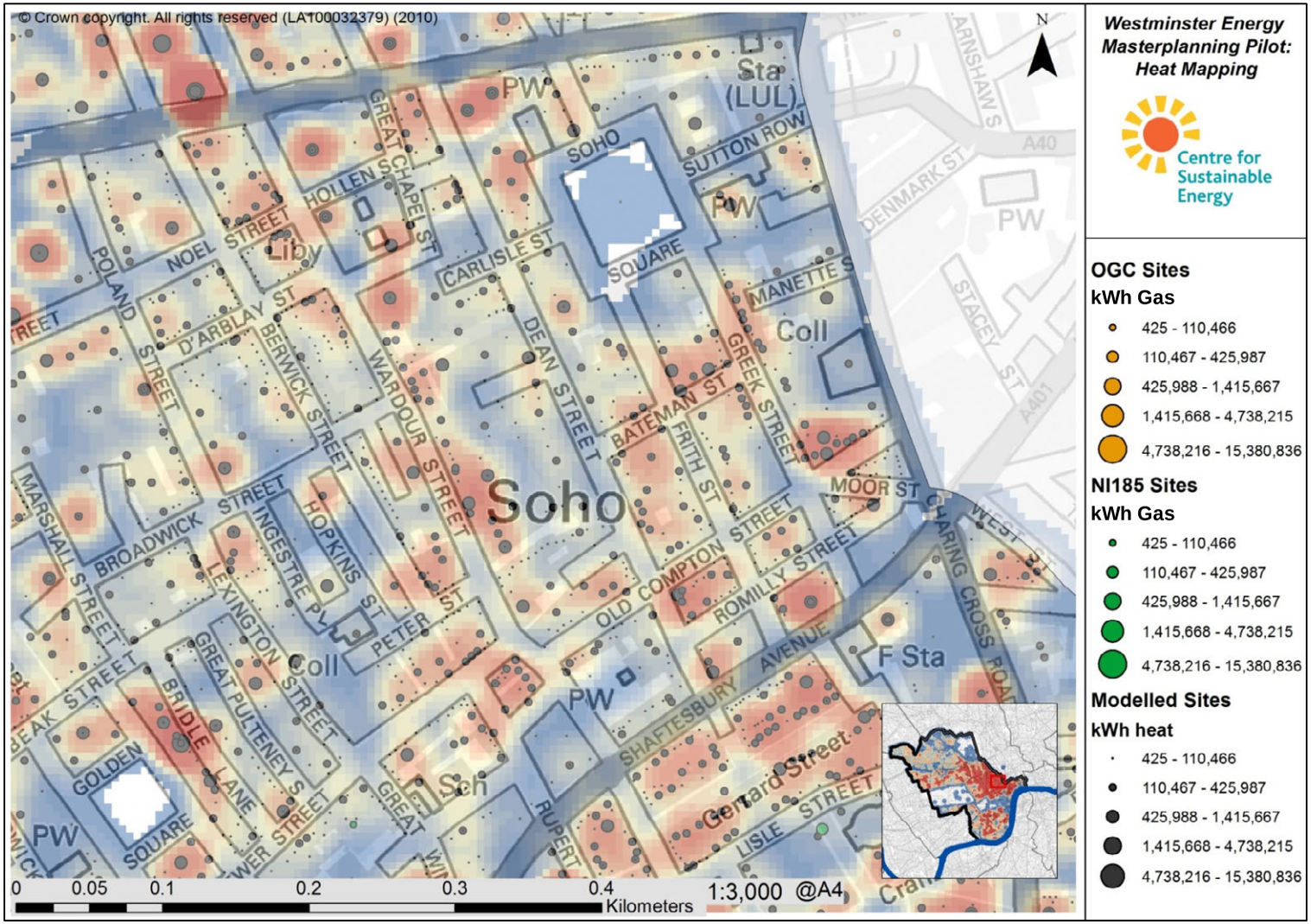
Full size map 10: Detail - The Strand



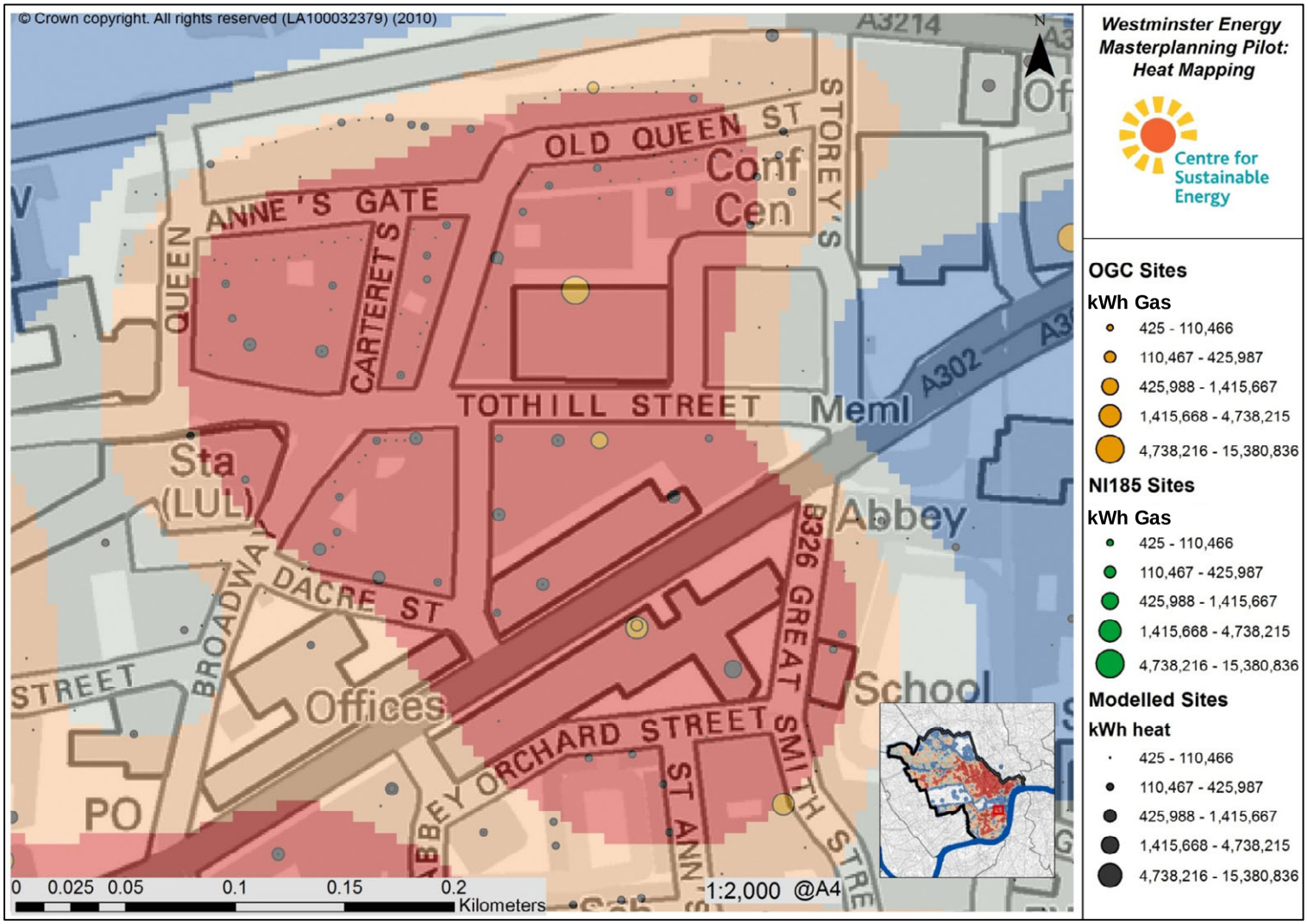
Full size map 11: Detail - Oxford Circus



Full size map 12: Detail - Marylebone)



Full size map 13: Detail - Soho



Full size map 14: Detail - Tothill Street

The Centre for Sustainable Energy, July 2010