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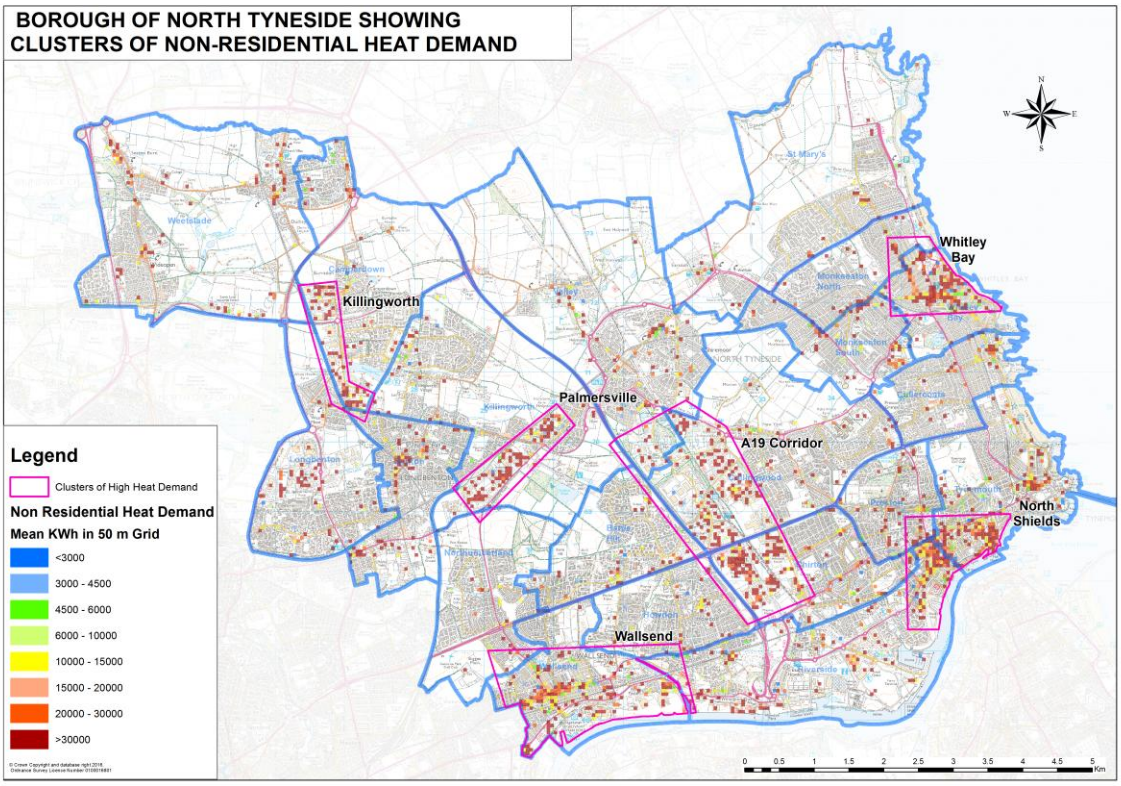

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DECCHNDU Energy Master-Planning & District Heating Feasibility Study (2015/16)

Heat Mapping Report

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1.0 Introduction

Capita were commissioned by North Tyneside Council (NTC) to undertake a heat mapping study of the North Tyneside administrative area following the Councils success in securing capital funding from the Department of Energy & Climate Change (DECC) under their Heat Network Development Unit Programme (HNDU). The overall aim of this study is to identify potentially useful heating, cooling and power demand loads and potentially useful heat supply opportunities for the purposes of subsequent District Energy Master-Planning & Feasibility Studies.

The purpose of this document is to support the GIS mapping outputs by providing further narrative to the analysis undertaken. The other key purpose of this document is to provide a detailed methodology as to how this analysis was undertaken with specific reference to the sources of consumption data used to create the various mapping outputs and how the various underlying datasets were used.

2.0 Methodology

2.1 Considerations in assessing Heat Network Opportunities

Given the cost intensive nature of district heating infrastructure, the shorter the distance of travel, the lower the cost of transporting the heat will be. Therefore the more densely packed the buildings, and the greater demand for heating, the better the performance of the network will be. A 2009 study into the potential and cost of district heating in the UK, undertaken by The Poyry and Faber Maunsell on behalf of DECC indicated that a minimum heat density of 3,000 kWh per square kilometre per annum is a pre-requisite for viability. Although guidance from DECC as a result of recent studies completed under the HNDU programme indicates that this viability density is now actually between 4,000 to 5,000 kWh per square kilometre per annum (or 4-5 kWh/m2). The heat density of an area can be assessed by mapping the fuel consumption of a group of buildings within a given geographic area.

The amount of energy consumed in a building over a given time frame (often a year, expressed as kWh) is known as that buildings demand load. This load is not even across 24hr period or throughout the year. When demand is mapped over a 24hr period across the space of a year this generates a load profile. Load profiles vary seasonally depending on external temperature and the requirement for heating and also across the 24hr period depending on the occupancy and use of a building. The following graphic (figure 1) taken from the TCPA’s 2010 community energy master-planning guidance publication provides an overview the characteristic of the likely daily demand profile for different buildings.

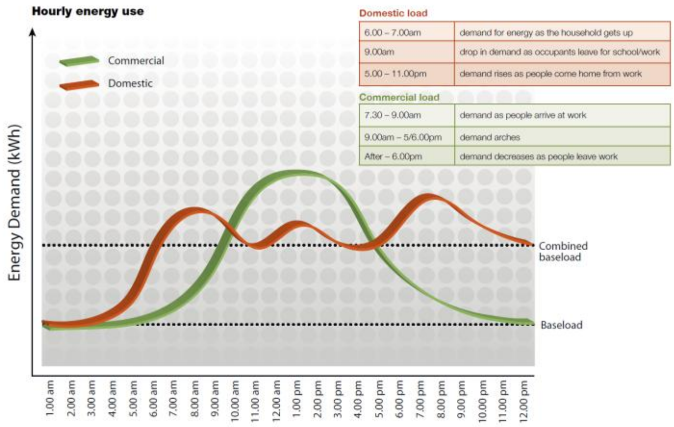

Figure 1: TCPA 2010: Daily demand profiles for Domestic & Commercial buildings.

Dwellings tend to have spikes of demand in the morning and evening with a trough during the day while occupants are at work, although households with retired occupants or young families may have a more constant demand. Commercial and office accommodation tends to have a reasonably constant daytime demand with a trough over-night and at weekends. Other buildings such as Hospitals, Hotels, and Leisure Centres may have fairly continuous high loads. The daily load profile will fluctuate between the period of highest demand or peak load, and the period of lowest demand or base load. A buildings heating system must be sized appropriately to meet the profile's peak load, however most systems are inherently inefficient operating to serve only the base load for the majority of time depending on the load profile.

A key requirement in the design of a successful network is the ability to include a mix of buildings with different uses which combines different demand spikes across a 24hr period to smooth out the overall demand curve. A heating system operates more efficiently over a continuous period, similar to an internal combustion engine which returns better fuel consumption on a steady motorway run compared to stop-start urban motoring. The combination of residential, commercial and public uses can give a relatively smooth load curve across an 18hr period, raising the base load which can be met by a CHP unit which is also generating electricity. Commercial energy services or investors will also be more interested in a project offering a diversity of potential consumers, while networks serving only domestic properties will be less attractive.

Large commercial buildings requiring cooling during the warmer months are also relevant to the mix of uses. Commercial buildings tend to use electric chilling plants to meet their cooling needs, however, absorption cooling which is similar to a reverse refrigeration cycle can convert the heat provided by the heating network into cooling. Whilst slightly efficient than electric plant, absorption cooling smooth's the annual profile providing demand for heating during the warmer months when demand would otherwise be low, allowing the continuous generation of electricity without having to store or dump heat.

Some buildings such as hotels, hospitals, leisure centres have both high and continuous demand for much of the day. Anchor heat loads also tend to be public buildings whose operators are able to make longer term contractual commitments to energy supply than private sector organisations, and may also be bound by more restrictive energy efficiency requirements and environmental obligations. If an anchor buildings heat load is sufficient to warrant the installation of district heating infrastructure, once that infrastructure is in place smaller heat loads can connect at a much lower cost. These buildings can act as significant catalysts in the development of district heating networks, often tipping the scales of viability towards success. Private sector organisations, whilst having significant energy demands, may not be able to provide this level of commitment to a proposed network and, whilst keen to connect, may need to maintain the flexibility to exit commercial energy supply agreements as necessary. For this reason building a network proposal around private sector anchor loads may carry a level of risk that is either unacceptable to finance providers, or so heavily penalised in financing arrangements as to be uncompetitive or unfeasible.

Physical constraints to the development of a district heating system could include railway lines, major highways, rivers, and other urban infrastructure, these should be identified as part of the initial mapping process to ensure they are identified as early as possible. Whilst none of these constraints is unsurpassable, they may only be overcome at considerable expense. Other local features may provide opportunities such as any highway ducting with unused capacity, existing underground tunnels which could accommodate heating infrastructure, a major road resurfacing programme could provide an ideal opportunity to save considerable cost in installing heating mains, although this could bring with it a number of further timing complexities. Surrounding industrial uses, such as waste incineration sites, anaerobic digestion plants, and power stations may have waste heat, or other industrial sites may have considerable boiler plant which may have spare capacity to supply to the network, although these types of uses are more than likely to have left city centres in recent years. Guidance provided by ARUP (Decentralised Energy Master-planning Manual, DENet, 2011) suggests that only a minimal thermal capacity of 2MWth should be considered as anything less is unlikely to have sufficient spare capacity to compliment a network.

2.2 Data Methodology

From the outset the project team were keen to use actual building consumption data wherever possible. This was no issue with regards to data for the Council’s operational buildings, however obtaining actual building consumption data for private buildings within a heat-mapping study area is known to be difficult. Prior to commencing the heat mapping analysis the project team engaged with the NTC Economic Development service to send out a communication to a list of 60 of the largest companies within the borough as well as other public sector organisations that NTC is in regular contact with. This communication explained both the aims of this study and need for support from local enterprises in developing a robust consumption dataset, the communication was accompanied by a letter of authority to be completed and returned by cooperating parties to allow the project team to approach suppliers directly for data. Disappointingly, there was no response from any of the letters sent out, only the Northumbria Police service provided half hourly data for their Cobalt building when they were contacted via existing networks.

In absence of actual consumption data work was commenced to create a hybrid/composite data-set using data drawn together from a number of sources.

The data used for NTC's operational portfolio was constructed from a 3 year average of consumption data for NTC operational sites taken from the NTC Energy Management System (TEAM-Sigma), this was augmented by the Half-hourly data available for NTC AMR sites. All of NTC's gas supplies are now half hourly metered, however, only Profile Classes 1 & 2 electricity supplies are half-hourly metered.

Residential consumption data was initially taken from the Lower Level Super Output Area (LLSOA) data set, produced by The Office of national Statistics in conjunction with DECC, for the NTC administrative area. This data identified a total of 85,273 gas supplies for the NTC LLSOA areas with a total annual gas consumption of 1,313 GWh (1,313,245 MWh).

Non-residential energy consumption was initially modelled using the Valuation Office Agency's (VOA) data-set for non-residential premises within the North Tyneside borough. A good amount of data-cleansing of the VOA file was required before it was ready to be used. The initial VOA file of 17,852 entries was longlisted to 6,154 entries following the removal of end-dated entries, this was then shortlisted to 5,633 entries following the removal of a number of anomalous entries for external and un-treated sites/measurements.

Relevant CIBSE TM46 and CIBSE Guide F energy consumption benchmarks were then applied to the cleansed VOA dataset to derive annual gas & electric consumption. Cooling benchmarks were applied to buildings within the CIBSE categories for which cooling benchmarks are published (note cooling benchmarks are not available for all categories).

Following a DECC HNDU review of the initial mapping outputs derived from this composite dataset a recommendation was made to obtain the Centre for Sustainable Energy (CSE) data-set for the NTC administrative area. The Centre for Sustainable Energy were commissioned by DECC to produce the dataset used by the online national heatmap tool, the dataset obtained provides the underlying building level data which is used by the national heatmap tool but cannot be extracted from the tool itself. The value of this dataset is that it provides externally ratified data, which is consistent with that used by other DECC HNDU studies.

2.2.1 CSE Data Methodology:

Once obtained, the CSE dataset also required an amount of data-cleansing, the detail of which is outlined in the sections bellow. It is also worth noting that the CSE dataset only provides detail on heat consumption and, whilst being derived in part from VOA/Experian data, the data does not include any measurement of floor area or building space so it is not possible to use relevant benchmarks to derive electricity consumption.

2.2.1.1 CSE Residential Data Cleansing:

The CSE dataset provided an initial total of 93,229 residential entries/sites with a combined annual consumption of 1,138,262 MWh.

Residential entries with a Postcode prefix of NE6 were removed as this lies within the Newcastle Council administrative boundary, not North Tyneside, this resulted in the removal of 11 entries, 253.13 MWh.

The remaining total of 93,218 residential entries provided a total annual consumption of 1,138.03 GWh (1,138,026.73 MWh). It is worth noting that this total number of residential entries is considerably higher than the equivalent LLSOA number of 85,273 supplies for NTC lower-level super output areas, however, despite the discrepancy of 7,945 additional residences/supplies within the CSE dataset the total consumption for the North Tyneside administrative area provided by the CSE data is actually 175 GWh (175,218.27 MWh) lower than the total consumption stated for the lower number of supplies within the LLSOA dataset. This is most likely to be a result of different modelling approaches applied in the production of the different datasets, but in absence of the explicit detail regarding how each dataset has been created it is not possible to pinpoint the cause of the discrepancy. This aside, it is still important to draw attention to the existence this discrepancy.

2.2.1.1 CSE Non-Residential Data Cleansing:

The CSE dataset provided an initial total of 5,439 non-residential entries/sites with a combined annual consumption of 511,178.19 MWh.

Non-residential entries with a Postcode prefix of NE10 & NE98 (non-North Tyneside postcodes) were removed which removed 3 entries with a total consumption of 2,884.08 MWh. Further to this 47 'Postal' entries (761.87 MWh) described variously as 'telecommunications infrastructure/masts/poles, radio masts, electricity substations, advertising hoardings' were removed on the basis that they appeared to be unoccupied and un-treated external infrastructure sites which would be unlikely to have any significant heat demand, many of the estimated consumption figures for these sites are low/de-Minimis which supports this assumption.

A total of 50 anomalous entries (5,425.31 MWh) variously described as 'sports ground, football ground, playing field, land, car park, scrap yard, sub-station, advertising sign, bus shelter' were removed on the basis that they are unlikely to be occupied/conditioned space. Further to this, given that many of these entries are open space their estimated consumption (derived from a benchmark driven by the size VOA measurement for the site) is likely to be misleadingly high, such as an estimated consumption of 255,564kWh for a school playing field, and 703,894kWh for a car park.

In total 100 sites with a combined annual consumption of 9,071.26 MWh were removed from the dataset prior to mapping, which left a remaining total of 5,339 entries/sites with a combined annual consumption of 502,106.93 MWh)

2.3: NTC Heat Mapping GIS Methodology:

The CSE dataset consists of individual property entries, each having its own KWh (Heat Demand). The data was in .csv format which only allowed the production of point data. Using the X, Y fields in the original data, a point shapefile was created showing each unique property.

A practical concern with using point data in this circumstance was that displaying this data at the scales required (A3 size) would cause overlap and obscuration of the heat values of nearby properties. The solution was to convert the point data to polygon data. To do this a 50 x 50m grid was created using the Ordnance Survey National Grid system and using the Create Fishnet tool in ArcGIS (Figure 2).

A set of 50 x50m tiles were created was a polygon shapefile and a unique identifier added to each individual tile.

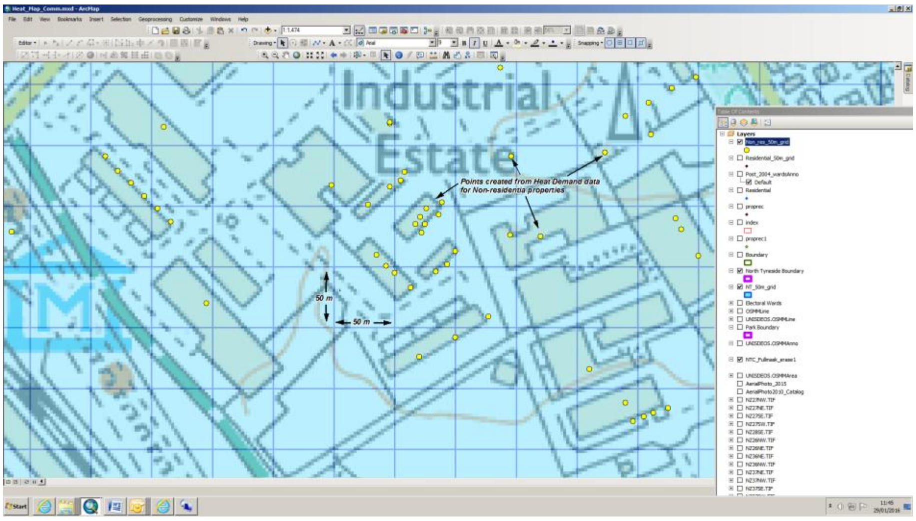

Figure 2 - screen shot of 50 x 50m grid created in ArcGIS

This unique identifier was then added to the Heat Mapping point data by spatially joining the 50 x 50 m grid to the point data before adding the tile's unique identifier to the unique property that lies within that particular 50x50m tile. As several properties may lie within a single tile, the heat demand within each tile was added and the mean calculated.

This created a table with the Tile's unique identifier and the Mean KWh demand within each tile. This table was then joined the Tile shape-file. This allowed us to give a mean Heat demand for each tile (figure 3).

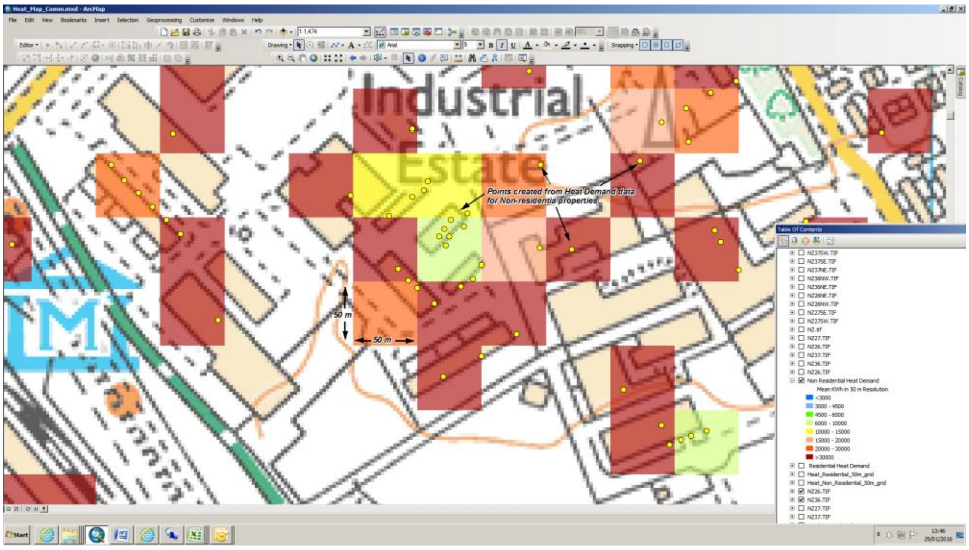

Figure 3 – screen shot of completed ArcGIS NTC Heat Map

This approach was followed to create a map for both residential heat demand and a separate map for non-residential demand.

The non-residential and residential mapping outputs are reproduced overleaf.

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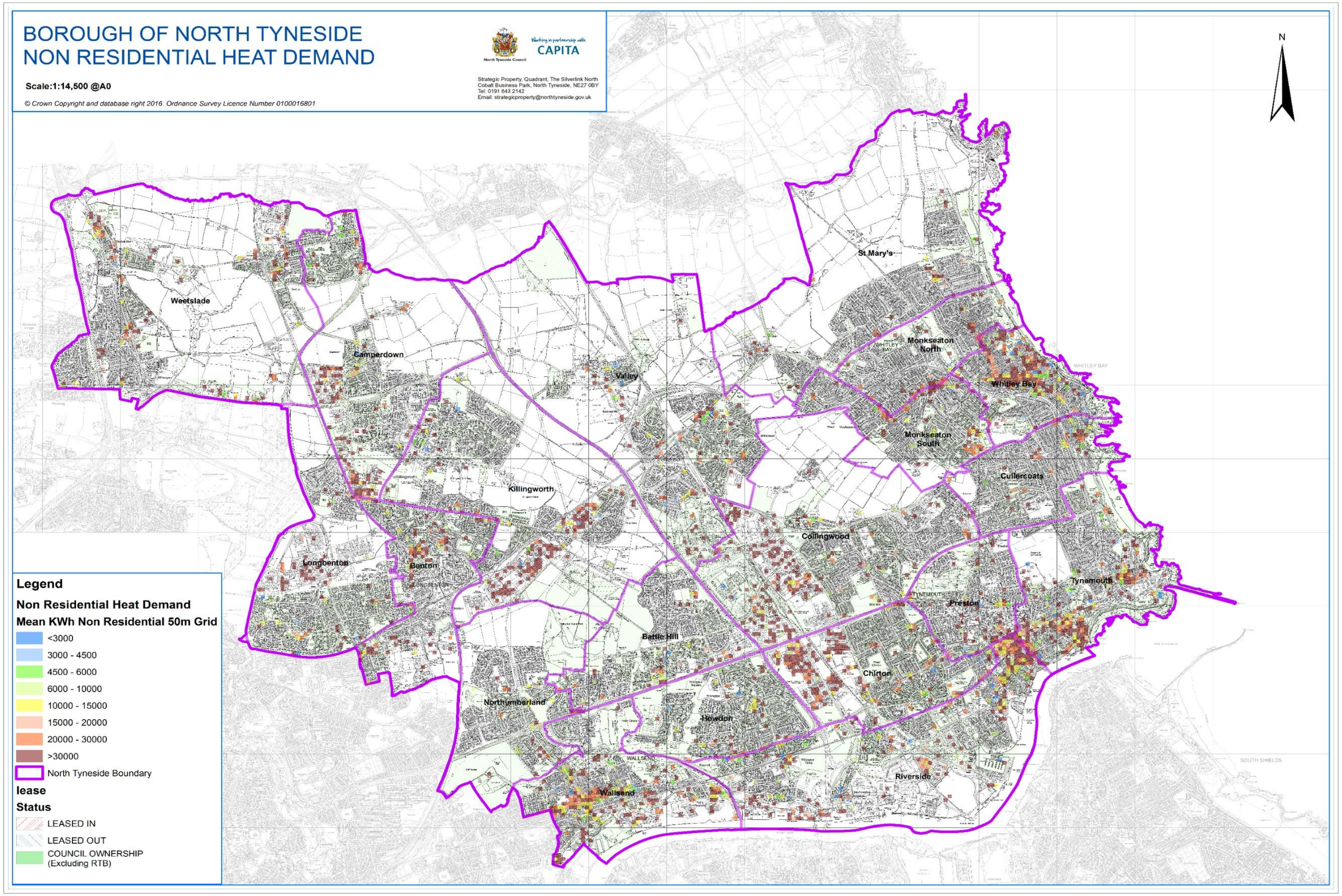

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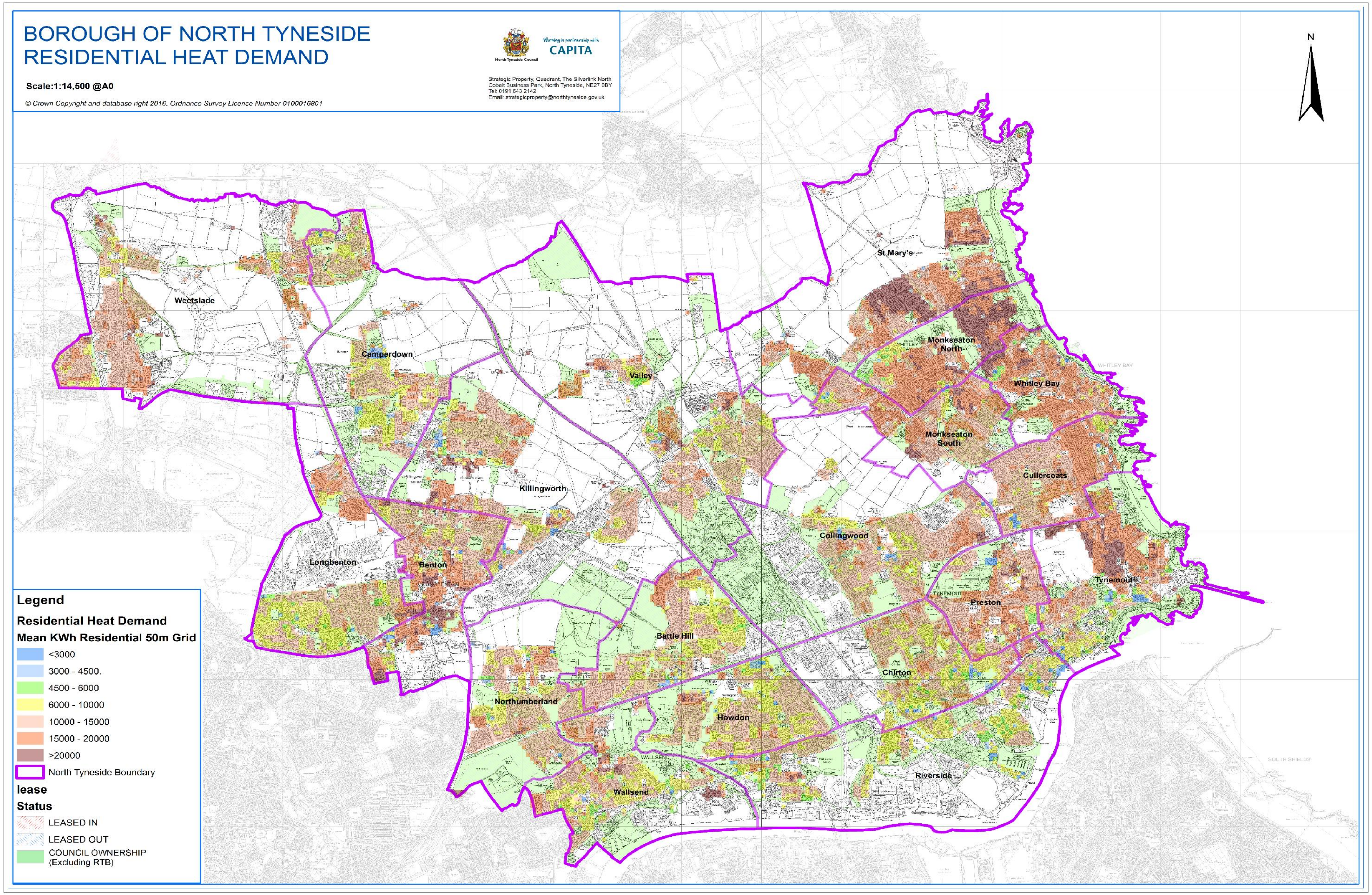
BOROUGH OF NORTH TYNESIDE
RESIDENTIAL HEAT DEMAND
Scale:1:14,500 @A0
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North Tyneside Council
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CAPITA
Strategic Property, Quadrant, The Silverlink North
Cobalt Business Park, North Tyneside, NE27 0BY
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N
St Mary's
Weetslade
Camperdown
Valley
Monkseaton North
Whitley Bay
Monkseaton South
Killingworth
Cullercoats
Collingwood
Longbenton
Benton
Tynemouth
Preston
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4500 - 6000
6000 - 10000
10000 - 15000
15000 - 20000
>20000
North Tyneside Boundary
lease
Status
LEASED IN
LEASED OUT
COUNCIL OWNERSHIP (Excluding RTB)

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3.0 Heat Mapping Findings

A summary of the data provided by the CSE dataset at the macro level, across the borough as a whole, is provided below.

Building category	Heat Demand (kWh)	Heat Demand Density (kWh/m2
Commercial Offices	78,629,096	0.954
Education	16,765,601	0.203
Health	28,430,908	0.345
Hotels	32,246,130	0.391
Industrial	121,130,190	1.470
Other	5,256,283	0.064
Recreational	31,067,140	0.377
Transport	62,840,290	0.763
Retail	113,237,390	1.374
Residential	1,138,261,857	13.816
Total	**1,627,864,885**	**19.76**

Table 1: NTC Heat demand across the borough as a whole

Picking up on the concept of heat demand density introduced in section 2.1 it is clear from the table above that the overall heat demand density for the borough surpasses the 4-5 kWm/m2 viability requirement highlighted previously.

It is important, however, to look at the density of the different sectors that make up this overall figure. By far the highest contributing sector to this overall demand density figure is the load from domestic properties, a number of factors must be examined when considering including residential load in a district heating system including the daily profile and the duration of that load. Also worth considering are the regulatory requirement around residential energy supply and the resulting risk to the stable/long-term income required for a heat network. Once this residential load is removed the overall demand density across the borough drops dramatically to 5.944 kWh/m2. Other potential higher risk sectors include retail and commercial offices which tend to be tenanted rather than owned. Depending on the size of the individual unit, the tenant operating out of the building is often not in direct control of energy purchasing as this is undertaken by the landlord with the costs passed on to the tenant via a service charge. On this pass-through basis, landlords are often not economically motivated and may not be willing to explore alternative energy supply options beyond the status quo of centralised grid supply. With the retail load removed the overall demand density is still within viability at 4.57 kWh/m2, however once the Commercial Office load is also removed the overall demand density at 3.616 kWh/m2 drops below the viability benchmarks.

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3.1 Public Sector Heat demand

Based on the analysis of the data available for approximately 180 buildings within North Tyneside Council's operational portfolio (including Schools and Social Housing/Care facilities) the combined annual heat consumption of these buildings is 55.65 gigawatt hours (55,645.09 MWh), of which 41.5 GWh (approximately 75%) of this is consumed throughout the winter heating months.

For larger operational sites (those with half-hourly metered gas supplies) it is possible to extrapolate a heating base-load of 94.39 kW during the heating season, and 76.49 kW outside of the heating season. Further to this, the extrapolated peak demand for these buildings is 19.36 MW during the heating season, and 19.93 outside of the heating season. This higher figure for peak demand outside of the heating season seems unusual at first, but some of the larger gas consuming sites within the portfolio are wet leisure centres with fairly constant year-round demand.

In terms of power demand the total annual electricity consumption over the NTC is around 22.36 GWh (22,360 MWh) with a base-load of around 86.7 kW and a peak demand throughout the year of 2.16 MW (2,161 kW).

There is relatively little air-conditioning throughout the operational estate, apart from the more recent customer service buildings, leisure centres, and some PFI schools, the vast majority of buildings have not had cooling equipment retro-fitted. Whilst there is no actual consumption data for cooling loads within the NTC operational estate as cooling equipment is not sub-metered within the estate (nor logged on an ongoing basis on the central BMS system), cooling loads have been derived using CIBSE benchmarks where available.

On this basis the annual cooling load for the operational estate has been calculated at 2.26 GWh (2,256.26 MWh).

Public Sector Loads	
Annual Heat Consumption	55.65 GWh
Winter Heating Season Consumption	41.5 GWh
Heating Season base-load (NTC AMR Sites)	94.39 kW
Non-Heating Season base-load (NTC AMR Sites)	76.49 kW
Heating Season Peak Demand (NTC AMR Sites)	19.36 MW
Non-Heating Season Peak (NTC AMR Sites)	19.93 MW
NTC Power Consumption	22.36 GWh
NTC Power base-load	86.7 kW
NTC Power Peak Demand	2.16 MW
NTC Cooling Load	2.26 GWh

Table 2: Public Sector load detail

3.2 Residential Heat demand

Based on the analysis of the CSE National Heat Map data the combined annual heat consumption of the 93,219 residential properties within the North Tyneside administrative boundary is 1,138.03 gigawatt hours (1,138,026.73 MWh). On this basis the average domestic annual gas consumption within the North Tyneside area is 12,208.23 kWh, which is in-line with the national average domestic consumption of approximately 12,500 kWh (DECC DUKES 2015).

Whilst some discrepancies between the CSE dataset and the LLSOA dataset have been noted earlier in the methodology section, the CSE dataset only provides detail on heat consumption but does not provide any figures for Electricity. Electricity consumption is however provided within the LLSOA dataset and based on analysis of this the combined annual electrical consumption of the 93,219 residential properties within the North Tyneside administrative boundary is 317.62 gigawatt hours (317,619.62 MWh). On this basis the average domestic annual electricity consumption within the North Tyneside area is 3,976 kWh, which is also in-line with the national average domestic consumption of approximately 4,000 kWh (DECC DUKES 2015).

Residential Loads	
Annual Gas Consumption	1,138 GWh
Average NTC domestic annual Gas consumption per property	12,208 kWh
National average domestic Gas consumption (DECC DUKES 2015)	12,500 kWh
Annual Electrical Consumption	317.62 GWh
Average NTC domestic annual Electrical consumption per property	3,976 kWh
National average domestic Electrical consumption (DECC DUKES 2015)	4,000 kWh

Table 3: Residential load detail

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3.3 Private Sector Heat demand

Based on the analysis of the CSE National Heat Map data the combined annual heat consumption of the 5,308 private sector buildings within the North Tyneside administrative boundary is 1,649.44 gigawatt hours (1,649,440 MWh)

Whilst it is not possible to derive the likely peak and base load of this demand from the data the daily demand profile graphic (figure 1: General methodology section) provides an overview the characteristic of the likely daily demand profile. In terms of the annual demand profile it is anticipated that this will follow the standard u-shaped seasonal curve where heat demand is highest over the winter heating months from mid-October to the end of March with a drop in demand from April onwards to the end of September.

It is not possible to derive power consumption for these buildings from the CSE dataset as building measurements are not provided. Electrical consumption has however been derived from the VOA dataset using relevant CIBSE TM46 and CIBSE Guide-F benchmarks. On this basis the combined total annual electrical consumption for the 5,633 buildings identified within the VOA dataset is calculated at 20.55 gigawatt hours (20,547.9 MWh) per annum.

Annual cooling consumption has also been derived from the VOA dataset using CIBSE Guide-F benchmarks for buildings in categories for which CIBSE has published cooling benchmarks. These categories include Offices, Banks and Agencies, Hotels, and Mixed use. Mechanical ventilation benchmarks are provided for sports and recreation buildings and hospitals, however mechanical ventilation is not specifically cooling (as these buildings are also typically heated by the mechanical ventilation system) therefore the use of this benchmark to derive cooling load would not be accurate. On this basis the combined total annual cooling consumption for the 5,633 buildings identified within the VOA dataset is calculated at 2.11 gigawatt hours (2,109.05 MWh) per annum. As there are very few cooling benchmarks available throughout the range of CIBSE building categories within their published benchmarks it is likely that this will be a considerable underestimate of the combined private sector cooling load throughout the borough. However, without more detailed actual building data it is not possible to produce a more accurate estimate at this initial stage.

It is not possible to derive base-loads and max demands for heating, cooling, or power for these private sector buildings using benchmarks, this will require further exploration at the feasibility stage once actual consumption data is available.

Private Sector Loads	
Annual Gas Consumption	1,649.445 GWh
Annual Power Consumption	20.55 GWh
Annual Cooling Load	2.11 GWh

Table 4: Private Sector load detail

4.0 Future Development Sites

In terms of historical development throughout North Tyneside the borough has seen significant residential development in the years from 2000 onwards, but recent non-residential development has been more limited. Whilst the borough could not be considered a dense urban area, benefiting from considerable green open space in the Northern wards, the former industrial areas along the Northern banks of the river Tyne provide higher development density. Recent non-residential, including retail & commercial office, development has concentrated along the Northern end of the A19 corridor (Silver-link & Cobalt developments), with some light industrial development at the Southern end of the A19 corridor (Tyne Tunnel Trading Estate).

4.1 Residential development

To assess the future residential load within the borough the Strategic Housing Land Availability Assessment (SHLAA) was interrogated and a shortlist created of 61 housing sites where full permission had been granted, within these sites the number of dwellings being delivered over next five years and 6-10 years were recorded (figure 4). This approach was agreed on the basis that only sites with full planning permission, and only the number of dwelling units being delivered over the next 10 years would provide the level of certainty required for a network feasibility study.

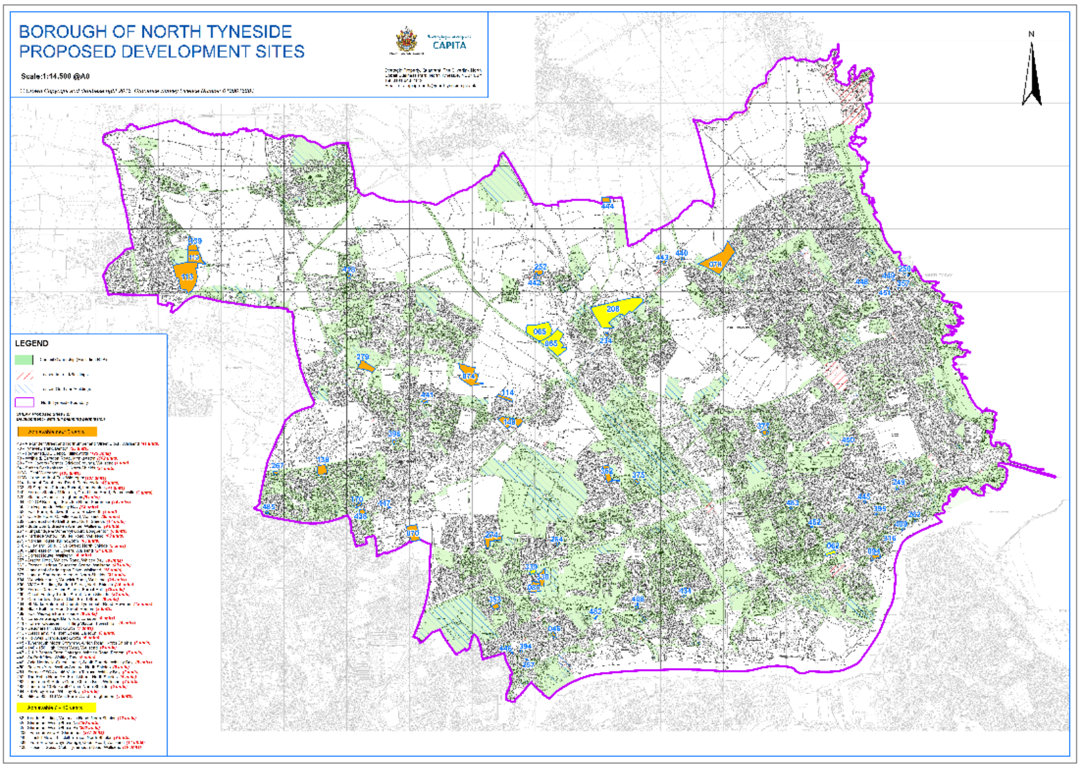

Figure 4 initial shortlist of NTC residential development sites

Following a survey of planning applications submitted for these sites it was clear that only the larger sites with higher dwelling numbers provided space standards for the proposed dwellings which would allow likely heating loads to be derived using heating benchmarks . The NTC Planning team advised that developers often employ bespoke architectural design on smaller-scale residential developments whereas the volume house-builders who bring forward larger sites have off-the-shelf housing types which are delivered across multiple sites. On this basis the list was narrowed down to sites delivering over 40 dwelling units bringing the list of sites down from 61 to 14 sites (Figure 5). There is a further logic to this approach in that developers of sites with less than 40 units may not be willing to consider district heating as an option for a site of that size.

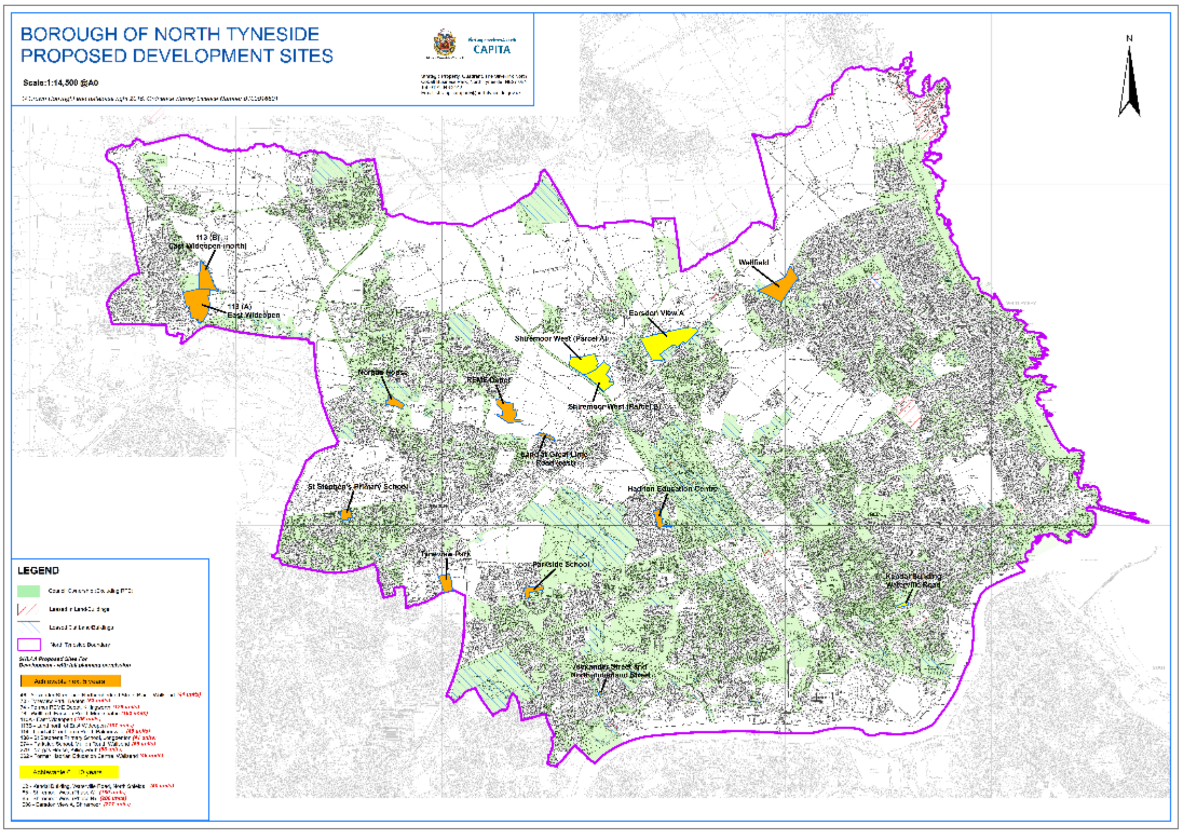

Figure 5 Shortlisted NTC residential development sites

Of the 14 remaining sites the site master-plan and accommodation schedules were interrogated to ascertain an overall square meter figure for the various dwelling units being delivered. The Building Regulations Part L (2013) Target Fabric Energy Efficiency rate (TFEE) for dwellings (54.26 kWh/m2 per year) was then applied to derive the future annual heating load (Table 2).

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Site Name	next 5 years	6 to 10 years	Total	GIA (m2)	Site modelled Heat requirement (Part L 2013 TFEE: 54.26kWh/m2/year)
Alexander Street & Northumberland Street Block, Wallsend	41	0	41	3051	165,547
Shiremoor West (Phase A)	120	60	180	22495.54069	1,220,608
Shiremoor West (Phase B)	120	80	200	22104	1,199,363
Tyneview Park, Benton	53	0	53	5946.05	322,633
Former REME Depot (Killingworth Stores), West Lane, Killingworth	125	0	125	14026.69	761,088
Wellfield, Earsdon Road, Monkseaton	162	0	162	25725.26	1,395,853
East Wideopen	105	0	105	9433.807135	511,878
Land north of East Wideopen	107	0	107	Dwelling unit sizes not provided - under query with developer*	
Land at Great Lime Road (east), Palmersville	45	0	45	6210.38	336,975
St Stephen's Primary School, Bardsey Place, Longbenton	41	0	41	Dwelling unit sizes not provided - under query with developer*	
Earsdon View A , Land north of Shiremoor	240	37	277	21804.03	1,183,087
Parkside School, Mullen Road, Wallsend	69	0	69	Dwelling unit sizes not provided - under query with developer*	
Norgas House, Killingworth	63	0	63	5036.25	273,267
Hadrian Education Centre, Addington Drive, Wallsend	49	0	49	4924.33	267,194

**note 3 of the 14 sites did not state dwelling unit sizes within the planning application, this is under query with the developer and figures will be provided once they have been made available.*

Table 5: NTC Residential development sites

In terms of residential development beyond these sites the Council's planning function are currently working to have their local plan adopted by early 2017. Two of the key developments within this plan are the large housing sites at Killingworth and Murton (Killingworth Moor up to 2000 dwellings, and Murton Gap up to 3000 dwellings). The Council's planning team are presently working with a consortium of developers to bring these sites forward with a full planning application anticipated mid to late 2017, with delivery commencing from 2018 onwards. There is insufficient detail available of use to this study at present as neither an accommodation schedule nor measurements for the dwelling types proposed are available. Individual unit sizes are required before a benchmark can be applied (kWh/m2). As the master-planning phase progresses we will continue to consult with the developers for these sites to secure this detail.

4.2 Future Non-Residential development

Whilst the Council are working towards having their local plan adopted in early 2017 there is a limited amount of non-residential development coming forward. In terms of sites with full permission granted there are only currently 3 sites scheduled for development over the near future (Table 3). It is anticipated that a number of additional sites will come forward as the Local Plan approaches adoption, but in its absence there is little further detail available that is of use to this study. Again the Council are keen that any emerging non-residential development will be aligned the eventual outcomes of the Energy Master-planning exercise.

Area	Site Name	GIA (m2)	Site modelled Gas Consum kWh (CIBSE Guide F)	Site modelled Elec Consum kWh (CIBSE Guide F)
Silverlink retail	Unit 1	4,830	937,020.00	1,144,710.00
	Unit 2	1,672	324,368.00	396,264.00
	Unit 3	1,672	324,368.00	396,264.00
	Unit 4	1,672	324,368.00	396,264.00
Killingworth retail	Lidl	2470	494,000.00	2,260,050.00
longbenton retail	Aldi	1,592	318,400.00	1,456,680.00

Table 6: NTC Non-residential development

5.0 Existing Heat Supply opportunities

As highlighted by the screenshot below (Figure 6) taken from the National Heat Map tool there are no registered CHP or thermal power stations within the North Tyneside local authority boundary.

There is a known CHP unit at North Tyneside General but this is provided by Dalkia/Cogenco under an energy performance/energy sale contract. Whilst initial discussions were held with the Hospitals energy manager and representatives from Congenco we were advised that there is no real spare capacity from this unit and that even with the application of a thermal store the existing contract could result in financial penalties for the Hospital trust if CHP operational hours were to exceed the contracted allocation.

There is also a 27.7 MWe biomass CHP plant undergoing construction in the North of the borough at Cramlington (partly GIB financed). Construction commenced in September 2015 but is not expected to be completed until late 2017. The plant will directly supply two large pharmaceutical manufacturers (Aesica & MSD) with heat and power with the excess electrical generation being taken by the national grid. A number of attempts were made to contact the construction contractors to establish the potential of excess heat capacity but no response has been received to date.

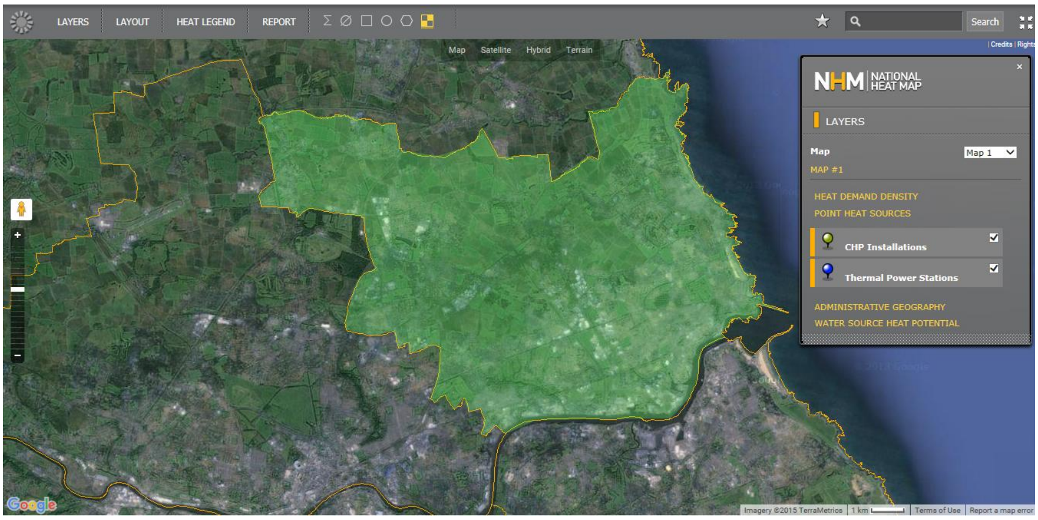

Figure 6: CHP & TPS Installations within NTC LA:

http://tools.decc.gov.uk/nationalheatmap?stateID=ba40d9b851f5370f0a1d5d1c53cca955

Following discussions with Northumbrian Water Ltd. (NWL) regarding their sewage treatment plant at Howdon to the South of the borough there is a potentially viable waste heat opportunity. The treatment facility at Howdon utilizes an Advanced Anaerobic Digester (AAD) which employs a thermal hydrolysis plant which pre-treats sewage sludge using steam which ultimately derives more energy than a conventional anaerobic digestion process. This plant processes approximately 33,000 tonnes dry solids each year. The AAD was originally designed to directly use the biogas produced from digestion to generate renewable electricity in CHP gas engines, which was subsequently used entirely on-site to power operations; predominantly aeration of the activated sludge plant and pumping.

Taking advantage of the Renewable Heat Incentive (RHi) Scheme the AAD unit was further improved with the addition of a gas to grid (GTG) plant which upgrades the biogas to biomethane. The GtG plant was commissioned in December 2014, and subsequently all of the methane produced by the plant is now injected directly into the gas grid. Northumbrian Water remains a large consumer of gas feeding the pre-existing gas engines that previously ran on biogas and now function on mains' gas. As before all the electricity generated by the use of mains' gas in the CHPs is consumed on-site.

The installed capacity of CHP at Howdon is 5.3 MW, with the engines producing on average 70 MWh electricity per day, and around 130 MWh per day of biomethane being injected into the grid.

The highest grade waste heat from the gas engines is used to assist in raising steam for the thermal hydrolysis plant, with the lower grade waste heat discharged to atmosphere. Analysis of a similar NWL plant on Teesside has suggested that there may be 2-3 MW of waste heat available but that it would be costly to recover and its temperature at less than 80˚C would be too low to be of use in any of the plants processing.

Whilst the volume of daily biomethane production onsite represents, in theory, a fantastic district heating opportunity there is also, unfortunately, an insurmountable constraint in that all the biomethane produced is subject to a gas network entry agreement with Northern Gas Networks (NGN) and an appropriate agreement with a gas shipper. Further to this if the plant were registered with the Renewable Heat Incentive following commissioning in December 2014, based on the volume of biomethane being produced, NWL will be receiving a tariff rate of around 7.6 pence per kWh for each kWh of gas fed into the grid. This is over double the rate that can be purchased at on a medium to large commercial scale, and higher again in comparison to the price that gas can be purchased at on a larger scale.

On this basis it is unlikely that any of this biomethane would be available for use in a district heating network, this assumption is reinforced by the fact that NWL are now using grid-gas to run their CHP engines to produce processing power for the site, as this will be more cost effective than sacrificing the valuable biomethane produced on-site.

The 2-3 MW of waste heat at less than 80˚C would warrant further exploration at a later stage, whilst the temperature is less than ideal for a district heating application it could provide a base supply that could be boosted at satellite energy centres throughout a larger network to deliver heat between 90-110 ˚C to a customer's site. In a well-designed network thermal losses in transmission mains can be as low as 1-2 ˚C per kilometre so it is potentially feasible to transport this heat for use across the borough but this would require detailed scrutiny at the engineering design stage to ensure the proposal would be feasible.

5.1 Other potential sources of Low-Carbon Heat Supply

Other sources of potential low-carbon heat supply within the borough are fairly limited, but recent work undertaken by DECC into the potential heat capacities of UK rivers and estuaries is worth consideration. The water source heat potential layer recently added to the National Heat map suggests that the river Tyne to the South of the borough has a potential heat capacity of 500 – 950 kW (Figure 7). It is worth clarifying at this point that kW is a unit of power, not energy (kWh), as such without more detail about the likely heat extraction rate (the speed at which, and the duration over which) it is not possible to speculate on the amount of energy (kWh's) that the river potentially holds. On this basis further investigation would be necessary at the master-planning/feasibility stage with specification detail from heat-pump manufacturers to ascertain an understanding of the true potential of the river-sourced heat. Initial discussions have been held with STAR refrigeration who were involved in the Drammen district network project, with initial indications positive on the basis that the heat/power embodied within the Tyne is understood to be higher than that of the river at Drammen.

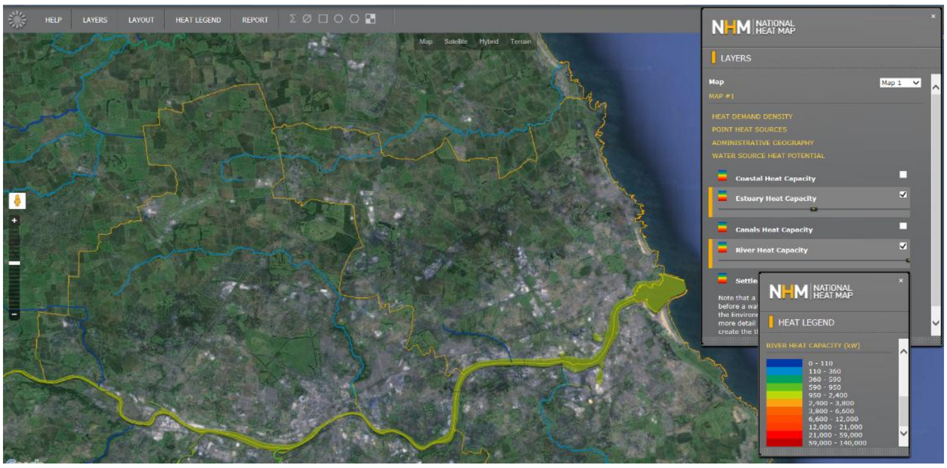

Figure 7: NHM River Tyne heat Capacity:

http://tools.decc.gov.uk/nationalheatmap?stateID=2498ed8e321c5751333e5e8385e949b3

The water source heat layer also provides an indication of the likely coastal heat capacity to the North East of the North Tyneside borough (Figure 8), whilst this layer does provide a measure of likely energy at 31,000 KJ/m2 (or 8.61 kWh/m2), further analysis would also have to be undertaken at the master-planning/feasibility stage using available heat pump specifications to ensure that heat could be extracted on a cost-effective basis (in excess of the cost of input energy required).

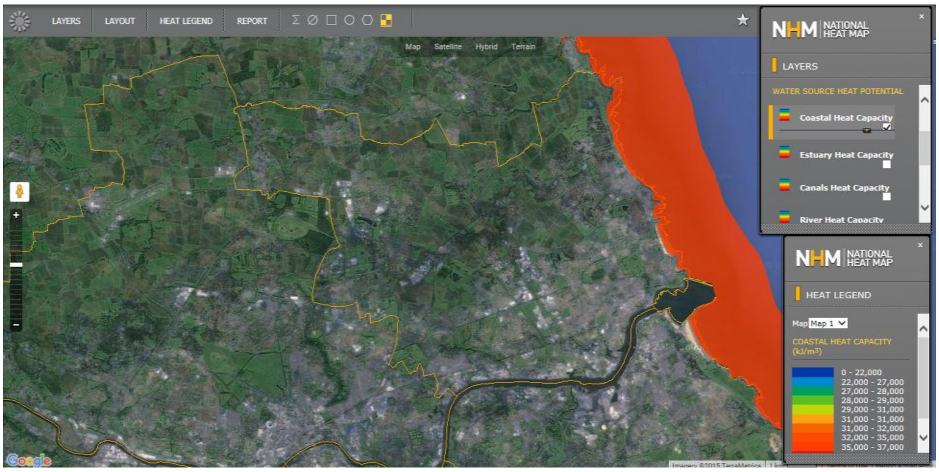

Figure 8: NHM Coastal Heat capacity for North Tyneside:
http://tools.decc.gov.uk/nationalheatmap?stateID=cb34d5fa0f95315de100e55680e4589e

6.0 Identified Clusters and recommendations for further study

Further to the Macro-level borough-wide analysis is important to look for clusters of concentrated demand within the study area. The map below provides an overview of identified cluster of non-residential heat demand within the study area. Only non-residential demand has been assessed on the basis that residential demand is unlikely to act as an anchor to kick-start a district heating network in the way that a close geographic groupings of high demand non-residential consumers might.

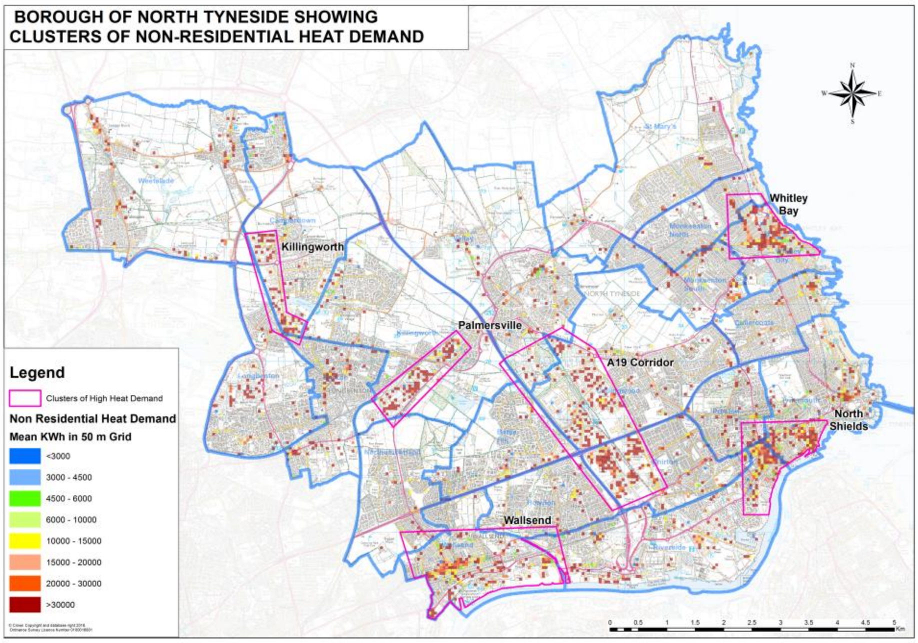

Figure 9: Clusters of non-residential heat demand density in North Tyneside

Cluster	Cluster size (m2)	Heat Demand (kWh)	CO2 (Tonnes p/a)	Overall density (kWh/m2)
A19 Corridor	4,280,195	157,999,207	29,143	36.91
Killingworth	895,451	27,418,646	5,057	30.62
North Shields	1,441,465	33,210,692	6,126	23.04
Palmersville	996,050	20,287,053	3,742	20.37
Wallsend	3,031,996	30,408,774	5,609	10.03
Whitley Bay	1,155,754	24,682,483	4,553	21.36

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Table 7: Key Statistics from Cluster level analysis

	Building Type density kWh/m2									
Cluster	**Commercial Offices**	**Education**	**Health**	**Hotels**	**Industrial**	**Other**	**Recreational**	**Transport**	**Retail**	**Govt. Buildings**
A19 Corridor	9.92	0.05	0.39	1.07	13.04	0.01	0.09	8.78	7.62	0.06
Killingworth	2.56	0.68	0.11	0.22	28.41	0.04	0.20	10.66	5.28	0.78
North Shields	3.40	0.25	0.78	2.92	3.91	0.98	1.60	0.50	7.02	1.68
Palmersville	0.29	0.00	0.00	0.06	7.28	0.02	0.74	6.01	5.97	0.00
Wallsend	0.86	0.95	0.40	0.37	2.13	0.15	0.78	0.73	2.85	0.81
Whitley Bay	1.70	0.40	0.70	6.70	0.36	0.57	2.27	0.11	8.33	0.22

Table 8: Demand density of building types within identified clusters

The tables above provide an overview of the key statistics for the six clusters identified, for each cluster the overall heat demand has been calculated and the demand density derived using the measurement of the cluster area. Annual CO2 emissions have also been derived using approved carbon conversion factors.

Analysis of the heat demand density suggests that the A19 Corridor and Killingworth cluster are clear candidates for further exploration at the master-planning and feasibility stage with demand densities of 36.91 kWh/m2 and 30.62 kWh/m2 respectively, followed by the North Shields cluster with a density of 23.04 kWh/m2. Both the Palmersville and Whitley Bay clusters are fairly close to the North Shields cluster in terms of demand density, whereas the Wallsend cluster has significantly lower density than the other clusters. There are a number of other location specific factors to consider at the cluster level, and as such each cluster should be individually assessed on its own merits.

6.1 A19 Cluster

With the highest overall load and density, the A19 cluster covers the largest geographical area of all the clusters, and it is also strategically placed towards the centre of the borough, which is worth taking into account in terms of future growth potential for a larger scale network. The A19 cluster is constrained to the west by the A19 which is a major traffic artery for the borough, another major traffic route, the Coast Road, dissects the cluster to the South, but there is a vehicle underpass which links the Silver-link retail park to the North of the Coast Road to the Tyne Tunnel Trading Estate to the South. With the Highest CO2 emissions of the six areas this clusters also offers the highest CO2 abatement potential. Whilst there is no residential demand within this cluster it is surrounded by areas of high residential demand to the North and East as well as areas of medium to high residential demand to the West. A further key locational factor is that the cluster is situated adjacent to the Murton Gap housing development site. Whilst the planning detail is currently being finalised for this site the size of the development would bring considerable scale to a proposed network, and the addition of residential demand to what is predominantly an industrial and commercial cluster load would be very beneficial in terms of viability. The A19 cluster is the closest cluster geographically the potential waste heat identified at the NWL Howdon treatment plant to the South of the area, and whilst a final decision has yet to be made the council are also considering a site in to the South of the A19 cluster for its new depot which is in fairly close proximity to the Howdon site. Potential NTC anchor buildings within the cluster include the Council’s two head office buildings towards the North of the cluster within the Cobalt Business Park, these two buildings are surrounded by a number of similar large office buildings, to the very North of the cluster there is a large hotel with a wet leisure facility which is anecdotally understood to have a very high occupancy rate in comparison to other hotels of a similar size/offer.

6.2 Killingworth Cluster

With the second highest overall density the Killingworth cluster is actually one of the smallest cluster in terms of overall size at 895,451m2, as such the overall demand is only the third highest of the clusters and the potential CO_2 abatement ranks fourth at 5,057 tonnes. The high density in comparison to the small geographical size is a positive factor in a network context on the basis that the capital costs will be lower for a network covering less distance. There are relatively few physical constraints within this cluster with good NTC land ownership in terms of potential network routing. Potential NTC anchor buildings include a wet leisure centre and a large customer service centre and office with a library, there is also a large secondary school next to the leisure centre along with a large Morrison’s supermarket and covered shopping arcade within close proximity to potential NTC anchors. There are areas of fairly dense residential demand to the South West and South East of the cluster, as well as areas of medium to high residential demand to the West. In terms of the wider-scale or longer-term network context this cluster is one of the more isolated clusters located in the North West of the borough.

6.3 North Shields Cluster

The North Shields cluster has the second highest overall heat demand, but due to its larger size at 1,441,465m2 its density is considerably lower than the A19 and Killingworth clusters at 23.04 kWh/m2, although given its higher consumption/demand its CO_2 abatement potential is higher than that of the Killingworth cluster at 6,126 tonnes/pa. In terms of constraints this is one of the more densely developed areas within the borough with lower NTC landownership so network capital costs are likely to be higher given higher the likely higher intensity of existing utilities and associated higher dig costs. Potential NTC anchor buildings include a large customer service centre/central library along with Council office accommodation in the town centre, the local Magistrates court is also situated in close proximity to these buildings. The clusters location in relation to the river Tyne is an opportunity in terms of potential river-sourced heat. There is medium to high residential heat demand within the cluster itself along with higher residential demand to the North of the cluster and medium to high residential demand to the South.

6.4 Palmersville Cluster

The Palmersville cluster has a reasonable level of density as a result of its overall heat demand in relation to its smaller geographical size, but its CO2 abatement potential is lowest of all the clusters at 3,742 tonnes/pa. There is medium residential demand to the West and the East of the cluster. There is little in terms of potential NTC anchors within the cluster, but a large Asda super-store and a number of other industrial sites provide potential private sector anchors within the cluster. In terms of geography the cluster is fairly strategically located as it could potentially link the A19 and Killingworth providing potential for future network growth, the other key locational factor is that the cluster is situated adjacent to the Killingworth Moor housing development site. Whilst no final planning detail is currently available for this site the scale of the development is such that it could act as a kick-start development for a network to serve this cluster.

6.5 Wallsend Cluster

The Wallsend cluster has the lowest overall density of all the clusters identified and whilst it has the third highest load of all the clusters having the second highest geographical size at 3,031,996m2 dilutes its overall demand density. The Wallsend cluster has the third highest potential in terms of carbon abatement at 5,609 tonnes/pa. With mostly medium residential demand within the cluster and some areas of medium to high residential demand to the North of the cluster the area's dense residential character is not reflected by the CSE dataset, the likely explanation for this is that the cluster sits within one of the boroughs worst areas for fuel poverty which explains the resultant impact on the residential consumption data. This dense residential character with lower NTC landownership is likely to have an adverse impact with network capital costs likely to be higher than less dense areas. In terms of potential anchor loads there is a large secondary school and wet leisure centre, and three other primary schools located within the cluster. There are a number of smaller industrial sites towards the South of the cluster along the Northern bank of the river Tyne, but beyond this there are a limited opportunities for anchor loads across the cluster as a whole so it is anticipated that the Wallsend cluster would not be viewed as a priority for further investigation in comparison to other clusters identified. The clusters location in relation to the river Tyne in terms of potential river-sourced heat could present an opportunity for a smaller scale network serving a small number of industrial along the North bank, but it is unlikely that this demand would support a network of any great scale.

6.6 Whitley Bay Cluster

With an overall demand density similar to the North Shields cluster the Whitleybay cluster has a smaller geographical size and a lower overall heat demand. The Whitleybay cluster has the second lowest CO2 abatement potential of all the clusters, and whilst there is high residential demand density throughout the cluster Whitleybay is not a recognised area of fuel poverty within the borough. In terms of potential NTC anchors there is a Wet leisure centre towards the North of the cluster with an adjacent primary school, and another primary school towards the centre of the cluster, beyond this there are a number of small to medium sized hotels and smaller retail units within the town centre but there is a lack of individual sites of considerable scale. In terms of constraints Whitleybay is also one of the more densely developed areas within the borough with lower NTC landownership so network capital costs are likely to be higher than less dense areas. In terms of future growth potential this is the most isolated of all the clusters identified so the potential for future interconnection is low.

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Appendices/Maps:

1.0 North Tyneside Proposed Development Sites
2.0 Short-listed North Tyneside Development Sites
3.0 North Tyneside – Clusters of Non-Residential Heat demand
4.0 North Tyneside – Clusters of Residential Heat demand
5.0 North Tyneside – Killingworth Cluster Residential Heat demand
6.0 North Tyneside – North Shields Cluster Residential Heat demand
7.0 North Tyneside – Palmersville Cluster Residential Heat demand
8.0 North Tyneside – Wallsend Cluster Residential Heat demand
9.0 North Tyneside – Whitley Bay Cluster Residential Heat demand