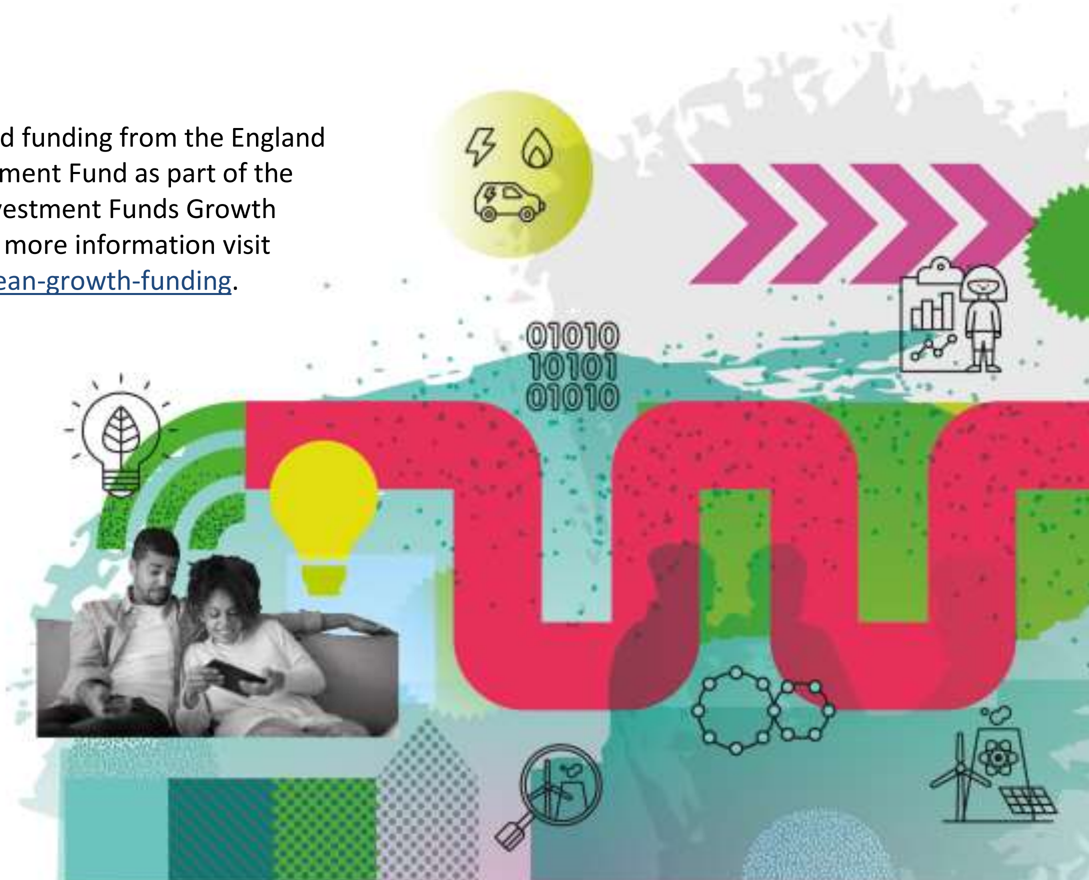
Local Energy Asset Representation for
Suffolk

24th January 2022

The ENE project has received funding from the England European Regional Development Fund as part of the European Structural and Investment Funds Growth Programme 2014-2020. For more information visit https://www.gov.uk/european-growth-funding.



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	Name	Position
Author(s)	Ben Walters	Consultant – Energy Systems Modelling
Reviewer	Karl Sample	Delivery & Technical Lead
Modelling Approver	Alex Buckman	Business Leader (Modelling)
Advisory Approver	Rebecca Stafford	Snr Manager, Local Energy Systems

Revision history

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19/11/2021	0.1	Skeleton report structure.
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24/01/2022	1.2	- Reordering of chargepoint graph for Suffolk West (p37) - Additional info for network usage. (p114)

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Contents

Acronyms & Initialisms

A	Amperes
ASHP	Air Source Heat Pump
BEIS	Department for Business, Energy & Industrial Strategy
CO_2	Carbon dioxide
DCLG*	Department for Communities and Local Government (now the Ministry for Housing, Communities and Local Government, MHCLG)
DfT	Department for Transport
DVLA	Driver and Vehicle Licensing Agency
ESC	Energy Systems Catapult
ESWI	External Solid Wall Insulation
EV	Electric Vehicle
FIT	Feed In Tariff
GSHP	Ground Source Heat Pump
GW	Gigawatt (1,000 MW)
GWh	Gigawatt-hour (1,000 MWh)
HV	High Voltage
I&C	Industry & Commercial
ISWI	Internal Solid Wall Insulation
$ktCO_2$	Kilo-tonnes of carbon dioxide
kV	Kilovolts (1,000 V)
kW	Kilowatt
kWh	Kilowatt-hour
LA	Local Authority
LAEP	Local Area Energy Plan(ning)
LEAR	Local Energy Asset Representation
LEP	Local Enterprise Partnership
LPG	Liquefied Petroleum Gas
LSOA	Lower-level Super Output Area
LV	Low Voltage
MHCLG*	Ministry for Housing, Communities and Local Government (formerly Department for Communities and Local Government, DCLG)
MSOA	Middle-level Super Output Area
MVA	Megavolt Amperes
MW	Megawatt (1,000 kW)
MWh	Megawatt-hour (1,000 kWh)
NAEI	National Atmospheric Emissions Inventory
ONS	Office of National Statistics
PV	Photovoltaic
REPD	Renewable Energy Planning Database
SCC	Suffolk County Council
V	Volts
VOC	Volatile Organic Compounds

**Please note: At time of writing, MHCLG is undergoing a further name change to the 'Department for Levelling Up, Housing and Communities' but this is not reflected in the table above.*

1. Introduction

Part of a world-leading network of innovation centres, Energy Systems Catapult (ESC) was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth. ESC is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia, and research. We take a whole system view of the energy sector – from power, heat and transport to industry, infrastructure, and consumers – helping us to identify and address innovation priorities and market barriers to decarbonise the energy system at the lowest cost.

As part of our offering, the Local Energy Asset Representation (LEAR) was developed. LEAR is a local energy system modelling tool developed by ESC that pulls together information on energy demand, generation, storage and distribution assets, social factors like fuel poverty and characteristics like building design types and local geography, using data analysis and aspects of machine learning. It enables planners and innovators to strategically decide how they might deploy and grow low carbon businesses.

This LEAR has been created by collating and processing data from a variety of sources and using in house modelling techniques. It gives an understanding of the buildings in the local area; their annual and peak energy demands and the energy networks that serve them. It also provides some information on the levels of employment and deprivation in the area. It is not expected that the information contained in this document exactly matches the items it reports on but, rather, provides a reasonable representation of them.

This document should be read in combination with the accompanying *Local Area Energy System Representation Datasets and Methodology*[1] document to understand the data used and how it has been processed. Accompanying Excel workbooks contain the data presented graphically in this document.

1.1. East of England European Regional Development Fund

The Eastern New Energy project is a European Regional Development Fund (ERDF) funded multi-partner collaboration with the aim to understand and remove barriers that prevent rapid decarbonisation, and to identify effective interventions to accelerate the transition to a low carbon economy. The partnership is working with local authorities, industries, SMEs, and communities to explore decarbonisation options and to help develop innovative interventions.

The study area is focussed on Suffolk to develop insights for the Eastern region which are applicable across the UK. The project is engaging with over 400 organisations in the East of England LEP areas of Hertfordshire, New Anglia, Greater Cambridge and Greater Peterborough.

The ENE project has received funding from the England European Regional Development Fund as part of the European Structural and Investment Funds Growth Programme 2014-2020. For more information visit https://www.gov.uk/european-growth-funding.

1.2. Suffolk

Suffolk County Council (SCC) has commissioned the Energy Systems Catapult (ESC) to produce a LEAR to help achieve their environmental goals of making the county of Suffolk carbon neutral by 2030[2].

This document provides a representation of the local energy system in Suffolk covering an area of 3,798 km^2 and a population of around 750,000 people.

The decarbonisation of the Suffolk area is within the context of the UK's legal binding target to reach net zero emissions by 2050 and milestone of 78% reduction compared to 1990 levels by 2035 (Carbon Budget

[1] Issued alongside this document. Also available via https://data.es.catapult.org.uk/dataset?topic=local-energy-asset-representation.
[2] https://www.greensuffolk.org/about/suffolk-climate-change-partnership/

6). Locally, each of the five authorities have declared a climate emergency setting a challenging decarbonisation target of 2030 – twenty years ahead of the UK as a whole.

The emissions attributed to an area varies depending upon the method used. One way is to use local authority CO_2 data which attributes the carbon to the end-use rather than where the emissions take place e.g. some of the emissions relating to electricity production are attributed to a domestic dwelling using their lighting. These emissions are broadly split into three categories: industrial, commercial, and the public sector (I&C), domestic, and transport. Table 1 shows the breakdown of these in each local authority area:

Table 1: Local Authority CO_2 Emissions

Local Authority Area	**Total 2019 [ktCO_2]**	**Ratio I&C : Domestic : Transport**	**Change in Emissions 2005-2018**
Babergh	*503*	*27% : 27% : 46%*	*-28%*
Ipswich	379	29% : 43% : 28%	-47%
Mid Suffolk	*638*	*33% : 23% : 44%*	*-27%*
East Suffolk	1,104	31% : 33% : 37%	-33%
West Suffolk	*1,189*	*44% : 21% : 35%*	*-27%*
TOTAL	**3812**	**35% : 28% : 38%**	**-32%**

The data above are from the 'subset' dataset which gives the "territorial CO_2 emissions estimates that are within the scope of influence of Local Authorities". The subset dataset therefore excludes large industrial sites, railways, motorways, and land-use.[3]

[3] For the whole dataset, and annual updates, visit: https://data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/emissions-of-carbon-dioxide-for-local-authority-areas [Accessed: 31/08/2021]. Updates are typically in late-June each year.

1.3. Report Structure

In order to represent an area as large as Suffolk, the region had to be split into three sub-regional areas: 'Suffolk West & Babergh', 'Suffolk Centre' and 'Suffolk East'. Figure 1 shows this graphically. The theory behind this split was to keep the number of dwellings in each sub-region to under 200,000 to simplify the modelling processes while maintaining contiguous sub-regions.

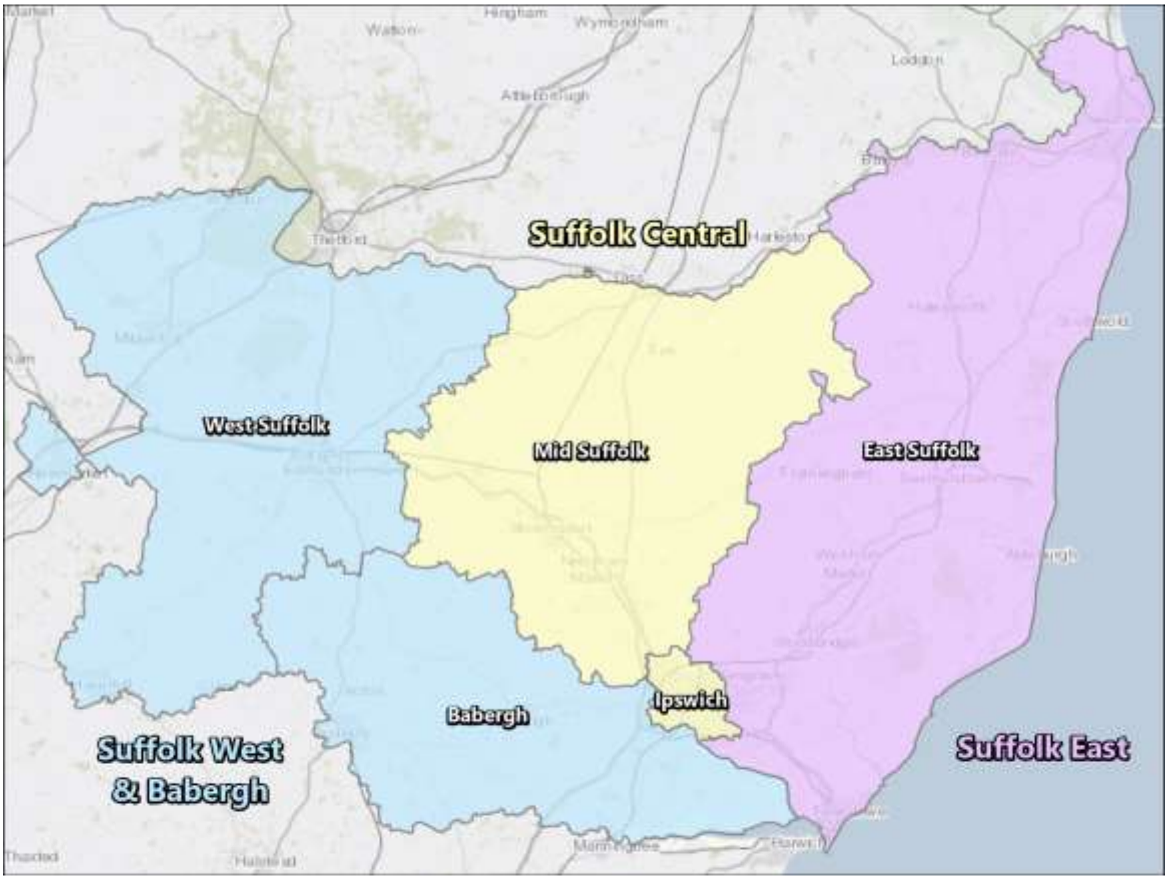


Figure 1: Suffolk split into three sub-regions to carry out the modelling and analysis.

This LEAR report is broken into four key sections: each of the three sub-regional areas are considered before looking at some examples of insights that can be gained from the data.

2. Suffolk Sub-Regional Analysis

This section of the report will provide information and mapping for each of the three sub-regional areas of the Suffolk West & Babergh (West Suffolk and Babergh), Suffolk Central (Mid Suffolk and Ipswich), and Suffolk East (East Suffolk). As these maps cover an area equal to 1-2 local authority areas some of the detail can be lost. More detail is provided in the Insights section of this report and all maps and data are available in the data pack which accompanies this report.

2.1. Suffolk West & Babergh (West Suffolk and Babergh)

The 'Suffolk West & Babergh' area of Suffolk has been defined in this report as covering the local authority areas of West Suffolk and Babergh which collectively cover an area of approximately 1,630 km^2 and have a population of around 265,000.

2.1.1. Building Stock

This section will provide an overview of the building stock – both domestic and non-domestic – across the Suffolk West & Babergh sub-region. The geographical location of the building stock will be shown, as will the relative rurality across the sub-region, and breakdowns of the domestic and non-domestic stock by category.

Figure 2 shows the building stock is fairly evenly distributed across the districts that form the Suffolk West & Babergh sub-region. The larger conurbations such as Newmarket, Sudbury and Bury St Edmunds can be clearly seen.

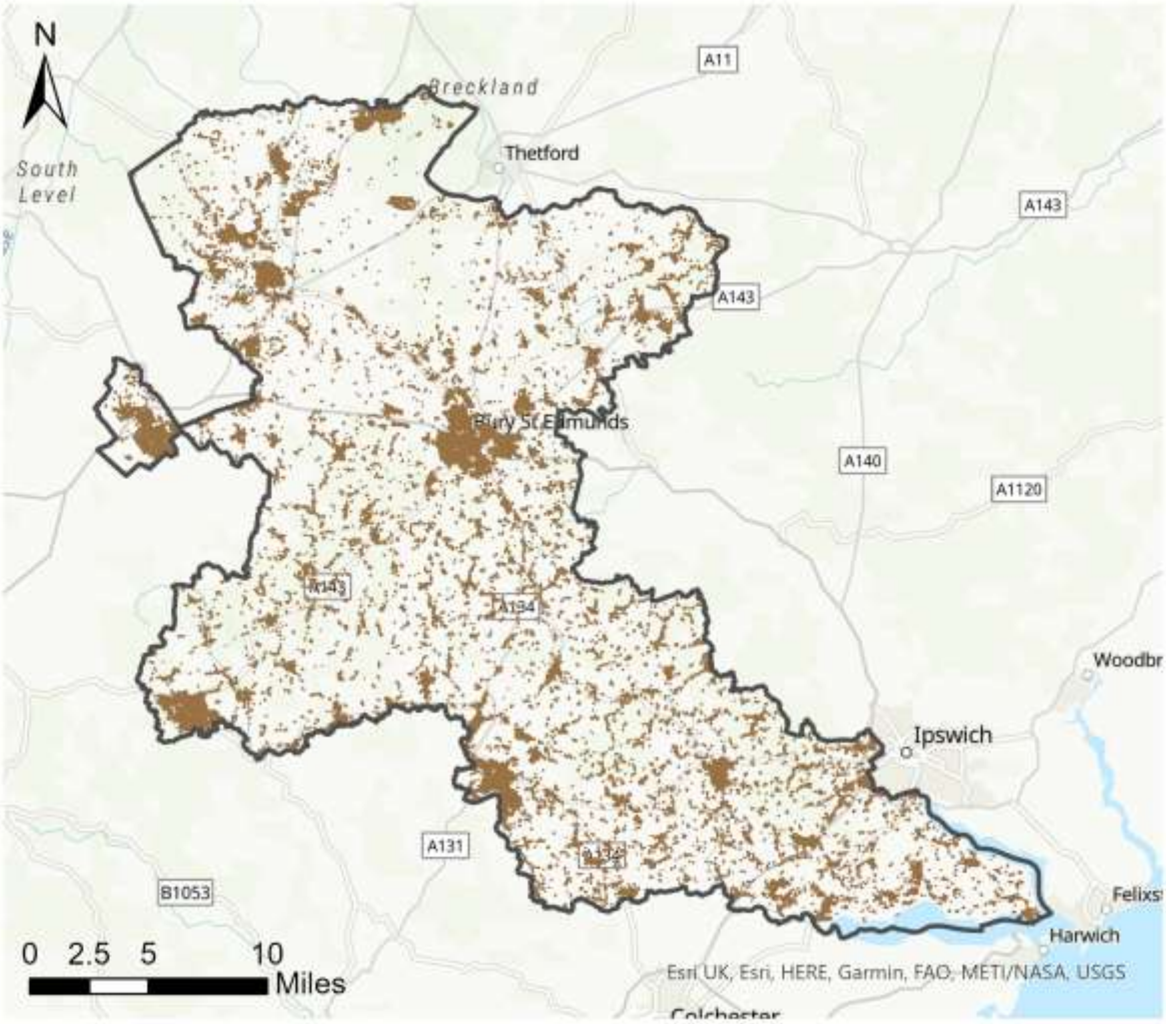


Figure 2: Building stock distribution across the Suffolk West & Babergh sub-region.

These areas correlate well to the rural/urban classifications given in the rurality map (Figure 3). An exception is noted to the north-west of the region, where RAF Lakenheath is located – while this may not show as a large number of buildings, it is nevertheless a large built-up area.

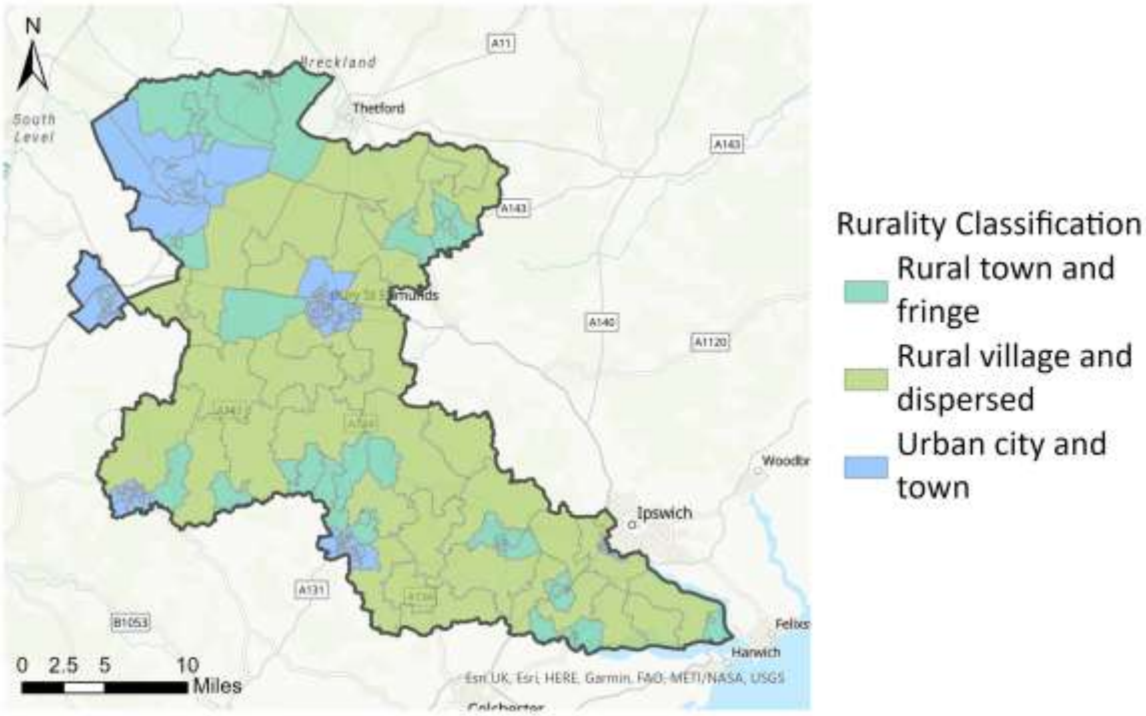


Figure 3: Rurality of the Suffolk West & Babergh sub-region.

Figure 3 shows the rurality of the Suffolk West & Babergh sub-region by Lower-level Super Output Area (LSOA). Most of the land area in Suffolk West & Babergh is classified as rural towns and villages with the more urban areas matching those noted in Figure 2.

Using data provided by Historic England[4], the location and grade of listed buildings; scheduled monuments; Battlefields; World Heritage Sites and Parks & Gardens can be mapped within the sub-region (Figure 4).

[4] https://historicengland.org.uk/listing/the-list/data-downloads

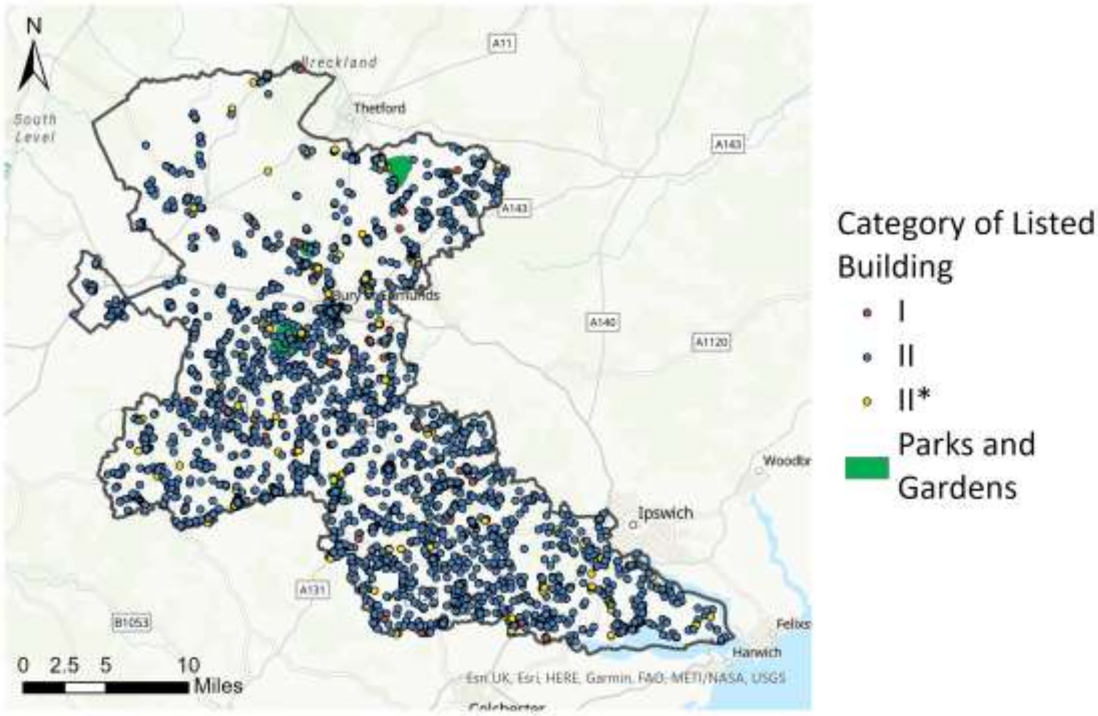


Figure 4: Location of listed buildings in the Suffolk West & Babergh sub-region grouped by grading according to Historic England

Figure 4 shows the large number of listed buildings, scheduled monuments, and areas of interest that could all pose a challenge to decarbonising the building stock. Table 2 shows the Listed Status of the buildings and the number of occurrences.

Table 2: Summary of listed buildings across Suffolk West & Babergh by grade category.

Grade Category	*Number*
Grade I	190
Grade II	5,369
*Grade II**	356
Scheduled Monument	139

To understand the housing stock in more detail, the domestic stock has been segmented by:

- Type (converted flat, detached, purpose-built flat, semi-detached, and terrace)
- Construction date (pre-1914, 1914-1944, 1945-1964, 1965-1979, post-1980)
- Floor area [m^2] (under 50, 50-70, 70-90, 90-110, 110-200, 200-300, over 300)
- Main heating system (ASHP, biomass, electric (no storage), electric storage, gas, GSHP, oil/LPG)
- Loft insulation level [mm] (no loft, no insulation, 1-99, 100-199, over 200)
- Wall type (filled cavity, unfilled cavity, solid with ESWI, solid with ISWI, uninsulated solid)
- Window type (single glazing, double glazing, triple glazing)

Table 3: Number and percentage of dwelling types across the Suffolk West & Babergh sub-region.

Dwelling Type	***Number***	***Percentage***
Converted Flat	2,600	2%
Detached	41,500	33%
Purpose Built Flat	16,300	13%
Semi-detached	30,500	24%
Terrace	33,500	27%
Total	**124,000**	**100%**

Due to rounding, some totals may not correspond with the sum of the separate figures.

Table 3 shows that there is a predominance of detached dwellings across the sub-region. Figure 5 shows that these are typically the most dominant in rural areas, whereas semi-detached and terraced are more common in urban areas.

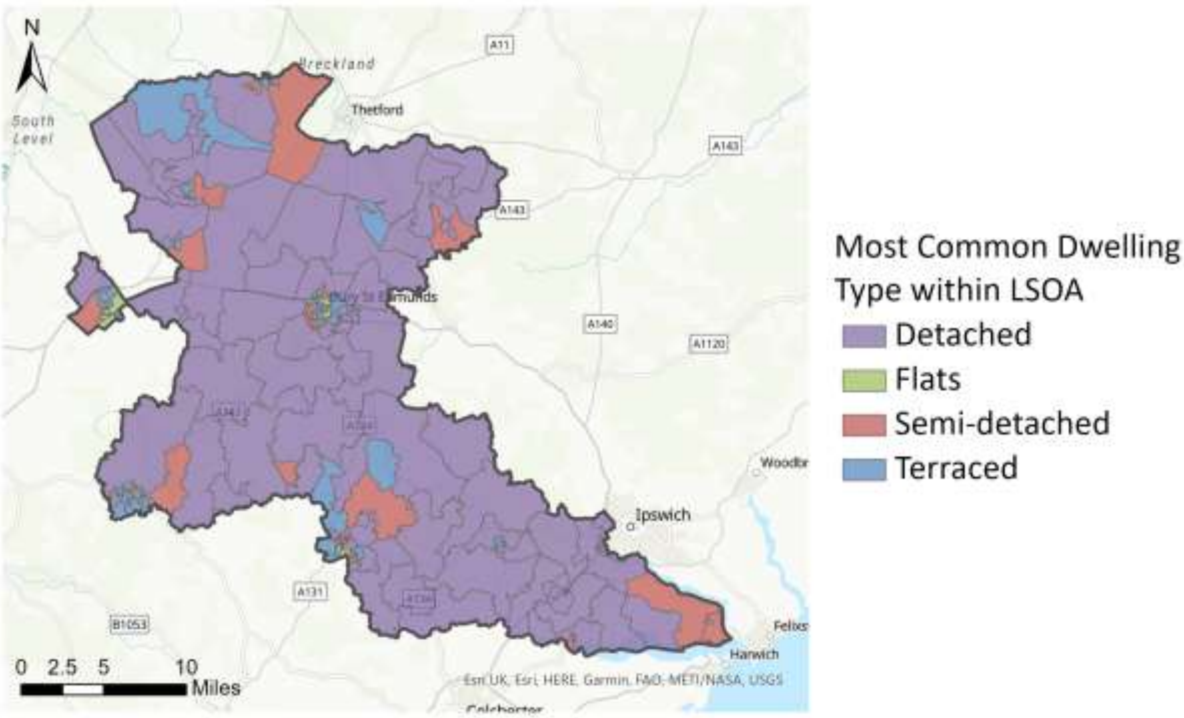


Figure 5: Most common dwelling type within each LSOA across the Suffolk West & Babergh sub-region.

A notable finding, shown in Table 4 is that around half of dwellings in the Suffolk West & Babergh sub-region have been constructed since 1965. A significant number of dwellings that were built before 1945 will likely require more substantial intervention to bring their heat loss to a point where a heat pump could be considered.

Table 4: Number and percentage of dwellings constructed in different periods across the Suffolk West & Babergh sub-region.

Dwelling Construction Period	Number	Percentage
Pre-1914	19,800	16%
1914-1944	7,800	6%
1945-1964	36,500	30%
1965-1979	34,000	27%
1980-present	25,500	21%
Total	**124,000**	**100%**

Due to rounding, some totals may not correspond with the sum of the separate figures.

By combining the dwelling type and the construction period, it can be seen in Figure 6 that pre-1914 terraced houses were dominant before the rise in semi-detached and detached properties in the post-war period (1945-1964). Indeed pre-1914 terraced houses account for 36% of all terraced dwellings and 10% of all dwellings in the Suffolk West & Babergh sub-region. In the most recent period (1980-present), detached dwellings have dominated construction accounting for 55% of all dwellings built.

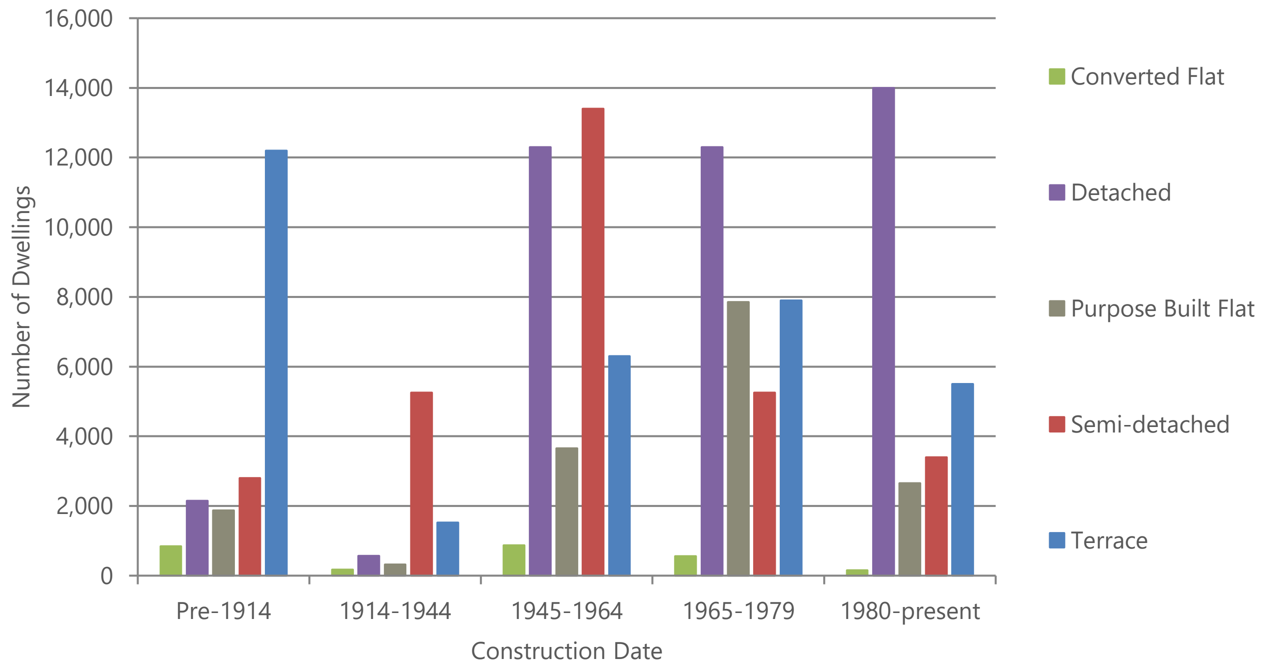


Figure 6: Estimated number of dwellings within each construction period (by dwelling type) across the Suffolk West & Babergh sub-region.

This can be visualised spatially (Figure 7) to show the most prevalent construction year in each LSOA in the Suffolk West & Babergh sub-region.

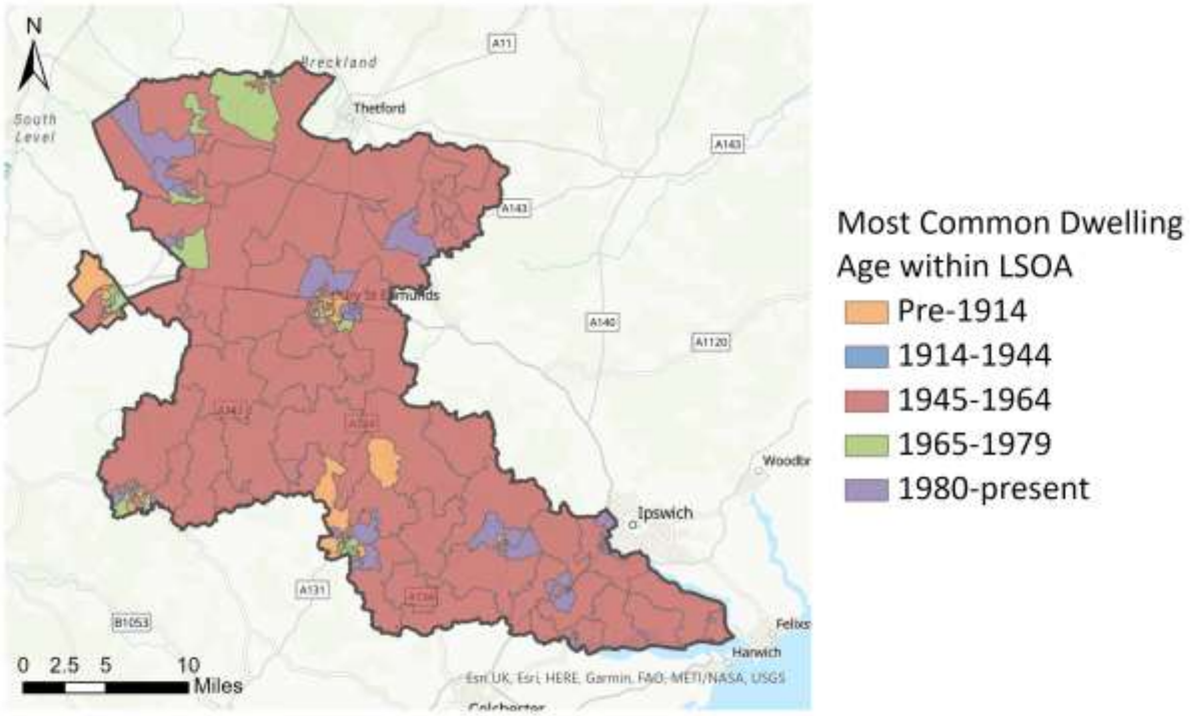


Figure 7: Most common construction period within each LSOA across the Suffolk West & Babergh sub-region.

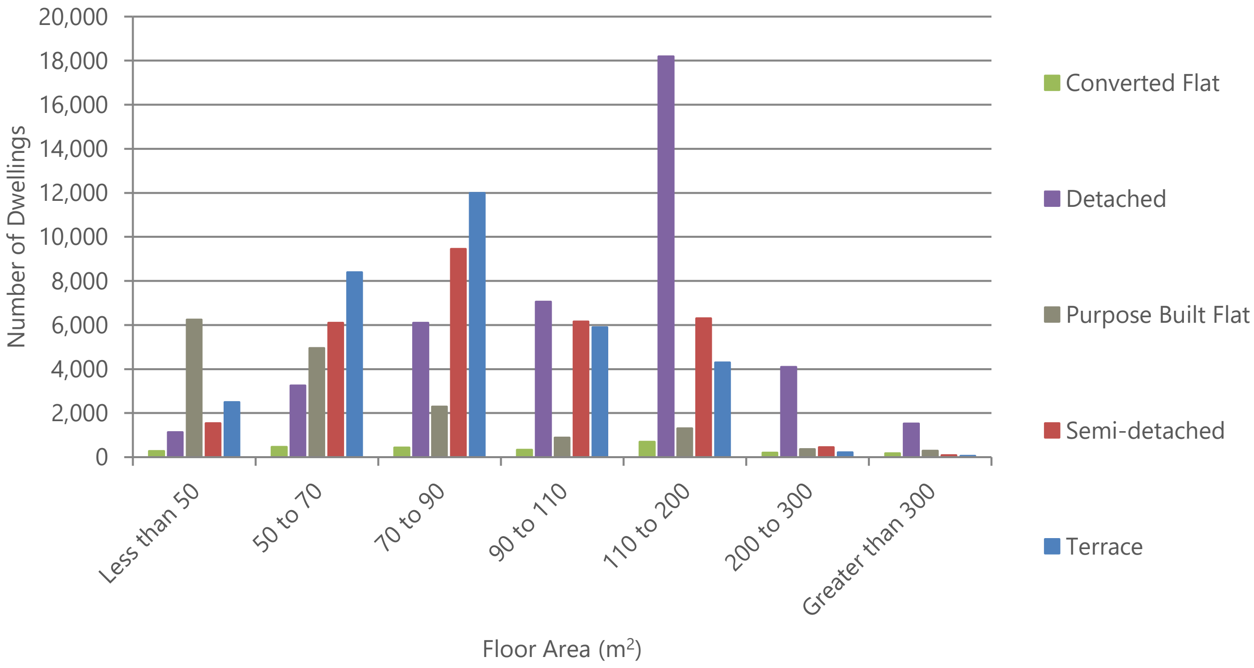


Figure 8: Estimated number of dwellings within each floor area band (by dwelling type) across the Suffolk West & Babergh sub-region.

Figure 8, as expected, shows flats (particularly purpose-built flats) have a lower floor area than semi-detached and detached dwellings. Almost 70% of purpose-built flats have a floor area of under 70m^2 whilst 44% of detached dwellings have a floor area of 110-200m^2.

Dwellings in the Suffolk West & Babergh sub-region are overwhelmingly heated using a fossil fuel boiler (88%) with the remainder being made up from electric storage heaters. Although there are estimated to be over 2,000 heat pumps in the Suffolk West & Babergh sub-region, this only equates to 1.6% of dwellings. Electric storage heaters are often used in modern flats where heat losses are low. Oil/LPG boilers are typically used in off-gas grid areas which in turn are often rural. Figure 9 shows that around one-third of detached dwellings use oil/LPG boilers as their main heating system. Gas boilers are prevalent throughout the housing stock.

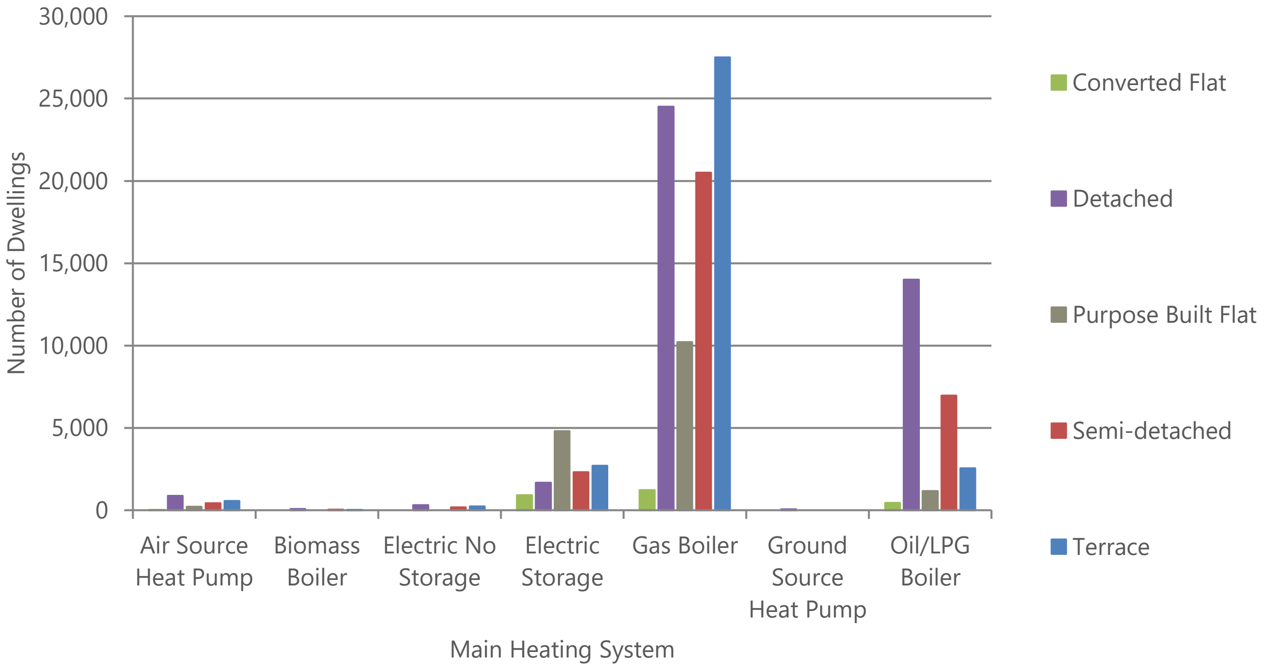


Figure 9: Estimated number of dwellings by main heating system (by dwelling type) across the Suffolk West & Babergh sub-region.

To make a heating system as efficient as possible insulation is required to reduce the heat loss from a dwelling. Figure 10 shows the level of loft insulation in each dwelling type. Flats (both converted and purpose built) are assumed not to have a loft to insulate as even those on the top-floor are unlikely to be able to access the loft space in which to add insulation. There are also a small number of detached, semi-detached, and terraced properties that are classified as having no loft; this is usually due to them having a 'room-in-roof' where the loft has been converted into part of the living area.

The expected level of loft insulation in the UK is 270mm meaning that there are at least 80% of the dwellings in the Suffolk West & Babergh sub-region that would benefit from additional loft insulation. Of particular concern are the 42,000 dwellings (34% of the housing stock) that have no loft insulation recorded.

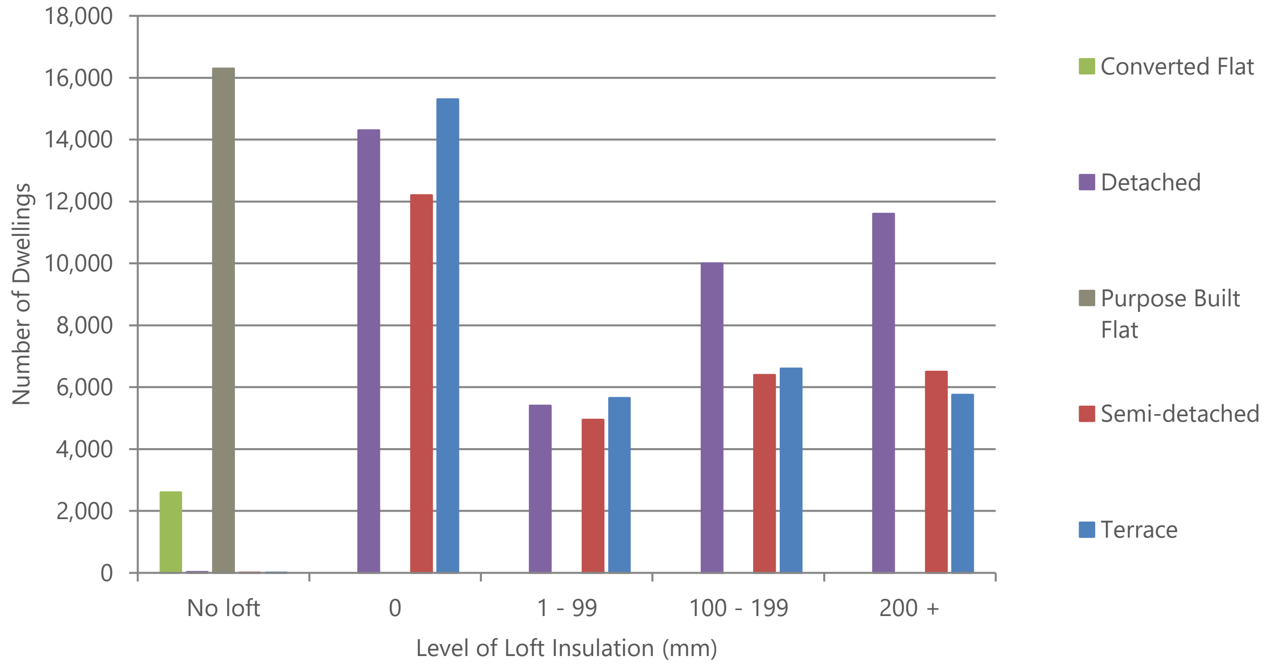


Figure 10: Estimated level [mm] of loft insulation (by dwelling type) across the Suffolk West & Babergh sub-region.

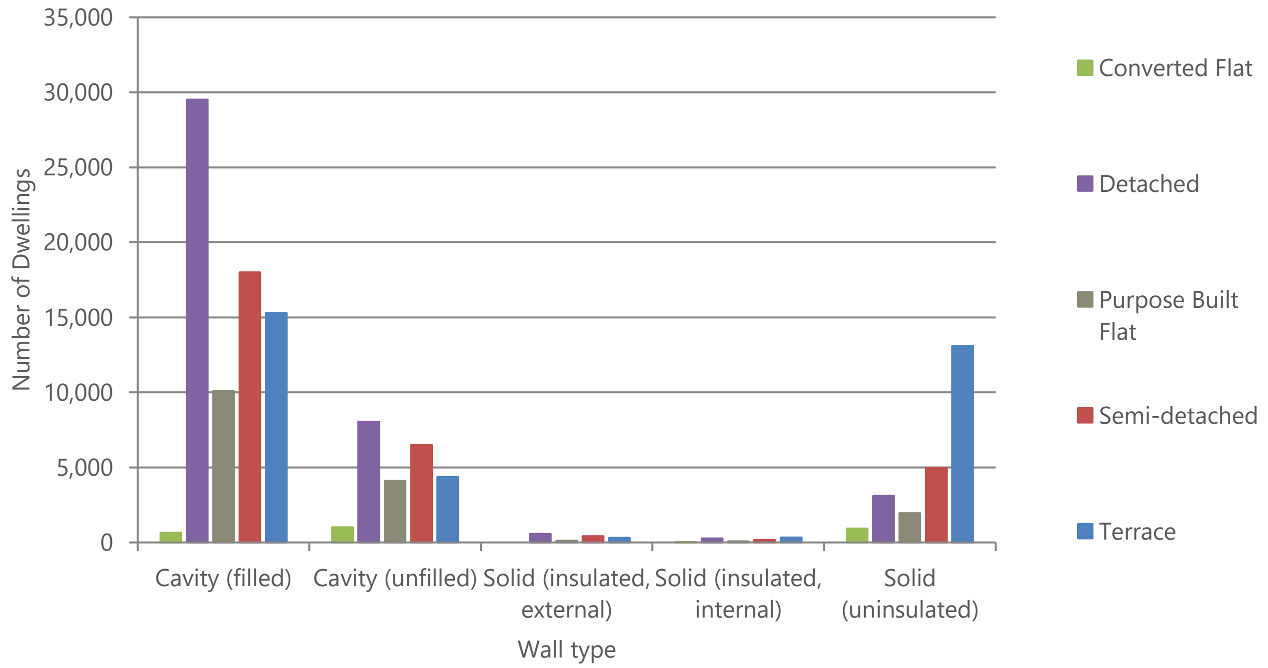


Figure 11: Estimated wall type and insulation level (by dwelling type) across the Suffolk West & Babergh sub-region.

Figure 11 shows that cavity walls are the most prominent wall type across the Suffolk West & Babergh sub-region. Of those dwellings with a cavity wall, 75% (c. 73,500) are insulated. Cavity wall insulation can be difficult on some archetypes where there are hung tiles or render on the external face of the brickwork, also around conservatories. Whilst these are deemed 'hard-to-treat' there are methods for ensuring that the cavity can be filled, albeit at a higher cost. Figure 11 also shows that almost all of the solid wall properties in the Suffolk West & Babergh sub-region are uninsulated. This may be due to listed status, other planning restrictions, occupant behaviour/preference, or cost.

Almost 95% of dwellings in the Suffolk West & Babergh sub-region have double glazing (Figure 12). Triple glazing is not prevalent in the housing stock.

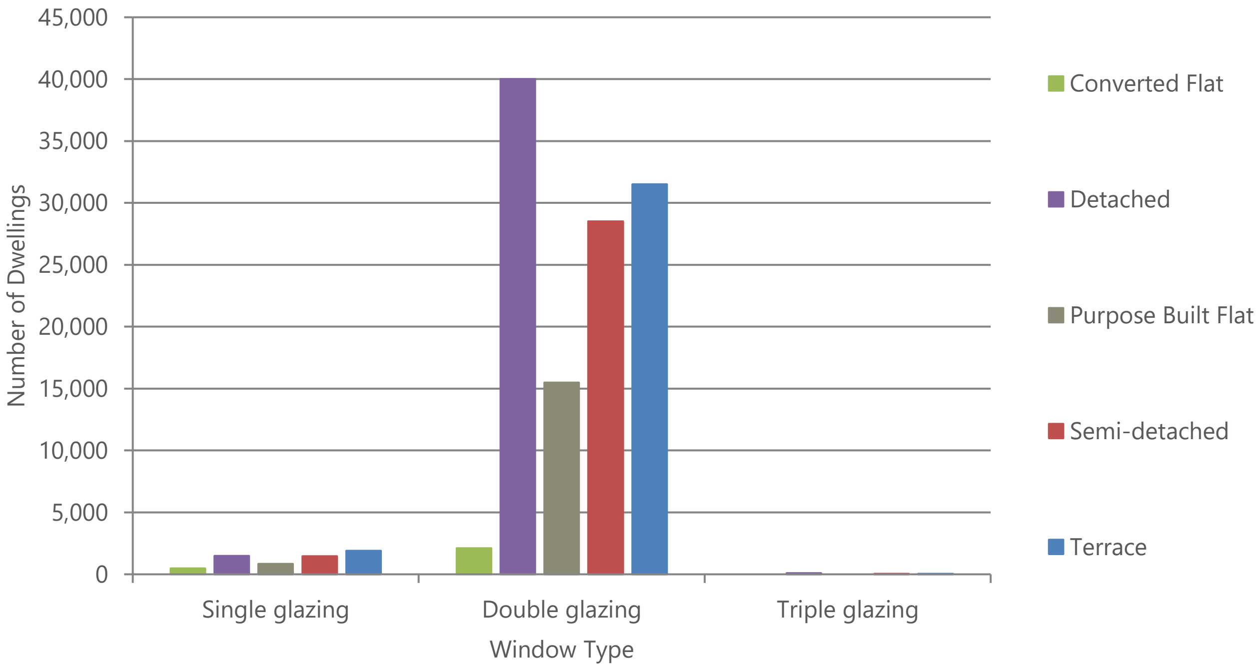


Figure 12: Estimated proportion of glazing type per dwelling type across the Suffolk West & Babergh sub-region.

To give a visual representation of the current energy efficiency of dwellings within the region, the EPC rating of all properties within an LSOA has been averaged to show where the most and least efficient regions of houses lie. Figure 13 below shows the proportion of the most efficient dwellings in the area, those that have an EPC rating of C or above. Figure 14 on the other hand shows the least efficient dwellings in the area, those that have an EPC rating of E or below. This criterion allows for direct correlation with that of the Local Authority Delivery (LAD) scheme which has a focus on homes living in fuel poverty and an EPC rating of E, F or G.[5]

[5] https://www.gov.uk/government/publications/green-homes-grant-local-authority-delivery-scheme-phase-2-funding-allocated-to-local-energy-hubs

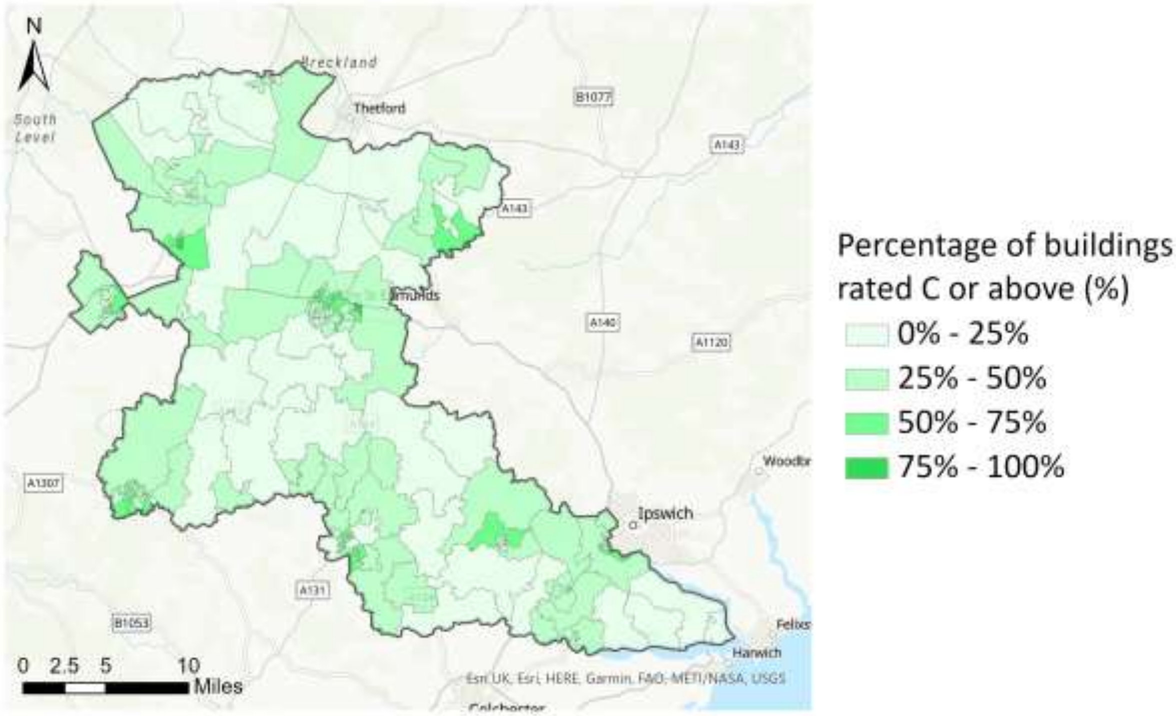


Figure 13: Proportion of dwellings rated EPC C or above across the Suffolk West & Babergh sub-region.

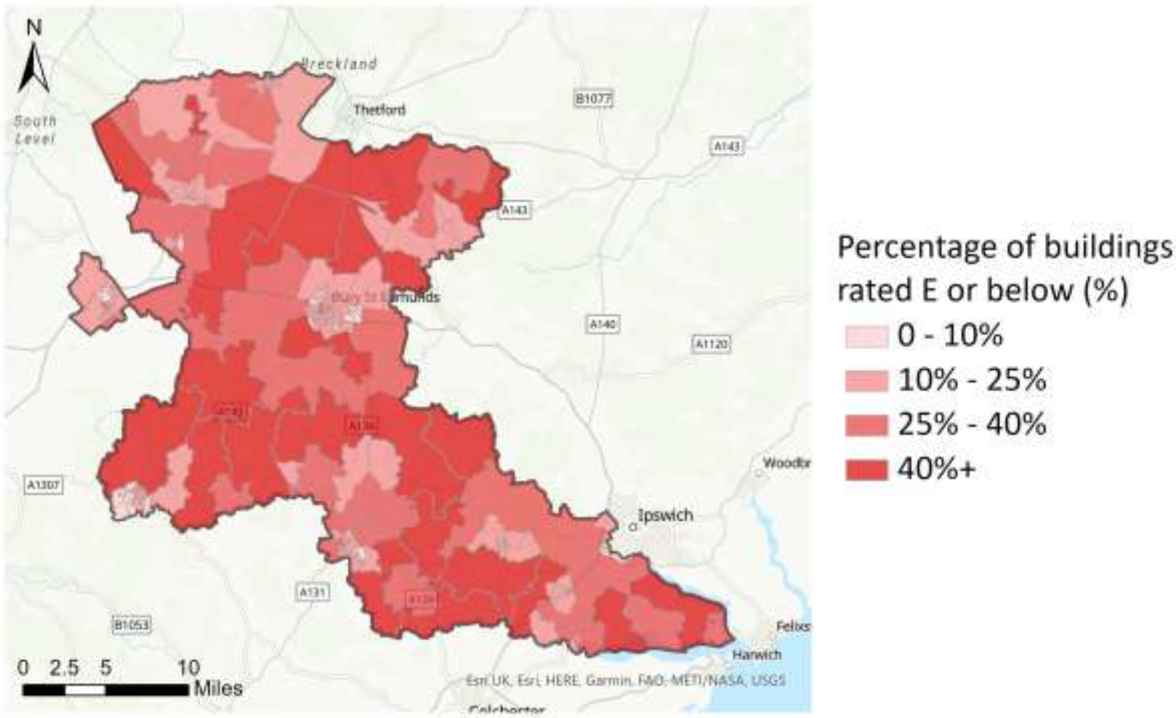


Figure 14: Proportion of dwellings rated EPC E or below across the Suffolk West & Babergh sub-region.

As well as the domestic stock, the non-domestic stock needs to be considered. The breakdown of the non-domestic building stock across the Suffolk West & Babergh sub-region is shown in Table 5.

Table 5: Breakdown of the non-domestic building stock by type across the Suffolk West & Babergh sub-region.

Type	*Floor Area [m²]*	*Percentage of total floor area*	*Number of non-domestic buildings*	*Percentage of non-domestic buildings*
Retail	4,000,000	41%	21,500	52%
Factory	3,150,000	32%	8,650	21%
Warehouse	795,000	8%	4,850	12%
Education	720,000	7%	2,300	6%
Other	695,000	7%	1,920	5%
Office	510,000	5%	2,150	5%
Total	**9,900,000**	**100%**	**41,500**	**100%**

Due to rounding, some totals may not correspond with the sum of the separate figures.

Data from the National Atmospheric Emissions Inventory (NAEI)[6] has been used to identify large individual emission point sources i.e. emissions from a known location. As well as CO_2, this data shows air pollutants, heavy metals, base cations[7], and greenhouse gases (GHGs)[8]. The point sources included within the project boundary are shown below in Figure 15. It should be noted that this dataset is for fixed emission sources only, and that non-fixed emissions such as those from road traffic are not included.

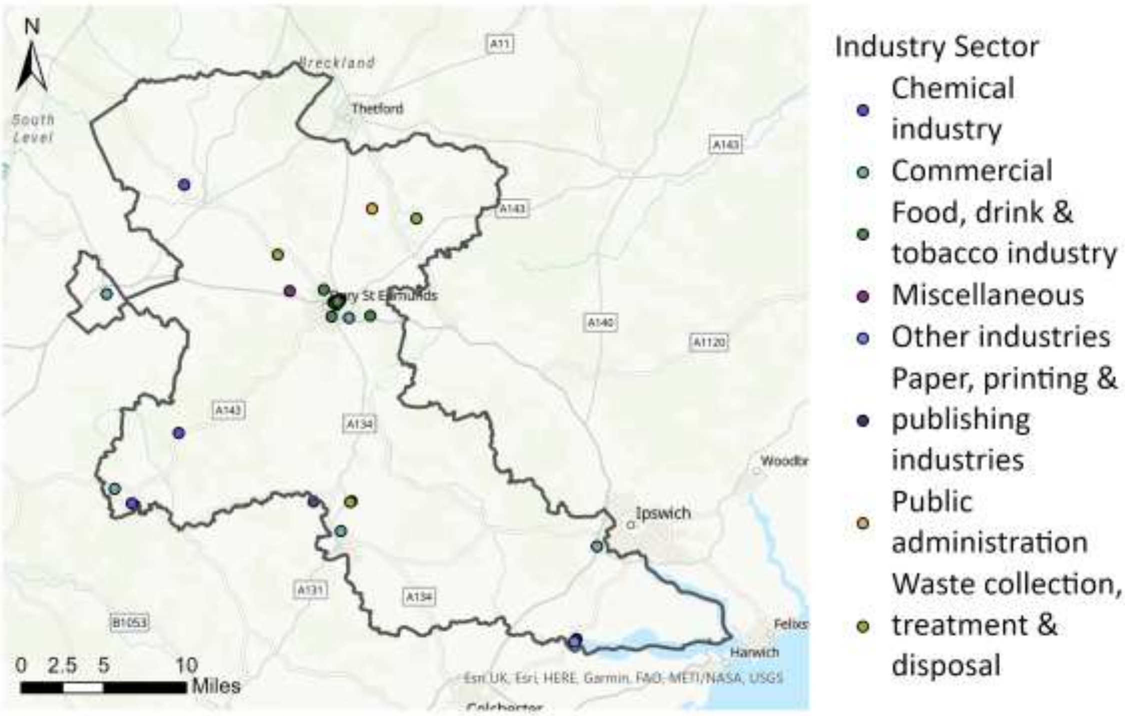


Figure 15: Individual emission sources identified by the National Atmospheric Emissions Inventory (NAEI) across the Suffolk West & Babergh sub-region.

[6] https://naei.beis.gov.uk/
[7] https://naei.beis.gov.uk/overview/ap-overview
[8] https://naei.beis.gov.uk/overview/ghg-overview

Often the high emitters are located closely together on an industrial park or similar, therefore the definition given in Figure 15 is lacking. However, the data pack accompanying this report contains the full background data providing more clarity.

2.1.2. Energy Demands

This section will show the estimated annual consumption and peak demands across the Suffolk West & Babergh sub-region in the domestic and non-domestic sectors, and the geographic distribution by LSOA.

Table 6 and Table 7 below show the total figures for the sub-region. Please note: Electricity is supplied locally at 400V (three-phase) which is then connected to a dwelling at 230V (single-phase), therefore for the purposes of these calculations all domestic properties are assumed to be connected at 400V. Large non-domestic loads are assumed to be connected to the electricity network at 11kV; other non-domestic are connected at 400V. Total electricity demand is therefore the sum of demand at the 11kV level and 400V level. Demand from power generators and utilities are not included in these figures.

Table 6: Annual energy consumption [MWh] across the Suffolk West & Babergh sub-region.

Energy Type	***Domestic Annual Consumption [MWh]***	***Non-Domestic Annual Consumption [MWh]***	***Total Annual Consumption [MWh]***
Electricity (11kV)	0	174,000	174,000
Electricity (400V)	420,000	1,200,000	1,620,000
Gas	545,000	1,350,000	1,895,000
Oil	198,000	0	198,000

Table 7: Annual peak demand [MW] across the Suffolk West & Babergh sub-region.

Energy Type	***Domestic Peak Demand [MW]***	***Non-Domestic Peak Demand [MW]***	***Total Peak Demand [MW]***
Electricity (11kV)	0	50	50
Electricity (400V)	120	375	460
Gas	485	515	940
Oil	180	0	180

The total peak demand is not the sum of the peak demands for domestic and non-domestic buildings since the peak demands of the different sectors occur at different times.

The following maps (Figure 16 to Figure 19) show the distribution of estimated peak and annual energy consumption for both domestic and non-domestic buildings across the Suffolk West & Babergh sub-region. Peak demands shown on these maps may not all occur at the same time of day or time of year. For example, an area predominantly made up of domestic dwellings is likely to have a peak energy demand during the early evening in winter. In contrast, an area that is mainly made up of commercial offices will have maximum energy demand around the middle of the day. Mixed-use areas could have a different peak time depending upon the nature of their buildings.

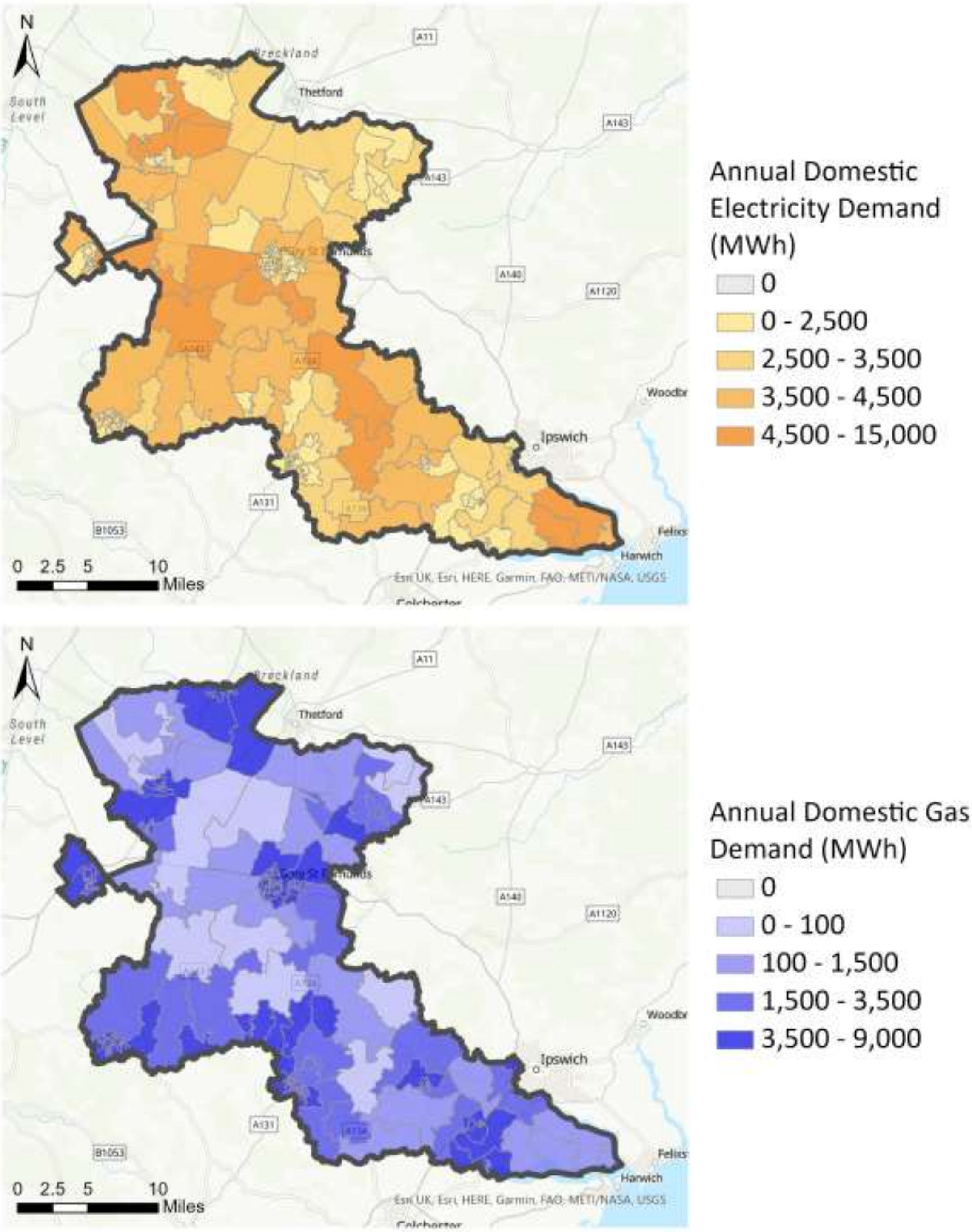


Figure 16: Estimated current domestic annual energy consumption by fuel and LSOA across the Suffolk West & Babergh sub-region.

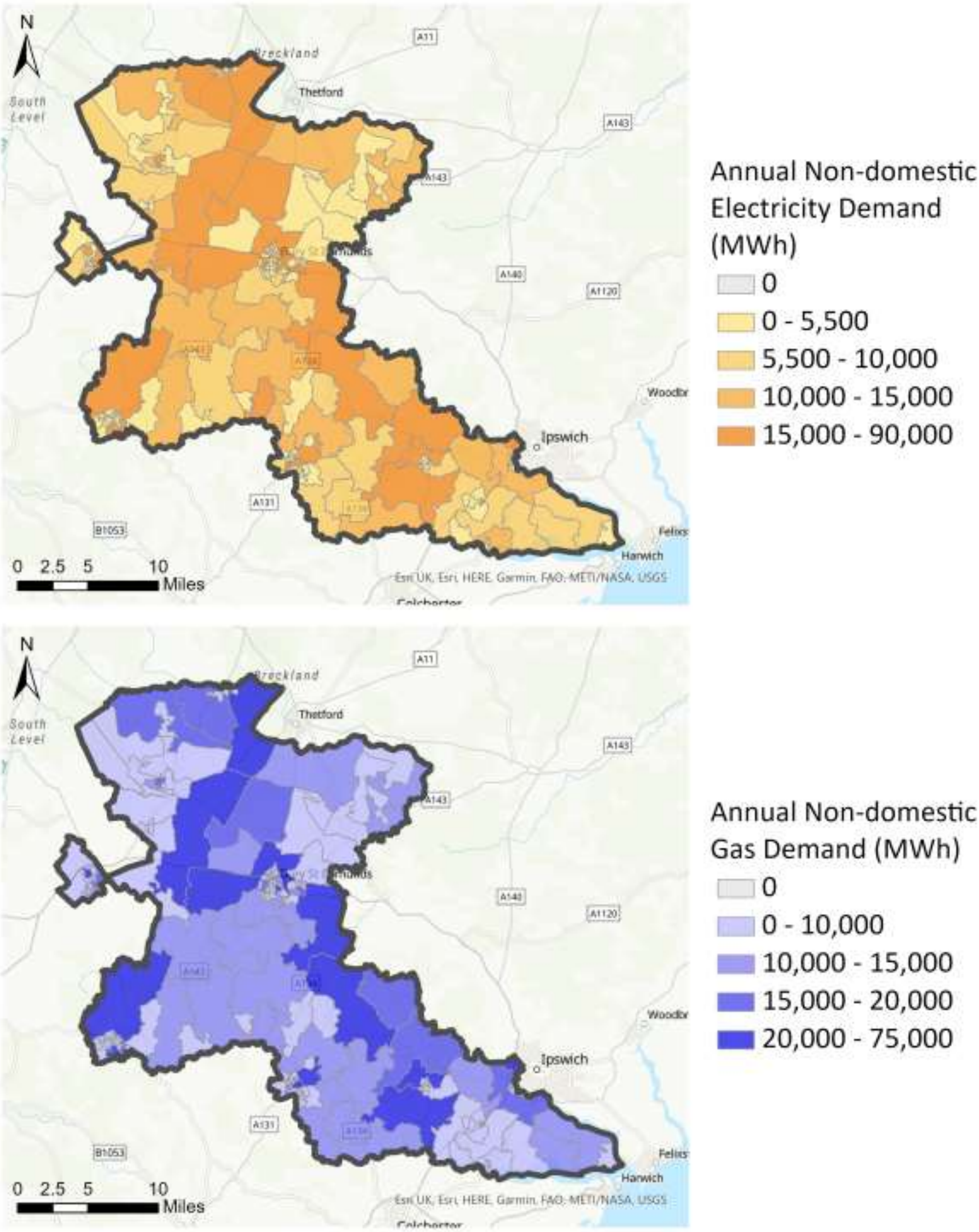


Figure 17: Estimated current non-domestic annual energy consumption by fuel and LSOA across the Suffolk West & Babergh sub-region.

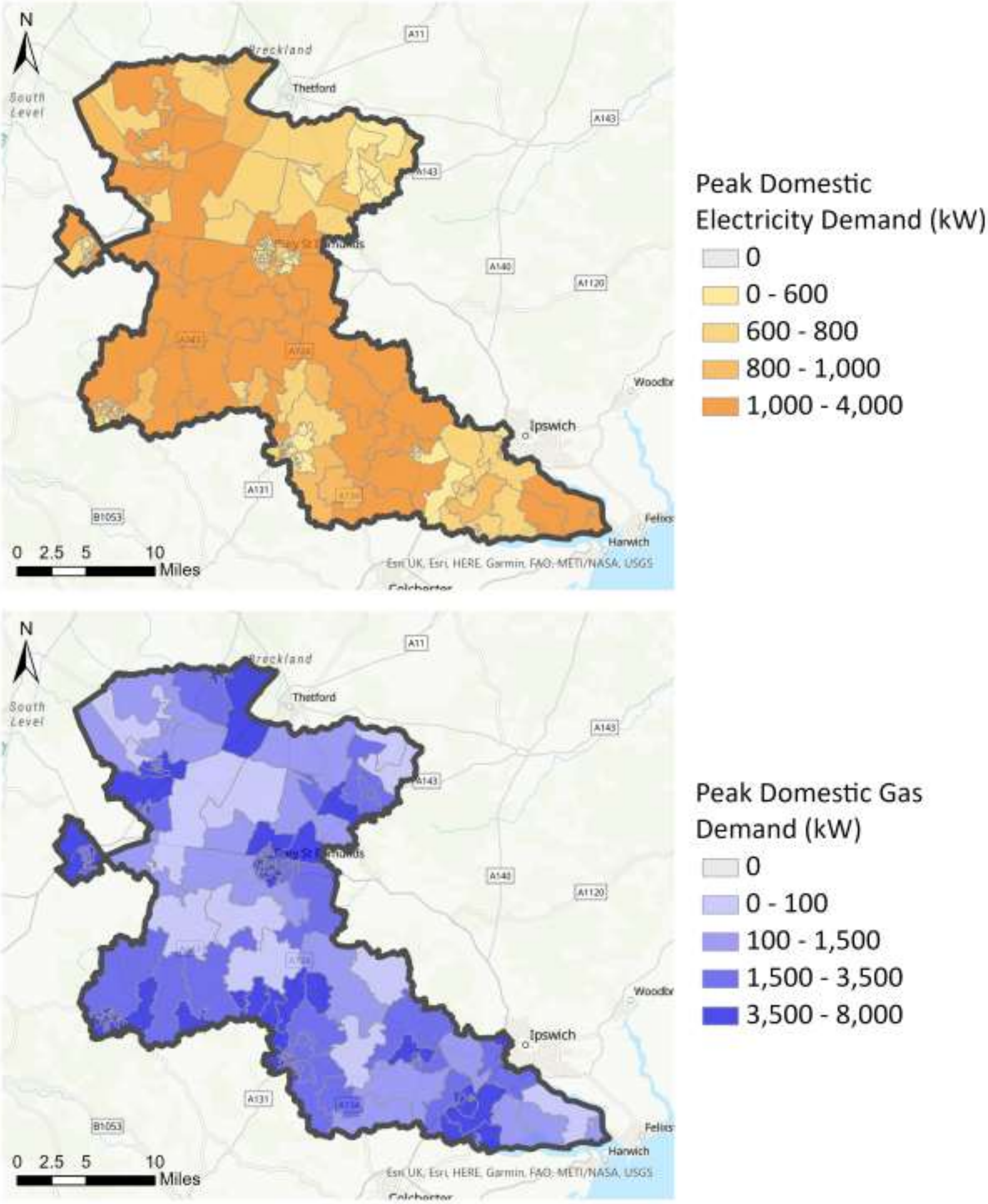


Figure 18: Estimated current domestic peak energy demand by fuel and LSOA across the Suffolk West & Babergh sub-region.

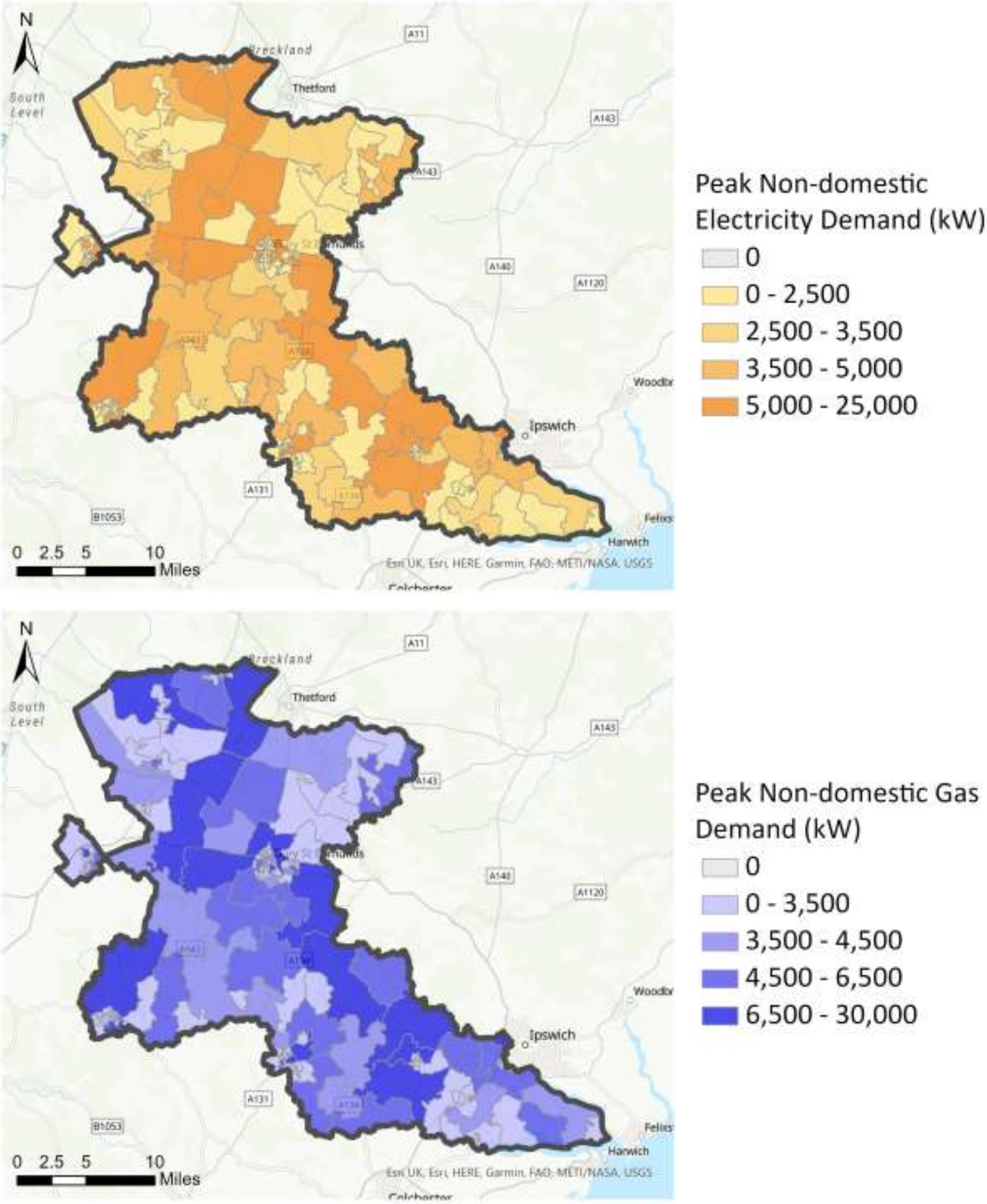


Figure 19: Estimated current non-domestic peak energy demand by fuel and LSOA across the Suffolk West & Babergh sub-region.

Figure 20 shows an estimate of the total electricity demand profile for the Suffolk West & Babergh sub-region for different days of the year representing the lowest typical demand and the highest. The peak day is also shown, which is used to determine a worst-case scenario on the network. Electricity demand includes heat, lighting, appliances, and electric vehicle charging when charge points are known to exist in the local area. The profile is for domestic and non-domestic buildings combined.

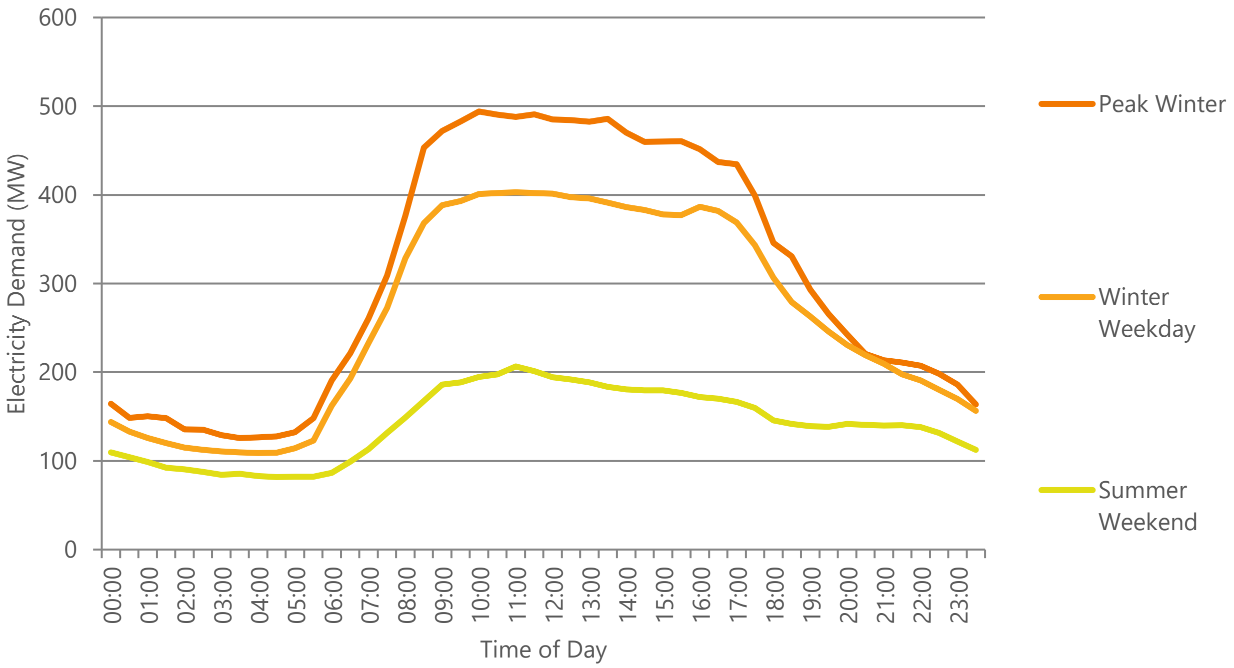


Figure 20: Estimated electricity demand profiles for different days of the year across the Suffolk West & Babergh sub-region.

As expected, the demand is far lower on a summer weekend when compared to a winter weekday.

Summer weekend represents the lowest end of demand profile; being summer means there is less need for heating, and weekend suggests that office/factory buildings are using less electricity, in contrast to a typical winter weekday.

The area between these two demand profiles demonstrates the typical demand i.e. the electricity demand will likely be within this middle section at any given time.

Figure 21 shows the estimated gas demand profile, and Figure 22 shows the estimated oil demand profile, for the Suffolk West & Babergh sub-region for the same days. Gas and oil demand include both heat and hot water and covers domestic and non-domestic buildings combined.

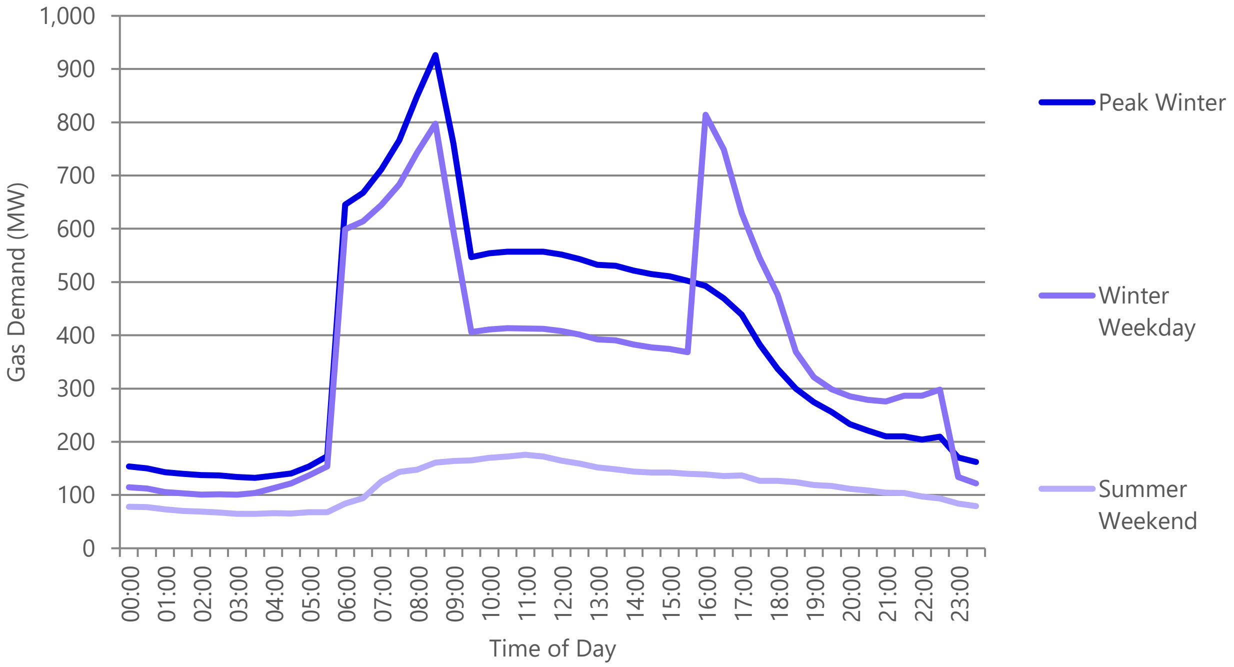


Figure 21: Estimated gas demand profiles for different days of the year across the Suffolk West & Babergh sub-region.

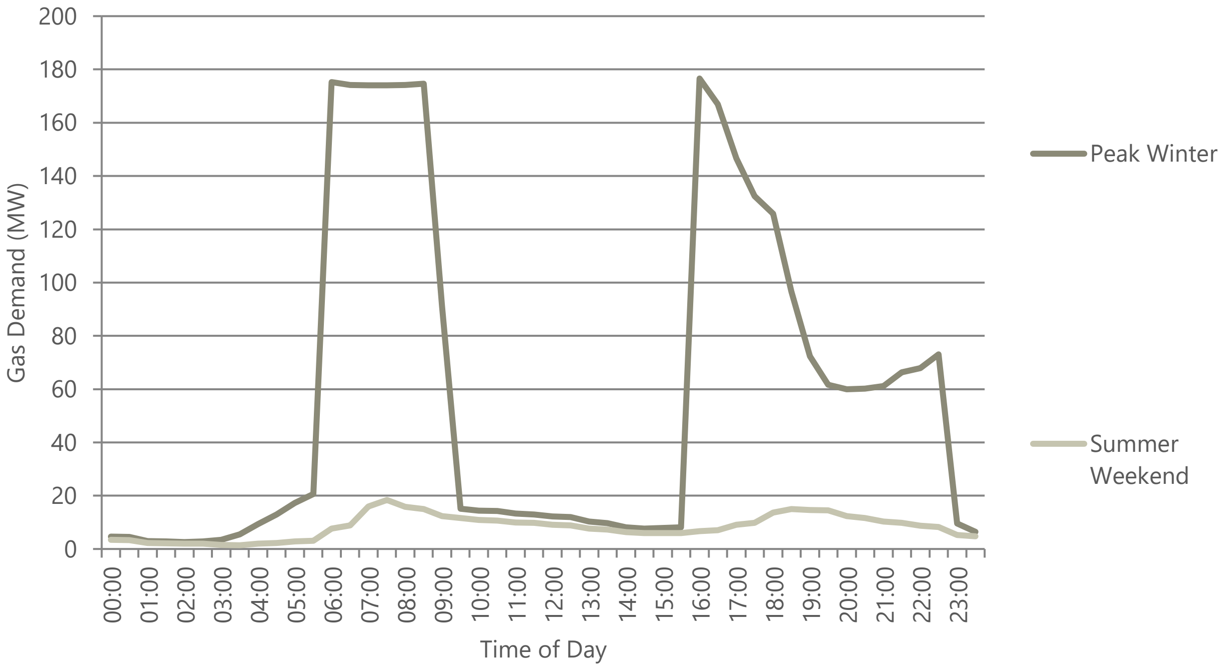


Figure 22: Estimated oil demand profiles for different days of the year across the Suffolk West & Babergh sub-region.

2.1.3. Energy Networks

A good understanding of the energy networks is vital to formulating a forward plan for the decarbonisation of any area. For example, identifying dwellings that are not on the gas network can help to focus a heat pump roll-out programme thus reducing the risk of competing heating vectors such as hydrogen or heat networks being a more financially viable option in the future. To identify those off-gas areas, Xoserve[9] postcode data was used (mapped in Figure 23) before being cross-referenced with Ordnance Survey records to calculate how many dwellings are estimated to be on- or off-gas (Table 8).

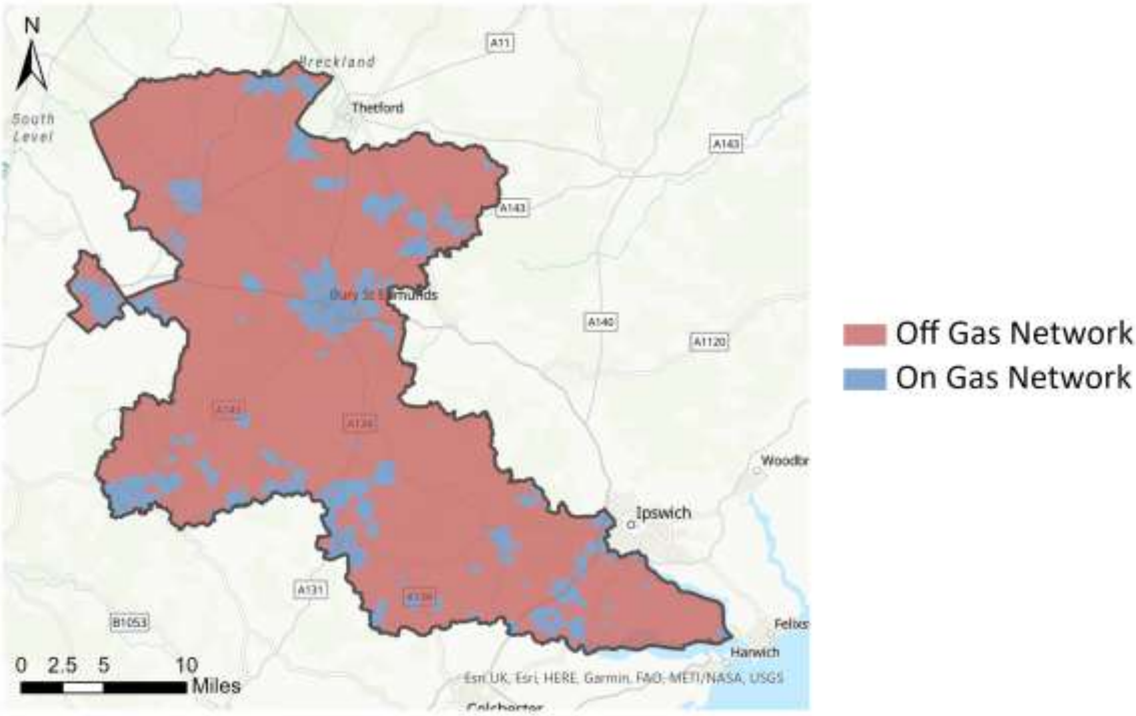


Figure 23: On-gas and off-gas areas of the Suffolk West & Babergh sub-region.

Table 8: Estimate of on-gas and off-gas dwellings across the Suffolk West & Babergh sub-region (rounded to nearest 5,000)

	Number
Off-Gas Dwellings	**40,000**
On-Gas Dwellings	**85,000**

Comparing Figure 23 and Table 8 leads to the conclusion that the off-gas grid areas are sparsely populated. This is confirmed by comparing to Figure 2 showing the location of the building stock.

[9] https://www.xoserve.com/wp-content/uploads/Off-Gas-Postcodes-V2.xlsx

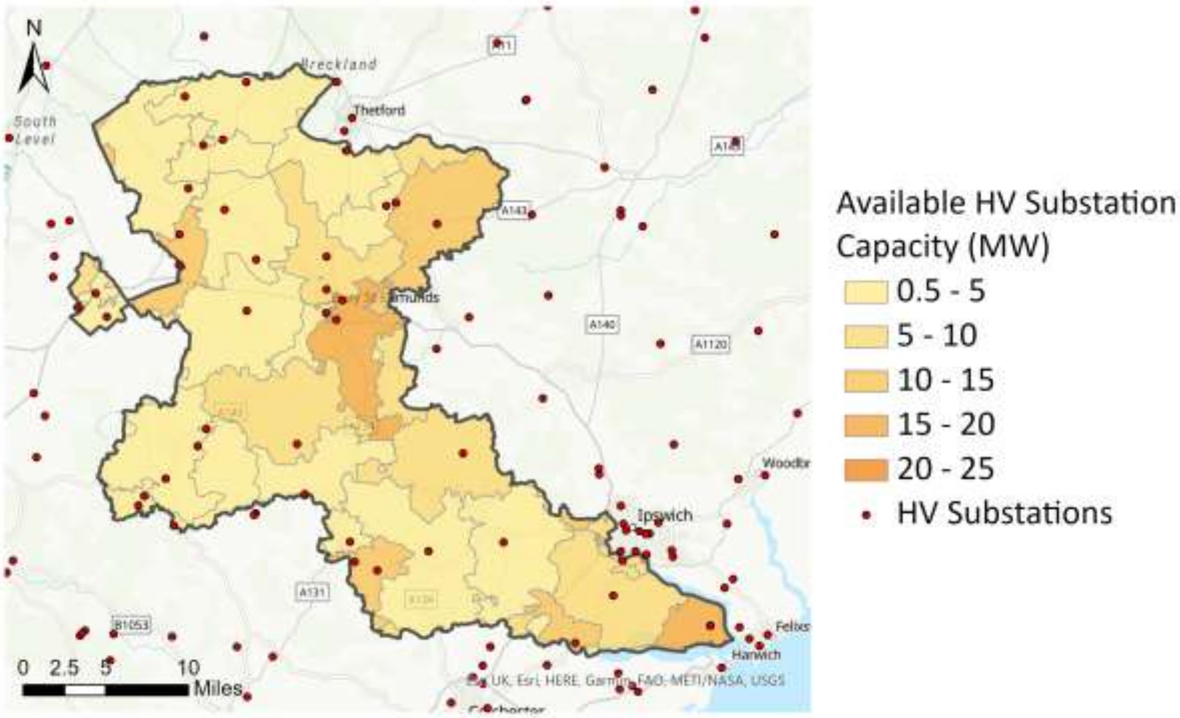


Figure 24: Available high-voltage substation capacity across the Suffolk West & Babergh sub-region.

Figure 24 shows an estimate of the available capacity on each 33kV-to-11kV substation and the extent of the area served by each substation. Capacity is calculated by subtracting the combined peak electrical demand on buildings in each area from the rated capacity of each substation. Those substations shown outside of the Suffolk West & Babergh boundary may serve buildings within it. Substations outside of the boundary have been included since it is likely some may serve assets within the project boundary. This is seen by new polygons that begin next to the project boundary. It should be noted that available capacity of areas on the Suffolk boundary may be overestimated since the demands of buildings outside of the county have not been modelled.

Where network connection is important from a project planning perspective the actual areas served should be established in conversation with the local Distribution Network Operator, (DNO) UK Power Networks. These capacity estimates are intended to give an indication of the capacity available on different parts of the network within the local energy system representation area and are not a substitute for detailed network modelling and analysis conducted by the local DNO. Substations identified as generation only in the DNO data are assumed to have no available capacity. Substations are not included in the analysis where DNO data on locations and capacities are unavailable. Where capacity data is unavailable, but locations are available, the 11kV-to-400kV capacity was set to the most prevalent substation capacity across all of Suffolk. Where capacity data is only available in MVA, it is assumed that capacity in MVA is equal to capacity in MW, unless power factors are available.

Figure 25 shows an estimate of the number of buildings, both domestic and non-domestic connected to each 33kV-to-11kV substation. As with capacity, the extent has been calculated as the area closest to each substation.

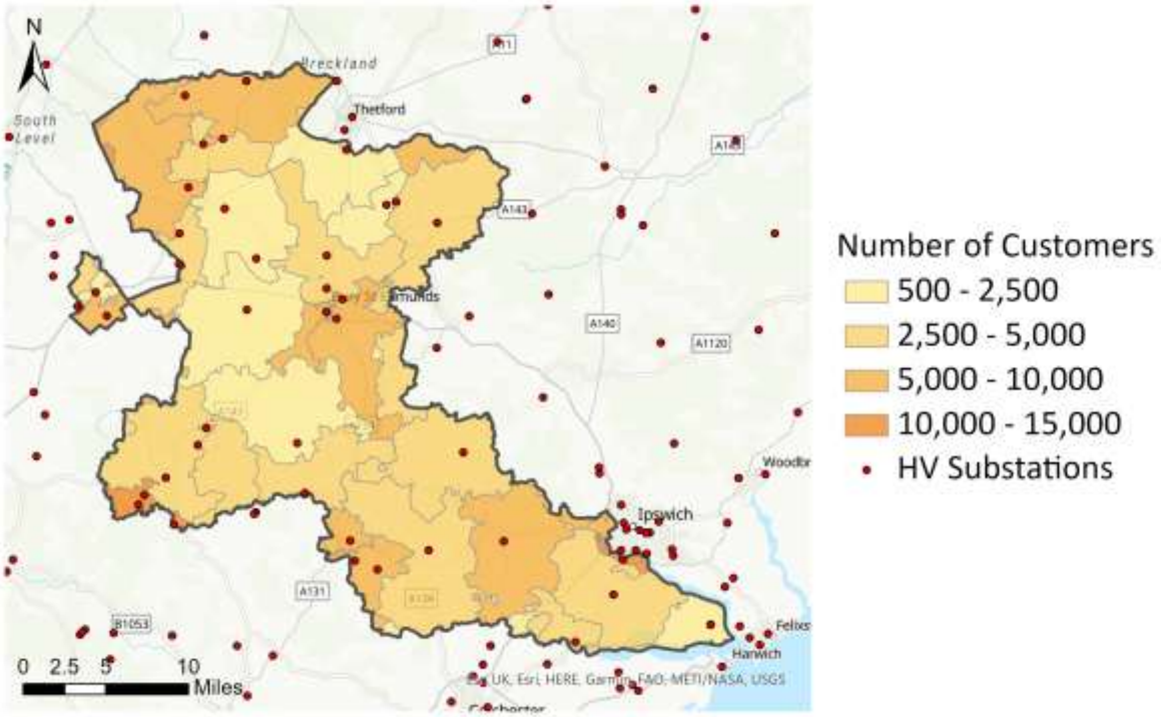


Figure 25: Number of buildings within the Suffolk West & Babergh sub-region served by each high-voltage substation.

In addition to the electrical considerations of the local network, there are physical considerations with planning. To assist with this, Ordnance Survey's definition of 'pylon' is shown below in Figure 26 within the local area. This can help to ensure assets are clear or aware of any existing network infrastructure in place.

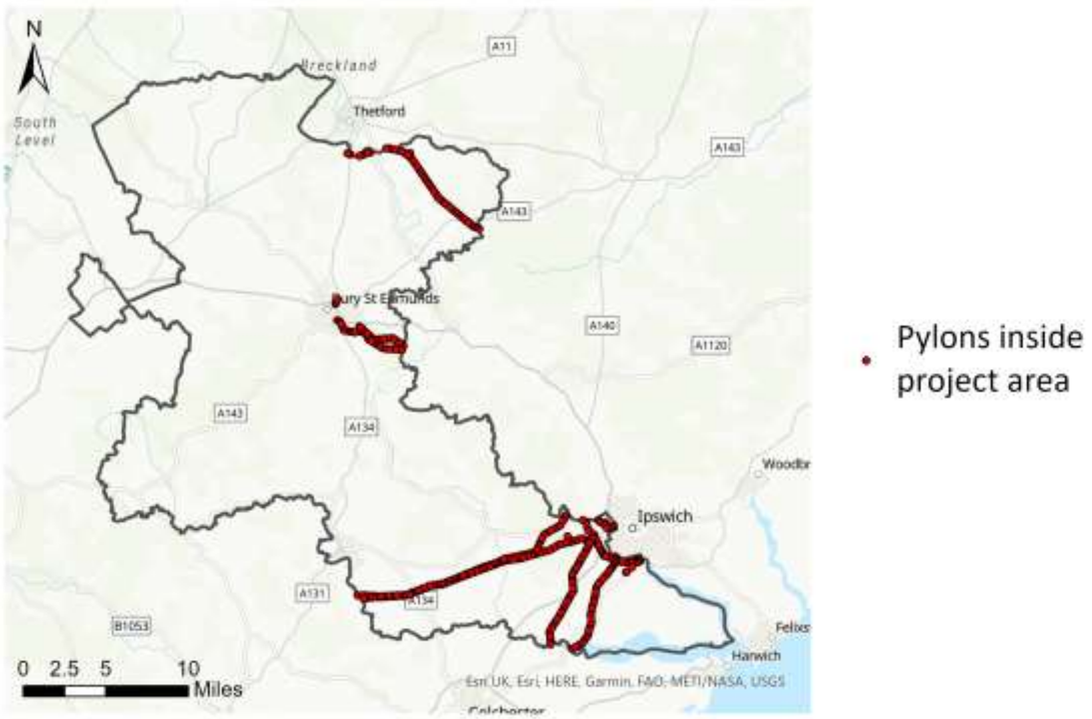


Figure 26: Ordnance Survey MasterMap classification of 'Pylon' within the Suffolk West & Babergh sub-region

2.1.4. Embedded Generation

The Renewable Energy Planning Database (REPD) was used to identify large scale embedded generation across the Suffolk West & Babergh sub-region. These sites, and the associated technologies, are shown in Figure 27. Data on domestic feed-in tariffs from BEIS are used to identify the amount of domestic solar photovoltaic (PV). The total installed capacity for each technology along with an estimate of the annual electricity generated in the local area is given in Table 9. This shows the proportion of annual electricity demand across the Suffolk West & Babergh sub-region estimated to be met currently using local embedded generation. Additional embedded generation technologies may be present in the area but not reported here if they are not recorded in the REPD or if they are below 100 kW.

Table 9: Estimated renewable energy capacity and estimated generation as a proportion of electricity demand in the Suffolk West & Babergh sub-region.

Renewable Tech	***Installed Capacity [MW]***	***Annual Generation [GWh]***	***Proportion of Annual Demand***
Domestic Solar PV	*26.4*	*30*	*1.7%*
Other Solar PV	*94.5*	*85.5*	*4.8%*
Landfill Gas	*1.2*	*5.3*	*0.3%*
Anaerobic Digestion with CHP enabled	*1.4*	*7.3*	*0.4%*

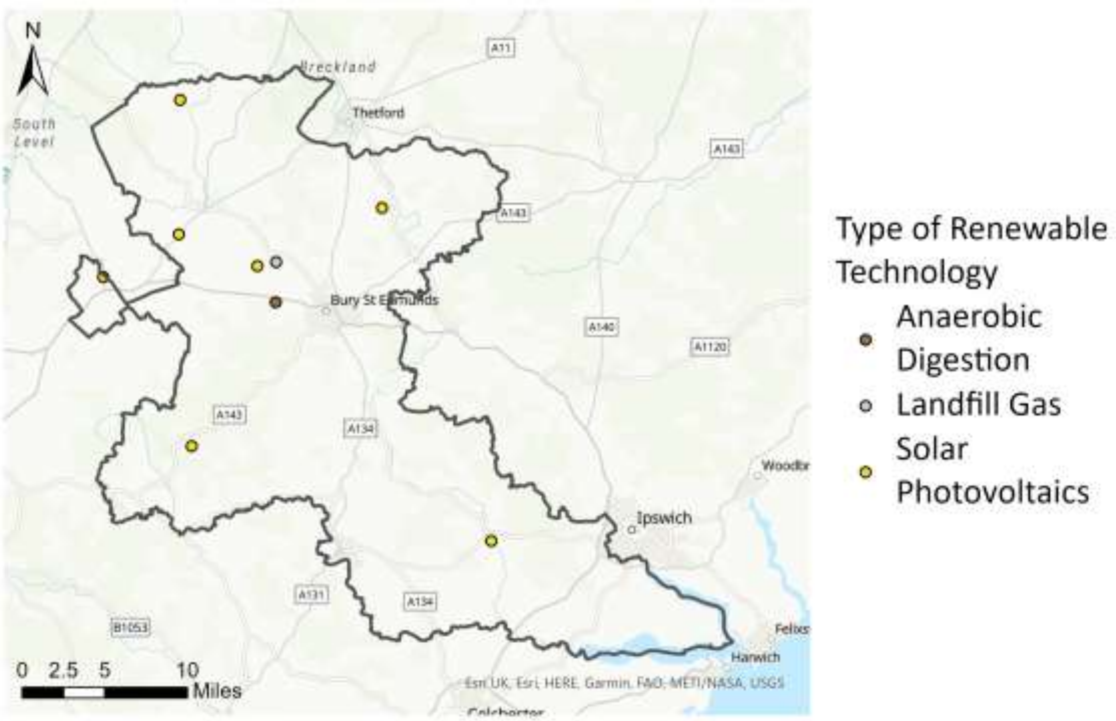


Figure 27: Existing embedded generation in the Suffolk West & Babergh sub-region according to REPD database (October 2020).

As can be seen from Table 9, solar PV is the largest contributor to the electrical generation; although not all installations of solar PV are registered for the feed-in tariff (FIT), and not all FITs were given to solar PV, the majority will be and therefore Ofgem's Feed-in Tariff Installation Report[10] is a useful way of identifying the

[10] https://www.ofgem.gov.uk/environmental-programmes/fit/contacts-guidance-and-resources/public-reports-and-data-fit/installation-reports

overall capacity and number of registrations in each LSOA. Figure 28 and Figure 29 show the installed capacity of renewables and number of registrations respectively.

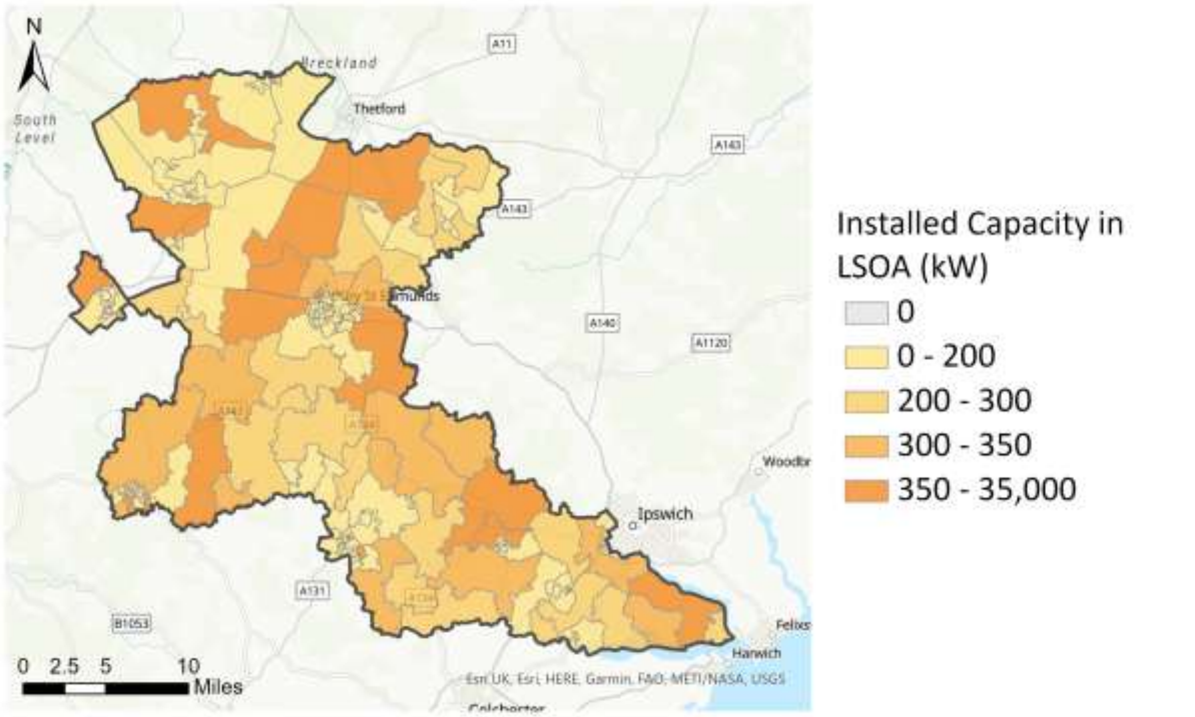


Figure 28: Aggregated capacity of renewable installations registered for FIT within each LSOA of the Suffolk West & Babergh sub-region.

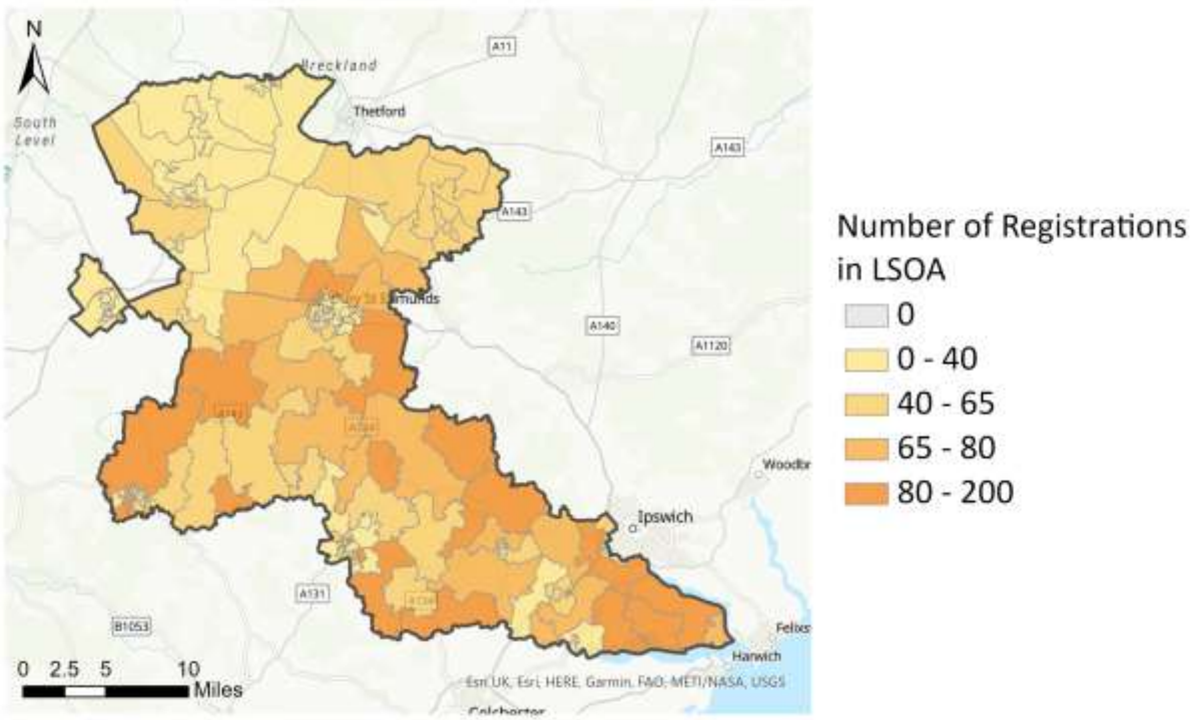


Figure 29: Number of renewable installations registered for FIT within each LSOA of the Suffolk West & Babergh sub-region.

To assess the potential for domestic on-roof solar PV within the Suffolk West & Babergh sub-region, the footprint and orientation of all dwellings have been analysed to calculate the potential generating capacity. These results are then aggregated to 200m radius areas to identify places best suited for mass deployment.

The dwellings identified as suitable for rooftop solar PV in each of the three best areas are shown in Figure 30 to Figure 32.

As a purely spatial exercise this analysis does not consider local planning constraints and should not be used as a replacement for a detailed feasibility study or installation design.

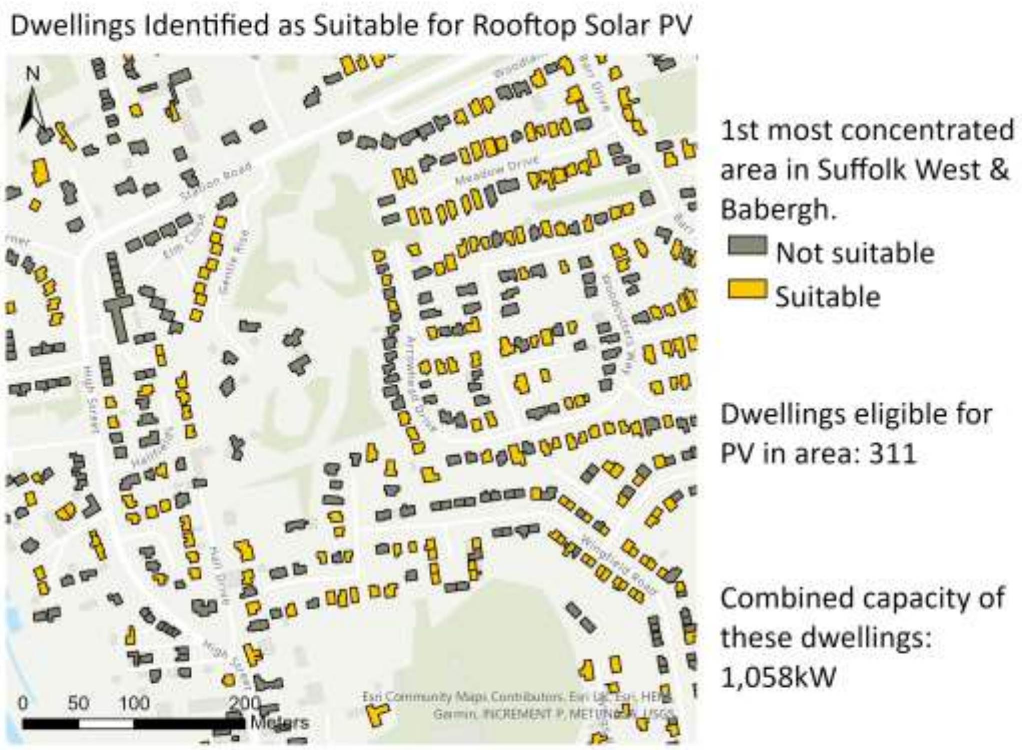


Figure 30: Dwellings identified as suitable for rooftop PV panels. (Location: Lakenheath, Suffolk)

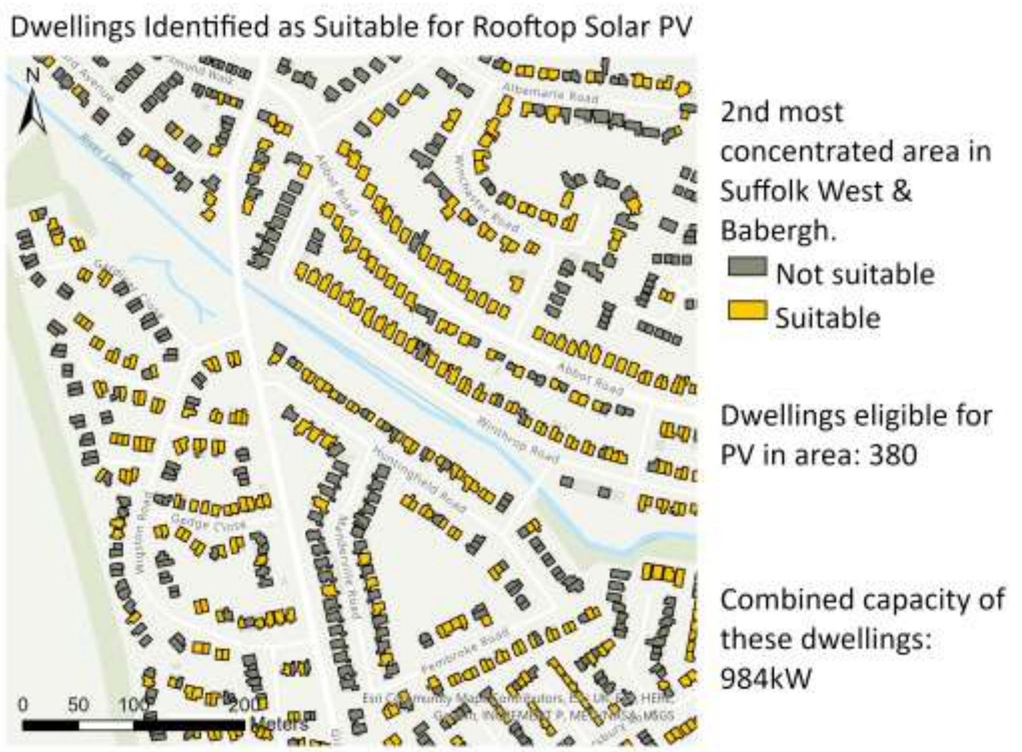


Figure 31: Dwellings identified as suitable for rooftop PV panels. (Location: Westley, Bury St Edmunds)

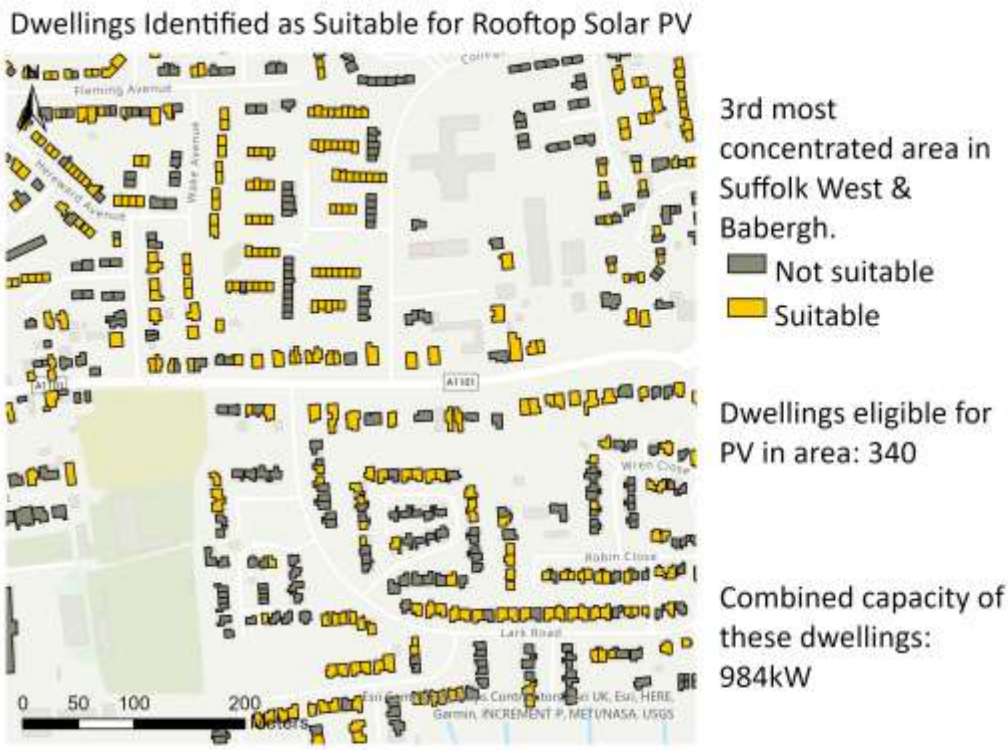


Figure 32: Dwellings identified as suitable for rooftop PV panels. (Location: Mildenhall, Suffolk)

In total these three areas alone have a total potential solar PV capacity of 3,026 MW.

2.1.5. Domestic & Public EV Charging

Data from the Zap-Map®[11] has been used to identify the locations and power outputs of public Electric Vehicle (EV) chargepoints across the Suffolk West & Babergh sub-region. The locations and the speed of the chargepoints are shown in Figure 33. In total there are 131 public chargepoints with a combined capacity of 4,791kW.

[11] https://www.zap-map.com/

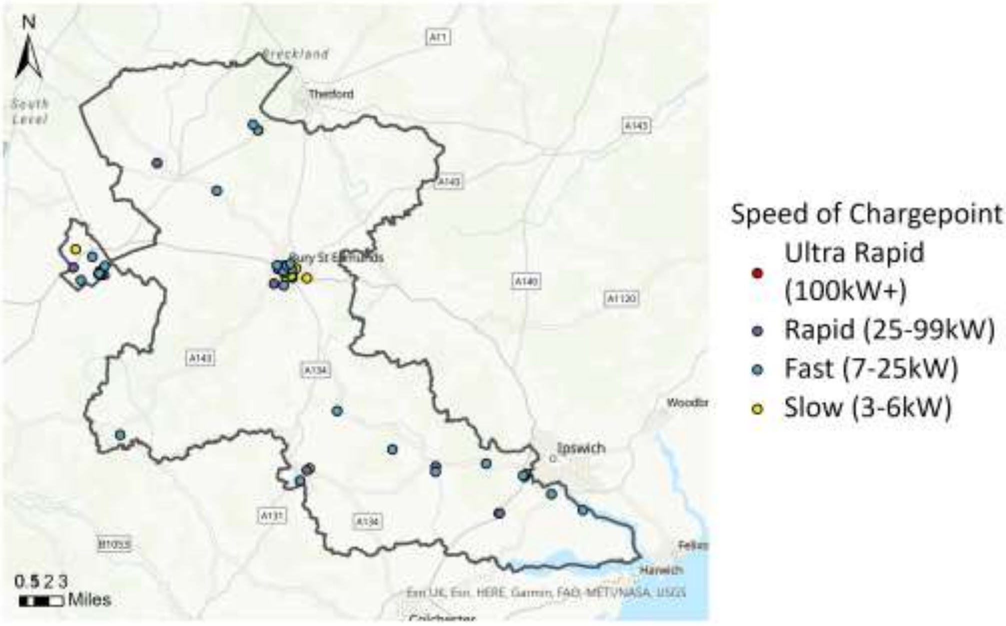


Figure 33: Location of public chargepoints according to Zap-Map® (December 2020)

ZAP MAP®

Chargepoint data provided by Zap-Map®

The Driver and Vehicle Licensing Authority (DVLA) publishes data on the numbers and types of different vehicles registered within different Local Authority Areas. This figure is for all plug-in vehicles, which includes both 100% electric battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). This gives an indication of the number of EVs that might be registered within the sub-region as shown in Table 10.

It should be noted that leased vehicles will be registered to the leasing company which may not be based within the project area.

Using National Travel Survey data representative charge profiles have been generated for both public and domestic charge points. The estimated peak demands for domestic chargepoints are shown in Table 10.

Table 10: Summary of plug-in vehicles[12] registered in the Suffolk West & Babergh sub-region according to data from DfT

Number of Plug-in Vehicles	***Percentage of Total Vehicles***	***Estimated Peak Demand [kW]***
425	0.33%	**928**

[12] Plug-in vehicles are all models identified as being fully electric or plug-in hybrid.

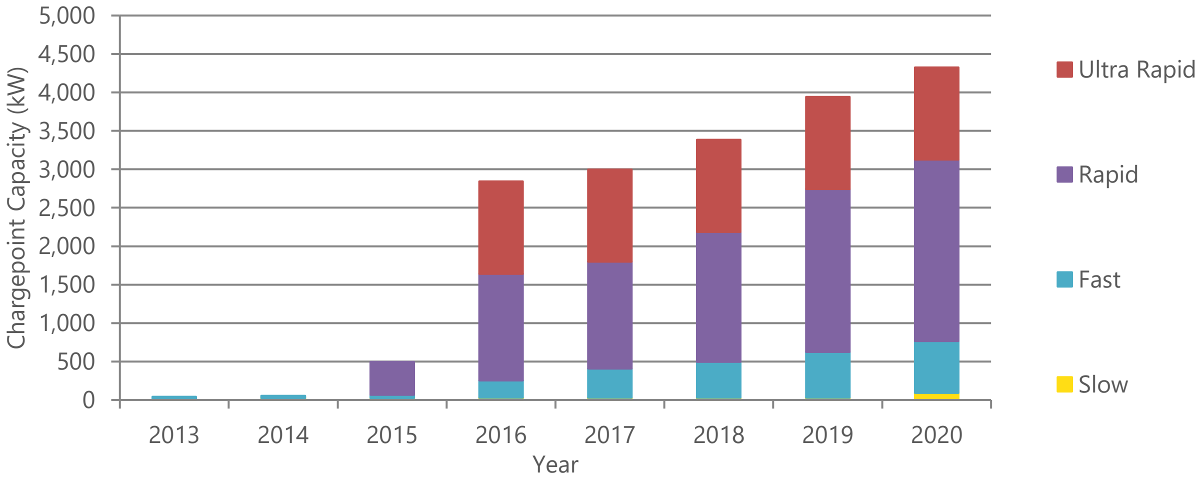


Figure 34: Chargepoint connector total capacity (kW) within the Suffolk West & Babergh sub-region over time.

Using the date that each chargepoint was added to the Zap-Map database the uptake of chargepoints in the area can be analysed. Figure 34 shows this uptake in total kW rating of connectors within the Suffolk West & Babergh sub-region by charger type.

Ordnance Survey Mastermap Topography and Land Registry INSPIRE polygons have been used to identify houses which have space for off-street parking. This is done by attempting to fit a standard UK parking space of 4.8m x 2.4m in the owned area between the house and its nearest road. This helps identify homes that may be able to charge an EV on a driveway, and areas that will require alternative charging solutions for on-street parking. Figure 35 shows the results of this analysis aggregated by road.

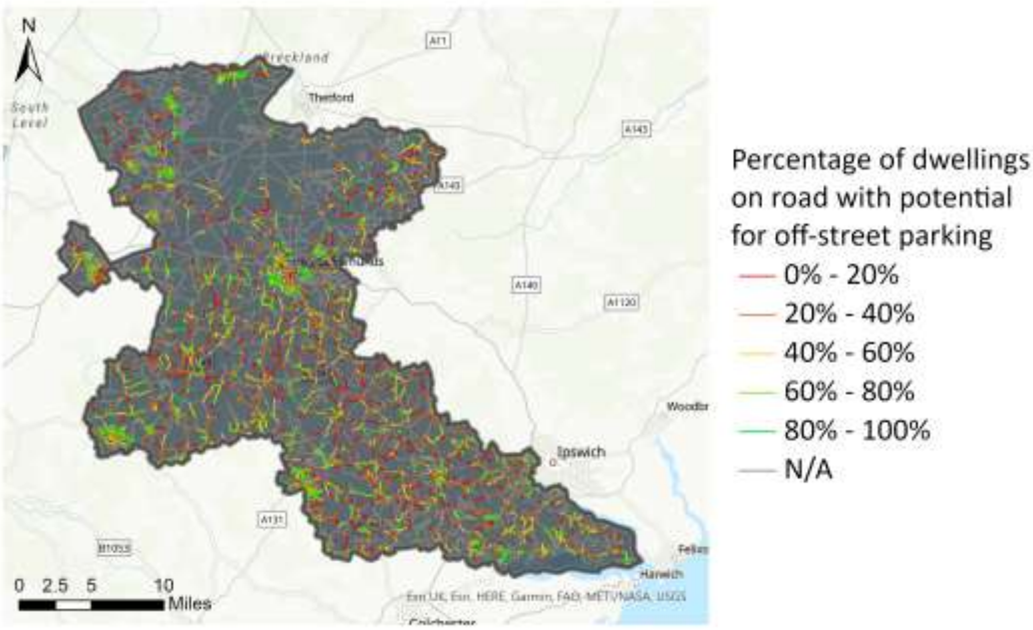


Figure 35: Percentage of dwellings with off-street parking on each road within the Suffolk West & Babergh sub-region.

As a purely spatial exercise this analysis does not consider local planning constraints and should not be used as a replacement for a detailed feasibility study.

2.1.6. Social Data

National data have been used to provide an indication of fuel poverty (Figure 36) and multiple deprivation (Figure 37) across the Suffolk West & Babergh sub-region.

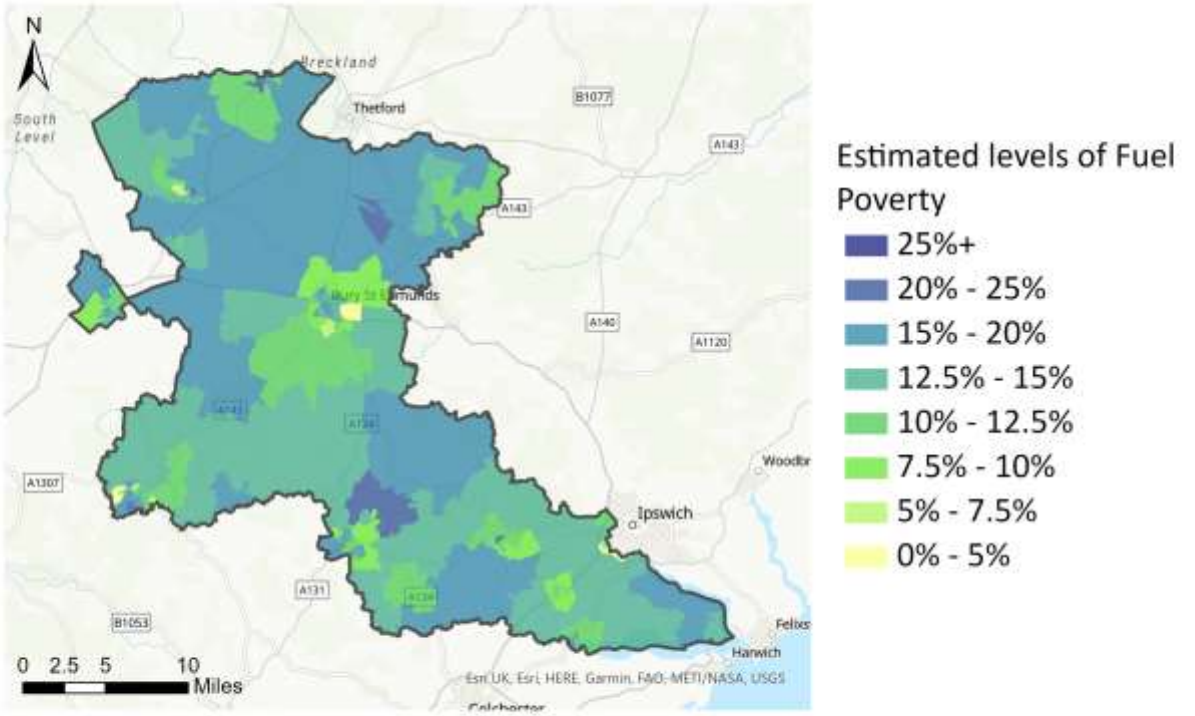


Figure 36: Estimated levels of fuel poverty according to 2020 BEIS data

Using the ranked Index of Multiple Deprivation[13] data published by The Department for Communities and Local Government (DCLG[14]) at LSOA level it is possible to compare localised levels of deprivation within the Suffolk West & Babergh sub-region against the rest of England. For mapping purposes these are shown by octile, with values falling in octile 1 being within the most deprived 1/8th of the country and values falling in octile 8 being within the least deprived 1/8th of the country.

[13] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015
For descriptions of the underlying indicators used in the indices of deprivation please refer to this document: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/467775/File_8_ID_2015_Underlying_indicators.xlsx

[14] Now Department for Levelling-Up, Housing and Communities (DLUHC). Formerly Ministry for Housing, Communities and Local Government (MHCLG).

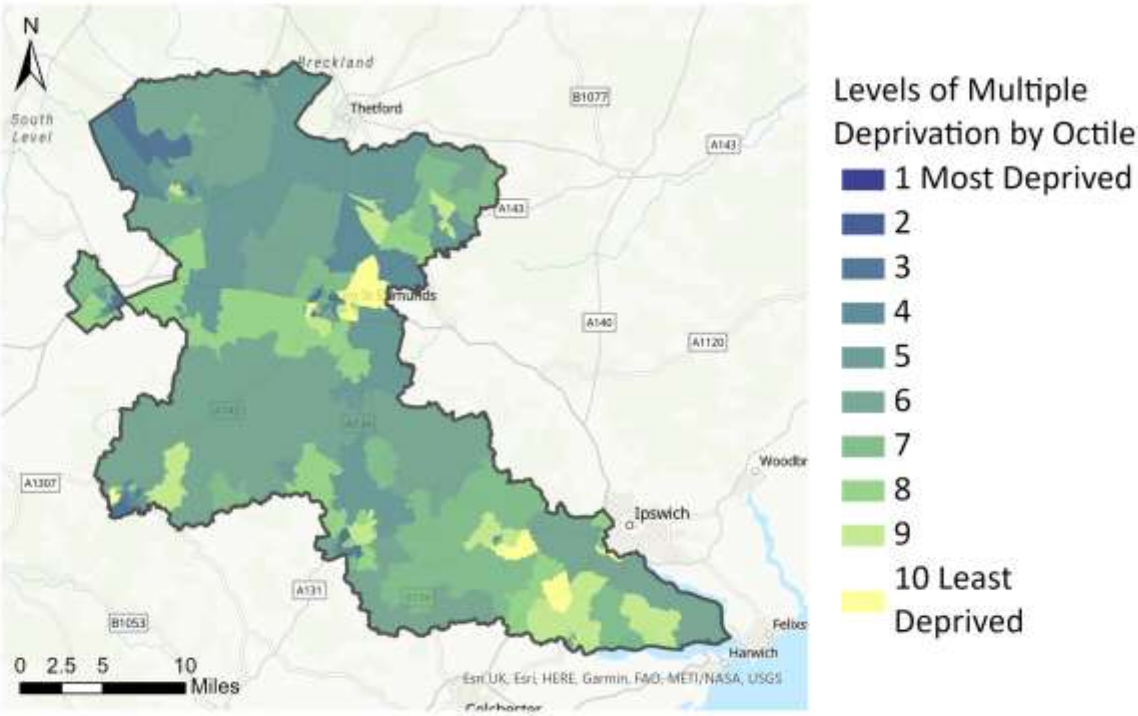


Figure 37: Ranking of English indices of deprivation 2019

The multiple indices that make up the IMD can be found in the accompanying data/maps to this report.

2.2. Suffolk Central (Mid Suffolk and Ipswich)

The sub-regional area of 'Suffolk Central' has been defined in this report as covering the local authority areas of Mid Suffolk and Ipswich, which collectively cover an area of approximately 911km^2 and has a population of around 241,000.

2.2.1. Building Stock

This section will provide an overview of the building stock – both domestic and non-domestic – across the Suffolk Central sub-region. The geographical location of the building stock will be shown, as will the relative rurality across the sub-region, and breakdowns of the domestic and non-domestic stock by category.

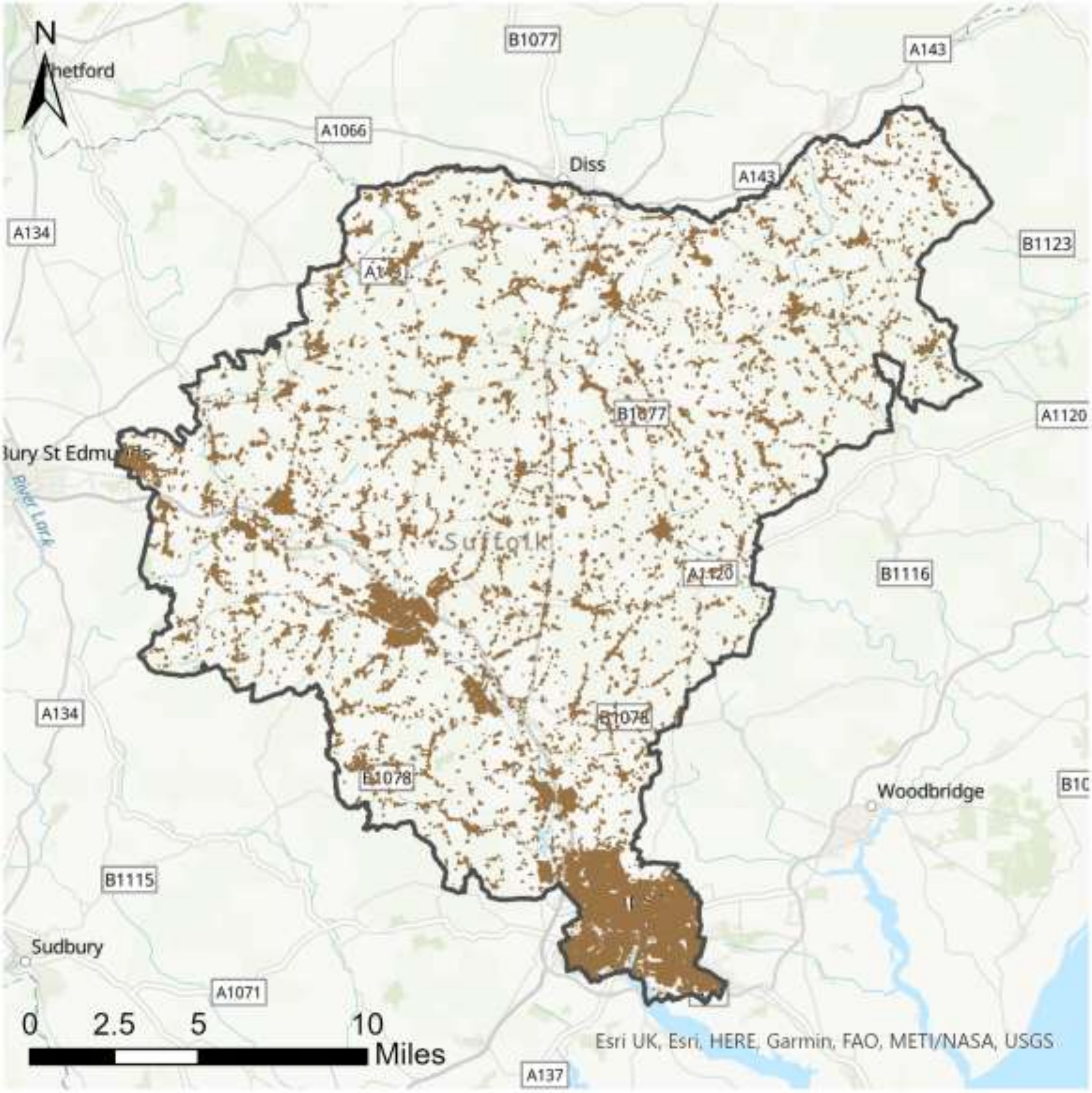


Figure 38: Building stock distribution across the Suffolk Central sub-region.

Figure 38 shows that across the Suffolk Central sub-region, the building stock is densely populated across the City of Ipswich. Across Suffolk Central, the building stock is distributed into clusters around conurbations including Ipswich and Stowmarket with the building stock being less densely situated elsewhere.

These areas correlate well to the rural/urban classifications given in the rurality map (Figure 39).

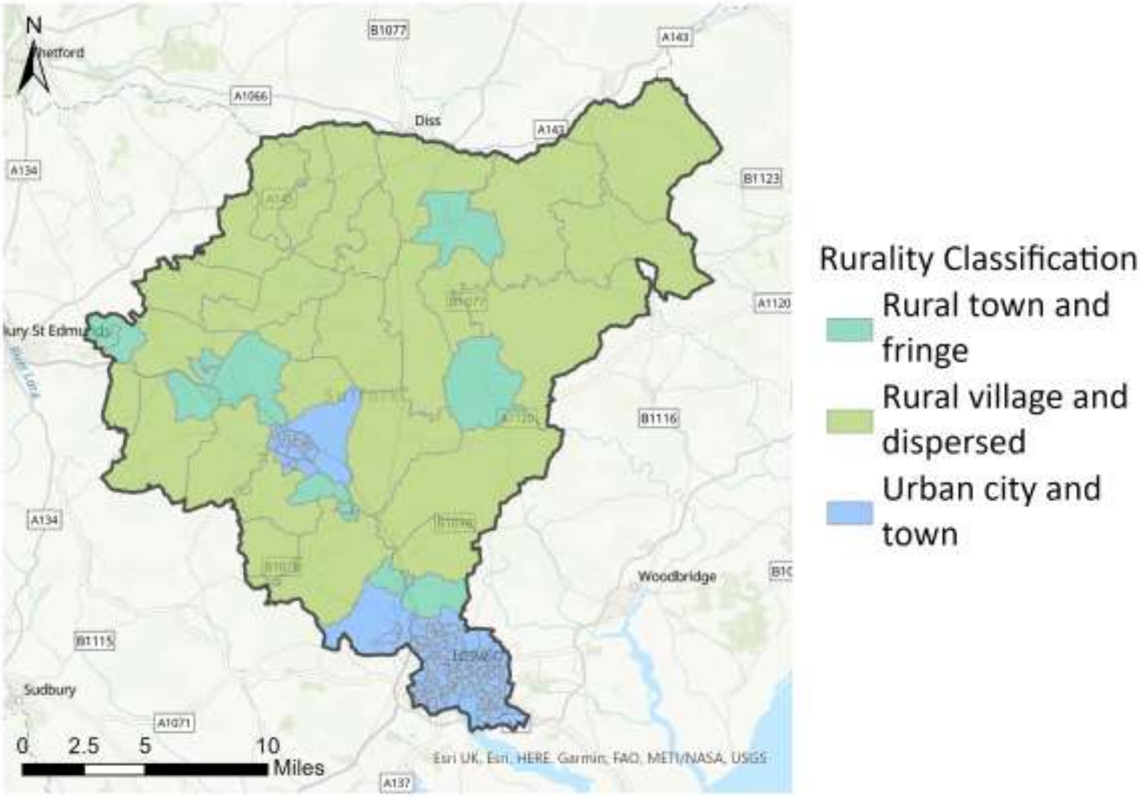


Figure 39: Rurality of the Suffolk Central sub-region.

Figure 39 shows the rurality of the Suffolk Central sub-region by Lower-level Super Output Area (LSOA). Most of the land area in the Suffolk Central sub-region is classified as rural towns and villages with the more urban areas matching those noted in Figure 38.

Using data provided by Historic England[15], the location and grade of listed buildings; scheduled monuments; Battlefields; World Heritage Sites and Parks & Gardens can be mapped within the sub-region (Figure 40).

[15] https://historicengland.org.uk/listing/the-list/data-downloads

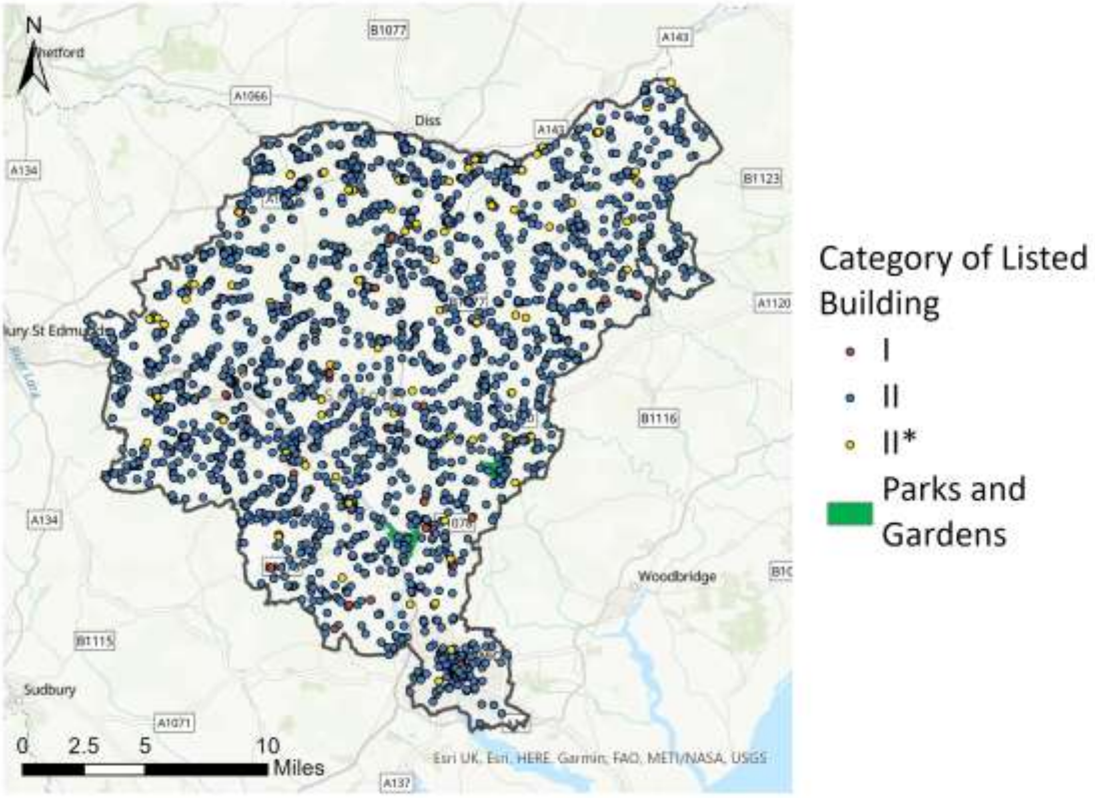


Figure 40: Location of listed buildings in the Suffolk Central sub-region grouped by grading according to Historic England

Figure 40 shows the large number of listed buildings, scheduled monuments, and areas of interest clustered in similar locations to the building stock as a whole. This could pose a challenge to decarbonising the building stock. Table 11 shows the Listed Status of the buildings and the number of occurrences.

Table 11: Summary of listed buildings across Suffolk Central by grade category.

Grade Category	***Number***
Grade I	99
Grade II	3,601
*Grade II**	217
Scheduled Monument	44

To understand the housing stock in more detail, the domestic stock has been segmented by:

- Type (converted flat, detached, purpose-built flat, semi-detached, and terrace)
- Construction date (pre-1914, 1914-1944, 1945-1964, 1965-1979, post-1980)
- Floor area [m^2] (under 50, 50-70, 70-90, 90-110, 110-200, 200-300, over 300)
- Main heating system (ASHP, biomass, electric (no storage), electric storage, gas, GSHP, oil/LPG)
- Loft insulation level [mm] (no loft, no insulation, 1-99, 100-199, over 200)
- Wall type (filled cavity, unfilled cavity, solid with ESWI, solid with ISWI, uninsulated solid)
- Window type (single glazing, double glazing, triple glazing)

Table 12: Number and percentage of dwelling types across the Suffolk Central sub-region.

Dwelling Type	Number	Percentage
Converted Flat	1,490	1%
Detached	27,500	26%
Purpose Built Flat	19,900	19%
Semi-detached	37,500	35%
Terrace	20,500	19%
Total	107,000	100%

Due to rounding, some totals may not correspond with the sum of the separate figures.

Table 12 shows that larger dwelling types are more prevalent across the sub-region with over 60% of the housing stock being detached or semi-detached dwellings. The prevalence of the dwelling types in each LSOA area (Figure 41) shows that detached dwellings are typically the most dominant in rural areas, whereas semi-detached are more common in suburban areas. Flats are far more common in the Ipswich LSOA compared to Mid-Suffolk.

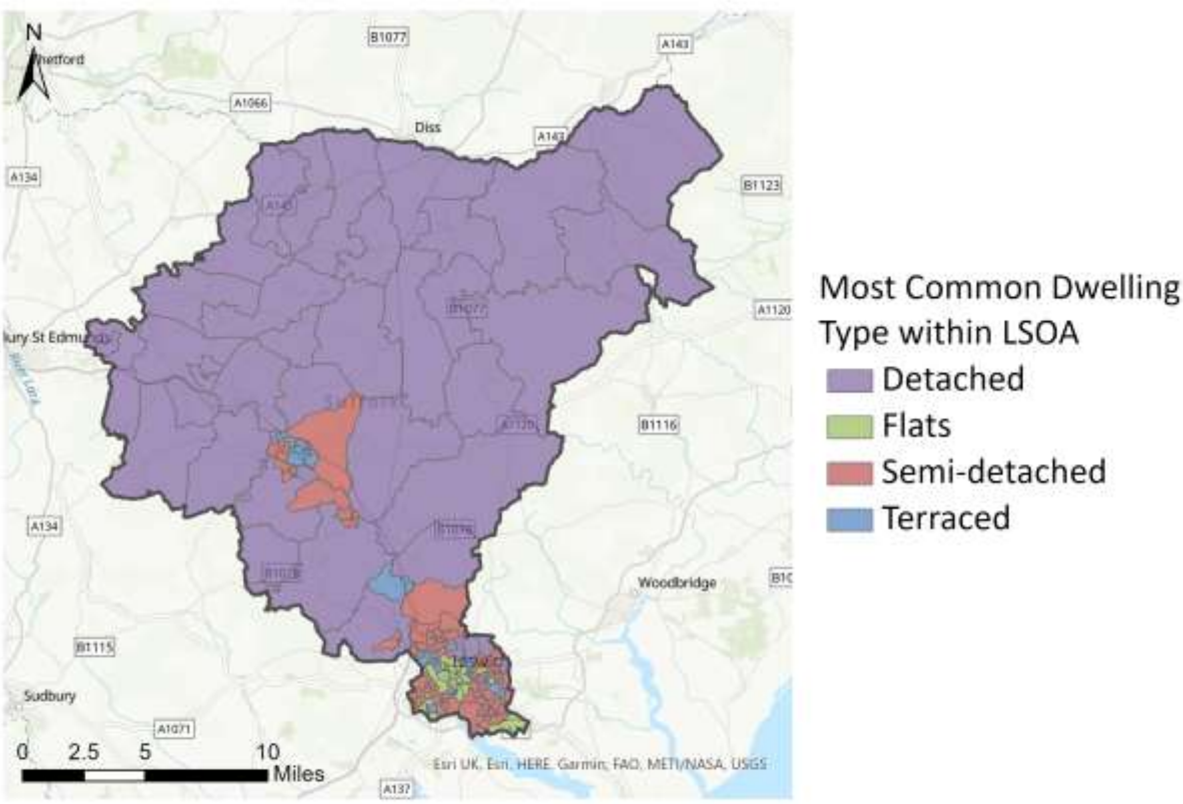


Figure 41: Most common dwelling type within each LSOA across the Suffolk Central sub-region.

Table 13: Number and percentage of dwellings constructed in different periods across the Suffolk Central sub-region.

Dwelling Construction Period	***Number***	***Percentage***
Pre-1914	20,000	19%
1914-1944	12,700	12%
1945-1964	31,500	30%
1965-1979	26,500	25%
1980-present	16,200	15%
Total	107,000	100%

Due to rounding, some totals may not correspond with the sum of the separate figures.

By combining the dwelling type and the construction period, it can be seen in Figure 42 that around 14% of all dwellings in the sub-region are 1945-1964 semi-detached dwellings. Terraced dwellings tend to be much older with over 50% being built prior to 1914. Detached dwellings are being built more commonly in recent years with almost all being constructed post-1945 and over a quarter constructed since 1980. A boom in purpose-built flats can also be seen between 1965 and 1979 with almost 10,000 individual dwellings constructed within this period.

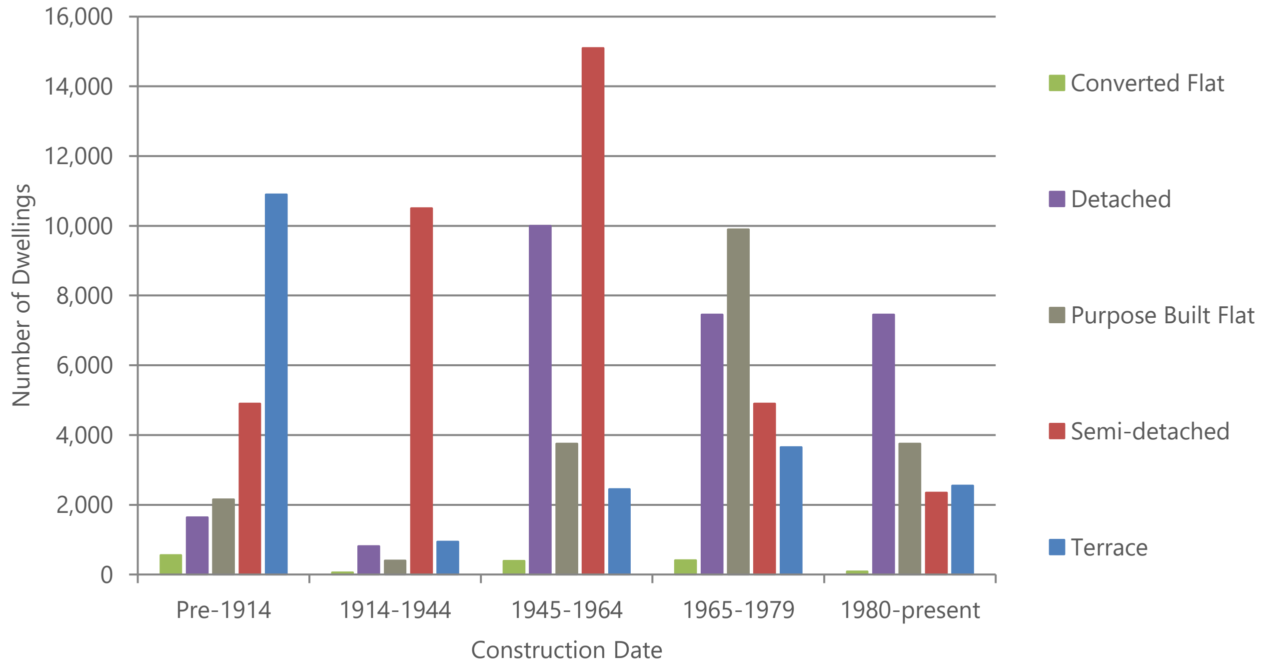


Figure 42: Estimated number of dwellings within each construction period (by dwelling type) across the Suffolk Central sub-region.

This can be visualised spatially (Figure 43) to show the most prevalent construction year in each LSOA in the Suffolk Central sub-region. Figure 43 shows a prevalence of 1945-1979 built dwellings in many of the larger LSOAs. In the centre of the urban areas, pre-1914 dwellings are more prevalent which we know from Figure 42 are likely to be terraced dwellings.

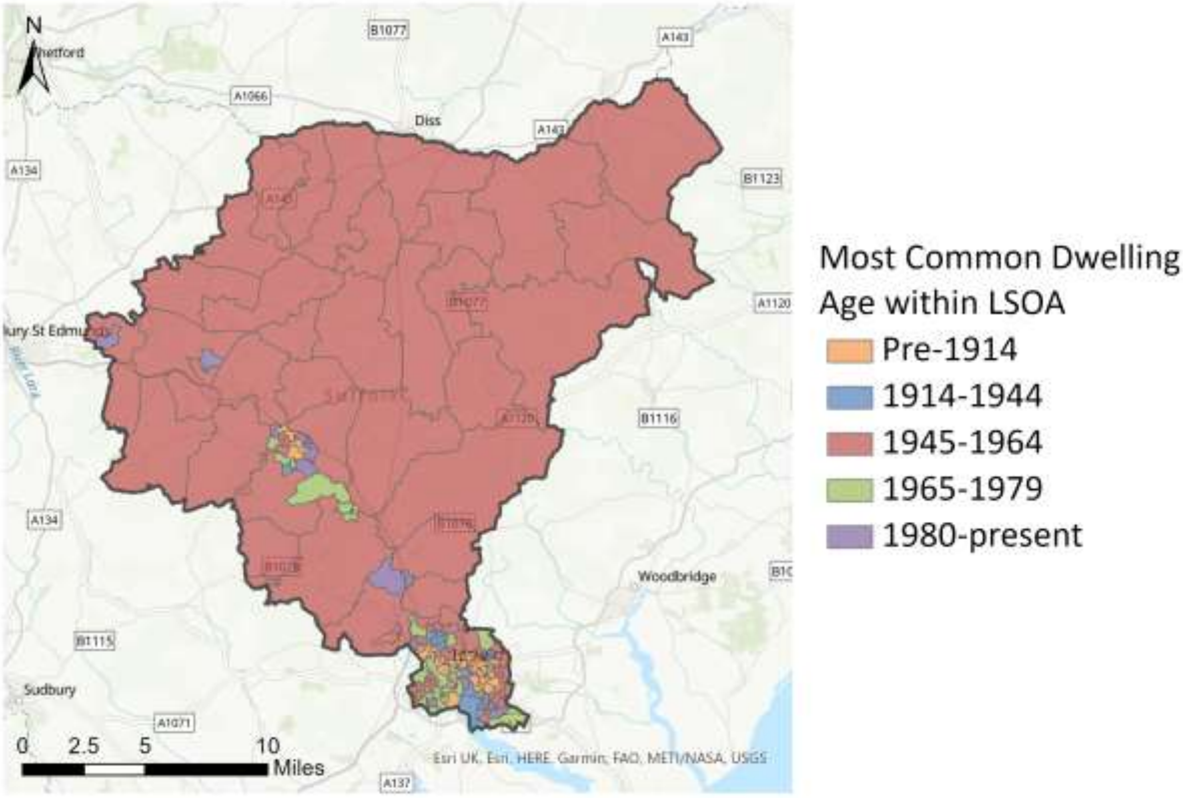


Figure 43: Most common construction period within each LSOA across the Suffolk Central sub-region.

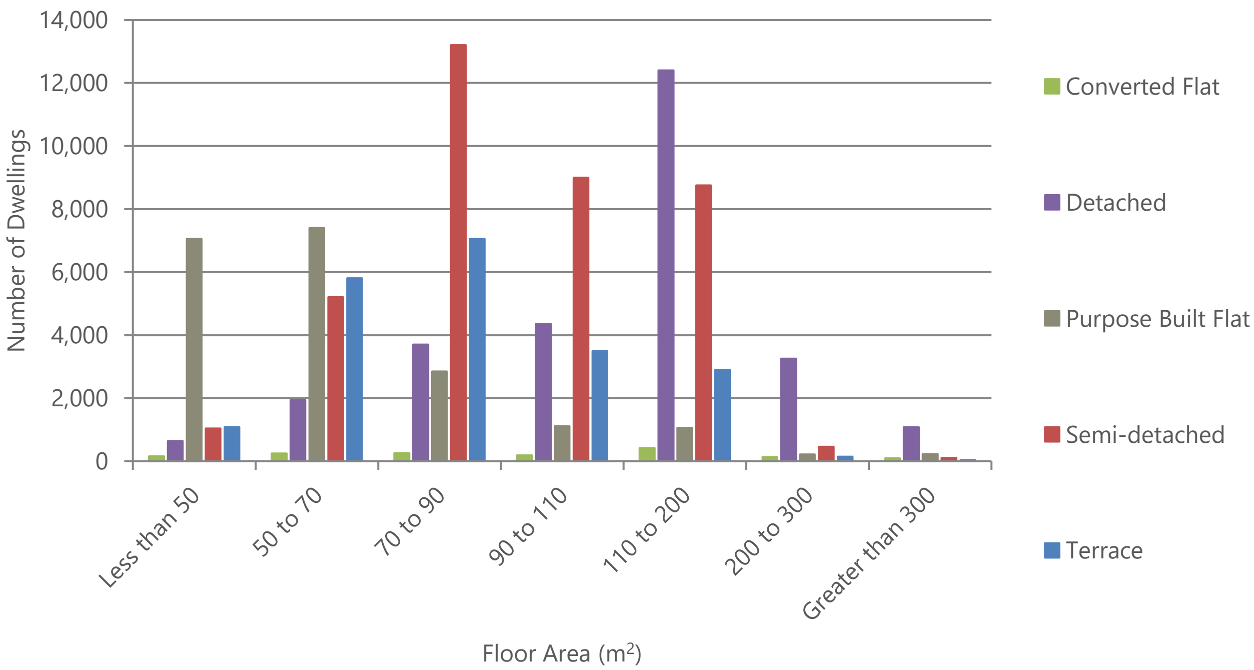


Figure 44: Estimated number of dwellings within each floor area band (by dwelling type) across the Suffolk Central sub-region.

From Figure 44, as expected, flats (particularly purpose-built flats) typically have a lower floor area than semi-detached and detached dwellings. Over two-thirds of purpose-built flats have a floor area of under 70m^2 whilst 45% of detached dwellings have a floor area of between 110 and 200m^2.

Dwellings in the Suffolk Central sub-region are overwhelmingly heated using a fossil fuel boiler – including a significant proportion using oil/LPG – with the remainder being made up from electric heating. Electric storage heaters are often used in modern flats where heat losses are low. Oil/LPG boilers are typically used in off-gas grid areas which in turn are often rural.

Figure 45 below shows that almost 40% of detached dwellings use oil/LPG boilers as their main heating system. Gas boilers are prevalent throughout the housing stock, particularly within semi-detached dwellings.

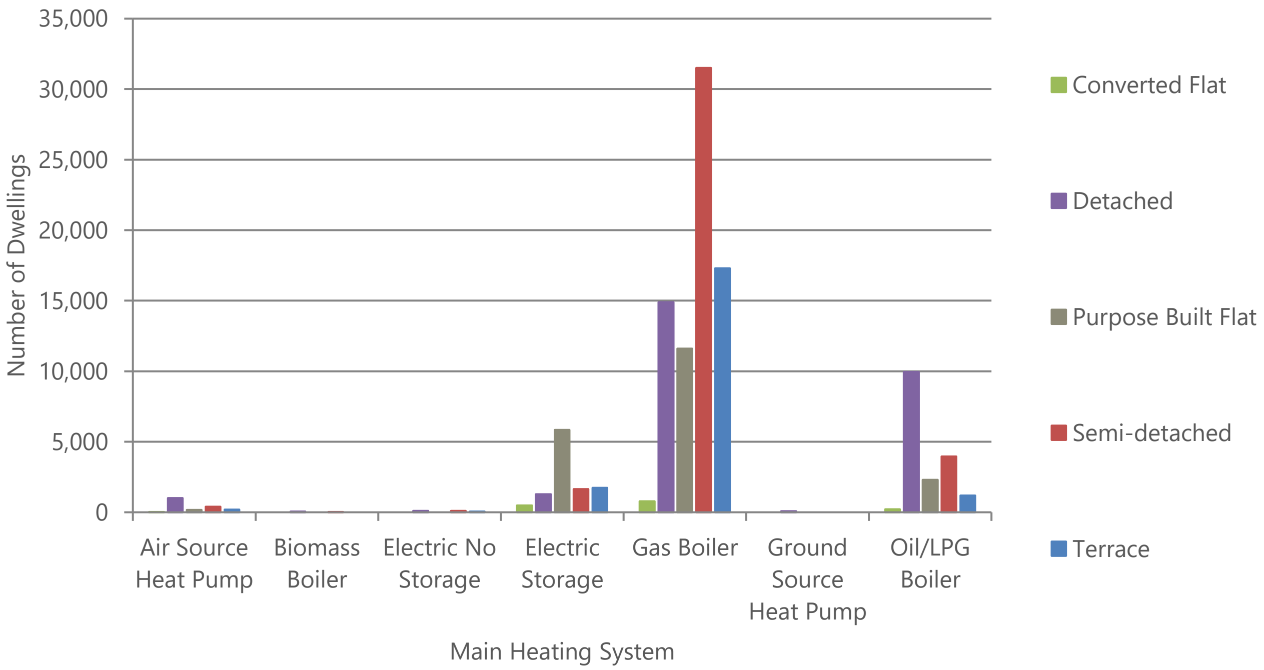


Figure 45: Estimated number of dwellings by main heating system (by dwelling type) across the Suffolk Central sub-region.

To make a heating system as efficient as possible, insulation is required to reduce the heat loss from a dwelling. Figure 46 shows the level of loft insulation in each dwelling type. Flats (both converted and purpose built) are assumed not to have a loft to insulate as even those on the top-floor are unlikely to be able to access the loft space in which to add insulation. There are also a small number of detached, semi-detached, and terraced properties that are classified as having no loft; this is usually due to them having a 'room-in-roof' where the loft has been converted into part of the living area.

The expected level of loft insulation in the UK is 270mm meaning that there are a significant proportion of those with a loft who would benefit from additional insulation. Almost half of terraced houses have no loft insulation whatsoever (Figure 46).

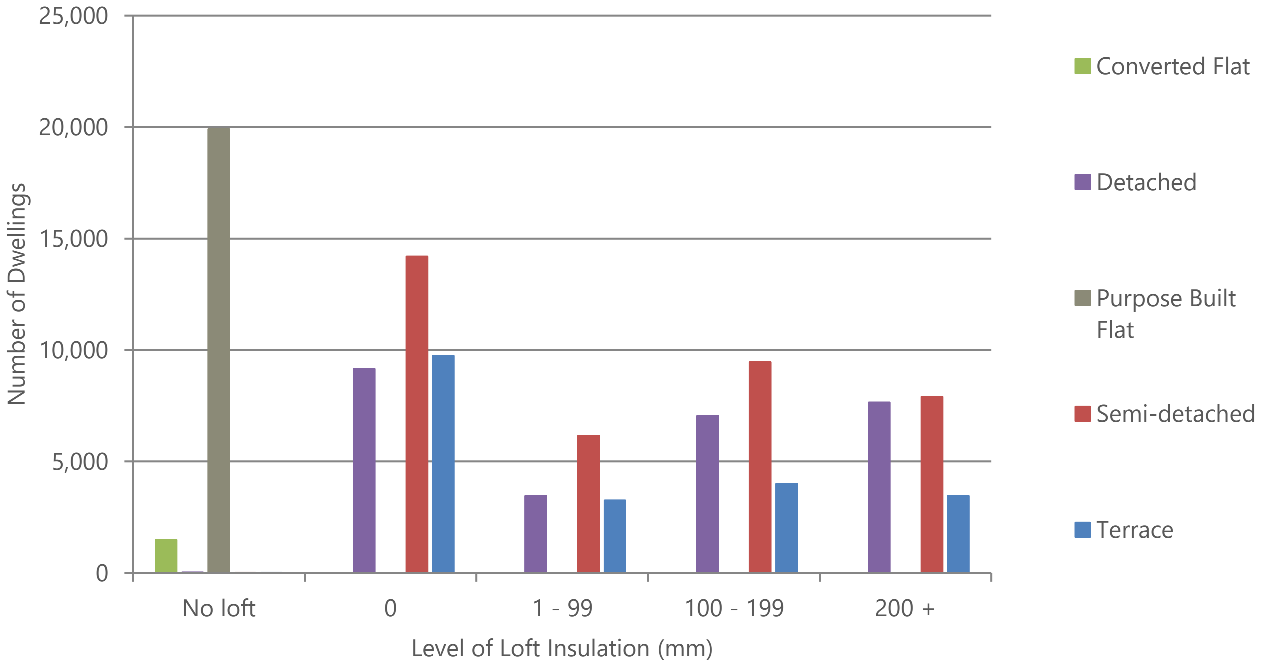


Figure 46: Estimated level of loft insulation (by dwelling type) across the Suffolk Central sub-region.

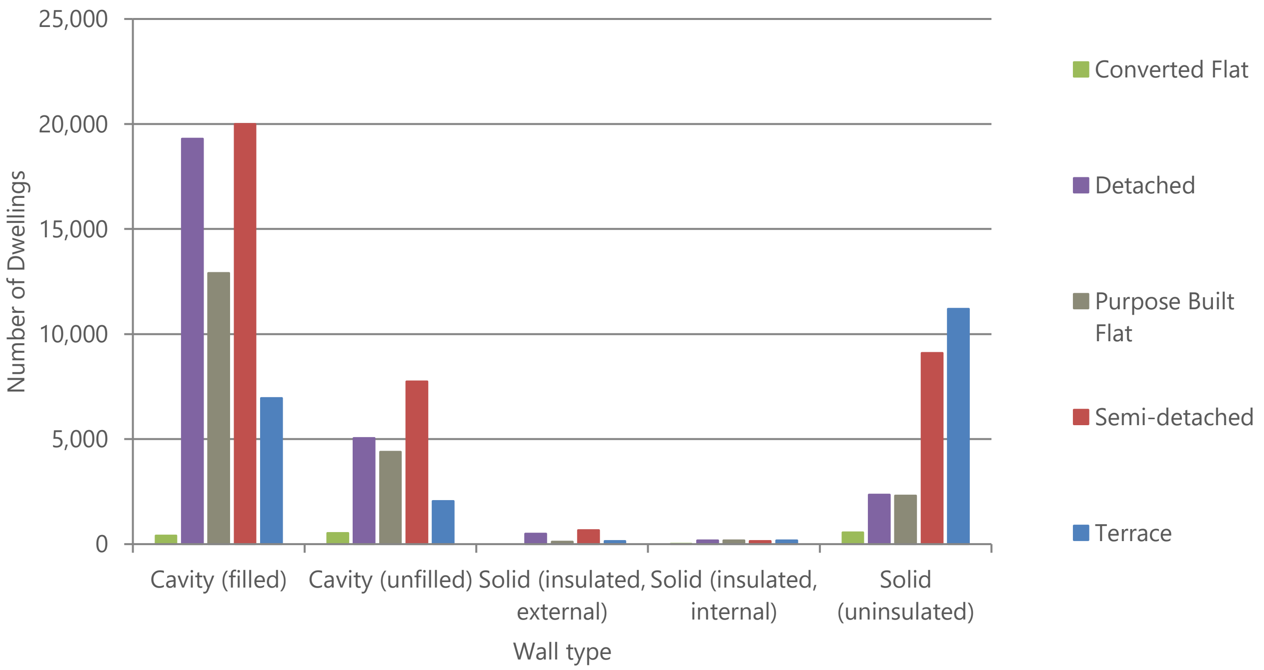


Figure 47: Estimated wall type and insulation level (by dwelling type) across the Suffolk Central sub-region.

Figure 47 shows that cavity walls are the most prominent (74%) wall type across the Suffolk Central sub-region. Of those dwellings with a cavity wall, around three-in-four are insulated. Cavity wall insulation can be difficult on some archetypes where there are hung tiles or render on the external face of the brickwork, also around conservatories. Whilst these are deemed 'hard-to-treat' there are methods for ensuring that the cavity can be filled, albeit at a higher cost.

Figure 47 also shows that almost all of the solid wall properties in the Suffolk Central sub-region are uninsulated. This may be due to listed status, other planning restrictions, occupant behaviour/preference, or cost.

94% of dwellings in the Suffolk Central sub-region have double glazing (Figure 48). Triple glazing is not prevalent in the housing stock, yet there remain around 7,000 dwellings with single glazing.

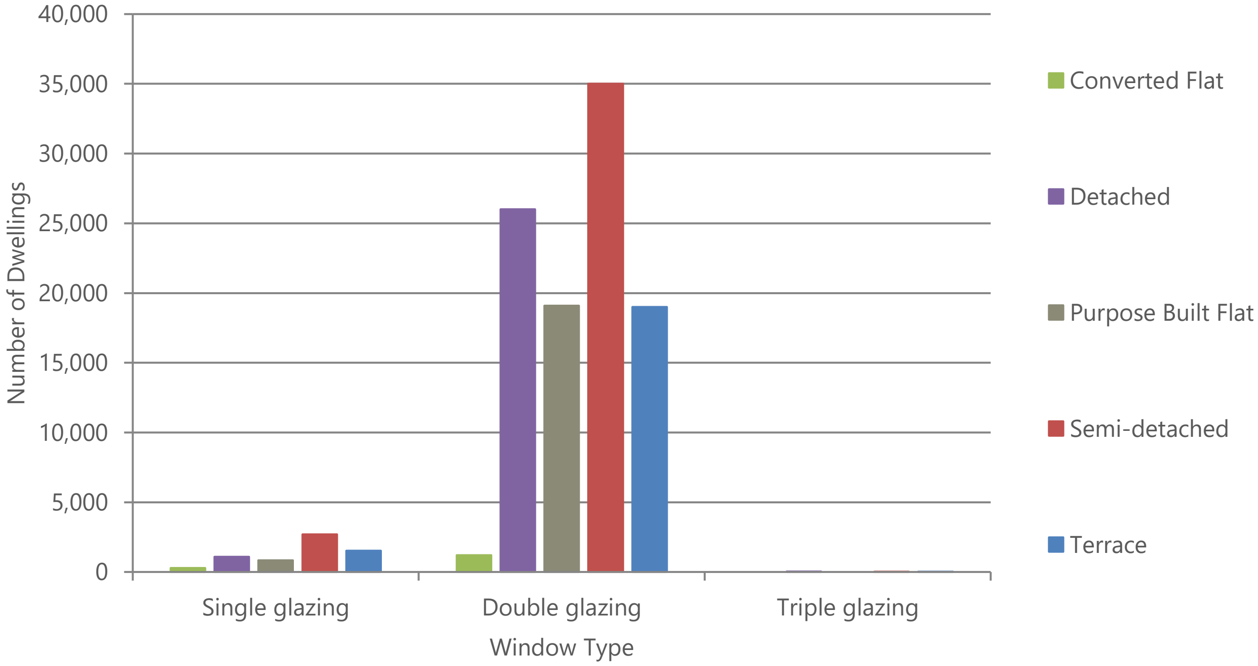


Figure 48: Estimated proportion of glazing type per dwelling type across the Suffolk Central sub-region.

To give a visual representation of the current energy efficiency of dwellings within the region, the EPC rating of all properties within an LSOA has been averaged to show where the most and least efficient regions of houses lie. Figure 49 below shows the proportion of the most efficient dwellings in the area, those that have an EPC rating of C or above. Figure 50 on the other hand shows the least efficient dwellings in the area, those that have an EPC rating of E or below. This criterion allows for direct correlation with that of the Local Authority Delivery (LAD) scheme which has a focus on homes living in fuel poverty and an EPC rating of E, F or G.[16]

[16] https://www.gov.uk/government/publications/green-homes-grant-local-authority-delivery-scheme-phase-2-funding-allocated-to-local-energy-hubs

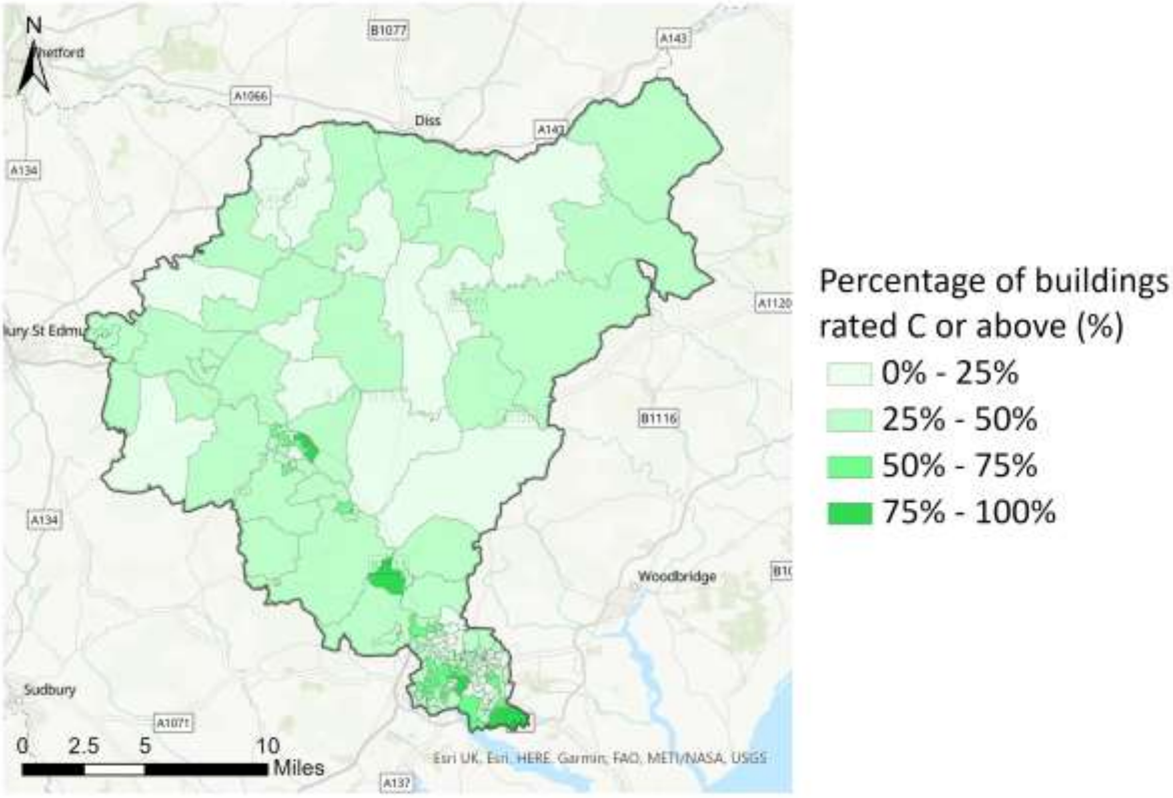


Figure 49: Proportion of dwellings rated EPC C or above across the Suffolk Central sub-region.

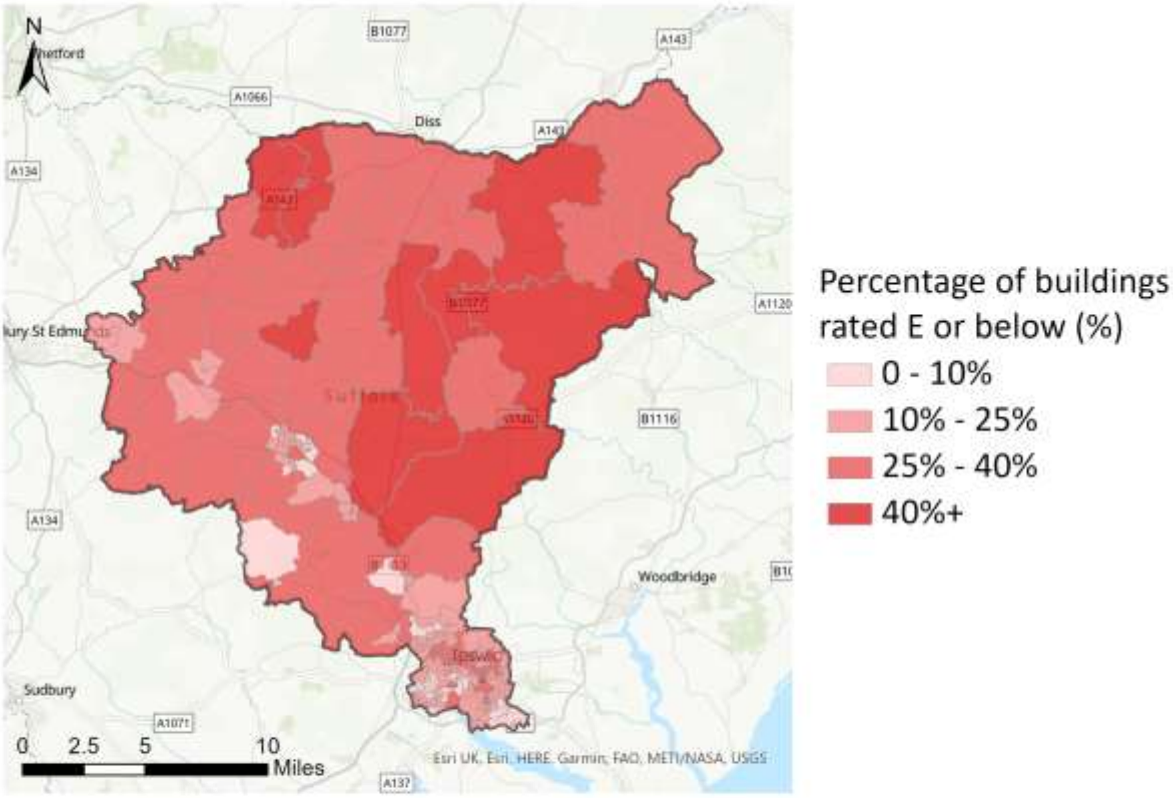


Figure 50: Proportion of dwellings rated EPC E or below across the Suffolk Central sub-region.

As well as the domestic stock, the non-domestic stock needs to be considered. The breakdown of the non-domestic building stock across the Suffolk Central sub-region is shown in Table 14.

Table 14: Breakdown of the non-domestic building stock by type across the Suffolk Central sub-region.

Type	***Floor Area [m²]***	***Percentage of total floor area***	***Number of non-domestic buildings***	***Percentage of non-domestic buildings***
Retail	3,450,000	40%	15,400	46%
Factory	2,450,000	29%	7,450	23%
Office	980,000	11%	3,700	11%
Warehouse	650,000	8%	1,840	6%
Education	540,000	6%	1,330	4%
Other	475,000	6%	3,350	10%
Total	**8,550,000**	**100%**	**33,000**	**100%**

Due to rounding, some totals may not correspond with the sum of the separate figures.

Data from the National Atmospheric Emissions Inventory (NAEI)[17] has been used to identify large individual emission point sources i.e. emissions from a known location. As well as CO_2, this data shows air pollutants, heavy metals, and base cations[18], and greenhouse gases (GHGs)[19]. The point sources included within the project boundary are shown below in Figure 51. It should be noted that this dataset is for fixed emission sources only, and that non-fixed emissions such as those from road traffic are not included.

[17] https://naei.beis.gov.uk/
[18] https://naei.beis.gov.uk/overview/ap-overview
[19] https://naei.beis.gov.uk/overview/ghg-overview

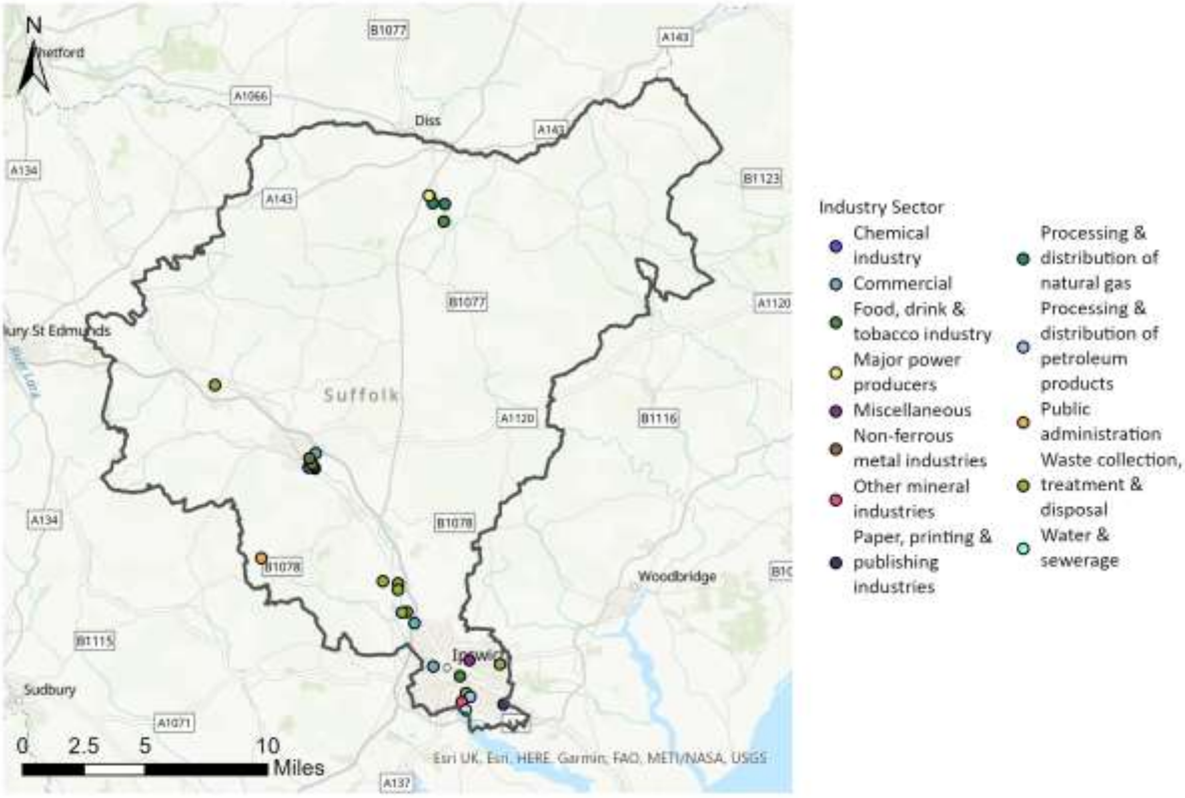


Figure 51: Individual emission sources identified by the National Atmospheric Emissions Inventory (NAEI) across the Suffolk Central sub-region.

Often the high emitters are located closely together on an industrial park or similar, therefore the definition given in Figure 51 is lacking. However, the data pack accompanying this report contains the full background data providing more clarity.

2.2.2. Energy Demands

This section will show the estimated annual consumption and peak demands across the Suffolk Central sub-region in the domestic and non-domestic sectors, and the geographic distribution by LSOA.

Table 15 and Table 16 below show the total figures for the sub-region. Please note: Electricity is supplied locally at 400V (three-phase) which is then connected to a dwelling at 230V (single-phase), therefore for the purposes of these calculations all domestic properties are assumed to be connected at 400V. Large non-domestic loads are assumed to be connected to the electricity network at 11kV; other non-domestic are connected at 400V. Total electricity demand is therefore the sum of demand at the 11kV level and 400V level. Demand from power generators and utilities are not included in these figures.

Table 15: Annual energy consumption [MWh] across the Suffolk Central sub-region.

Energy Type	***Domestic Annual Consumption [MWh]***	***Non-Domestic Annual Consumption [MWh]***	***Total Annual Consumption [MWh]***
Electricity (11kV)	0	114,000	114,000
Electricity (400V)	350,000	1,020,000	1,370,000
Gas	425,000	1,220,000	1,645,000
Oil	112,000	0	112,000

Table 16: Annual peak demand [MW] across the Suffolk Central sub-region.

Energy Type	***Domestic Peak Demand [MW]***	***Non-Domestic Peak Demand [MW]***	***Total Peak Demand [MW]***
Electricity (11kV)	0	35	35
Electricity (400V)	110	325	390
Gas	455	470	885
Oil	125	0	125

The total peak demand is not the sum of the peak demands for domestic and non-domestic buildings since the peak demands of the different sectors occur at different times.

The following maps (Figure 52 to Figure 55) show the distribution of estimated peak and annual energy consumption for both domestic and non-domestic buildings across the Suffolk Central sub-region. Peak demands shown on these maps may not all occur at the same time of day or time of year. For example, an area predominantly made up of domestic dwellings is likely to have a peak energy demand during the early evening in winter. In contrast, an area that is mainly made up of commercial offices will have maximum energy demand around the middle of the day. Mixed-use areas could have a different peak time depending upon the nature of their buildings.

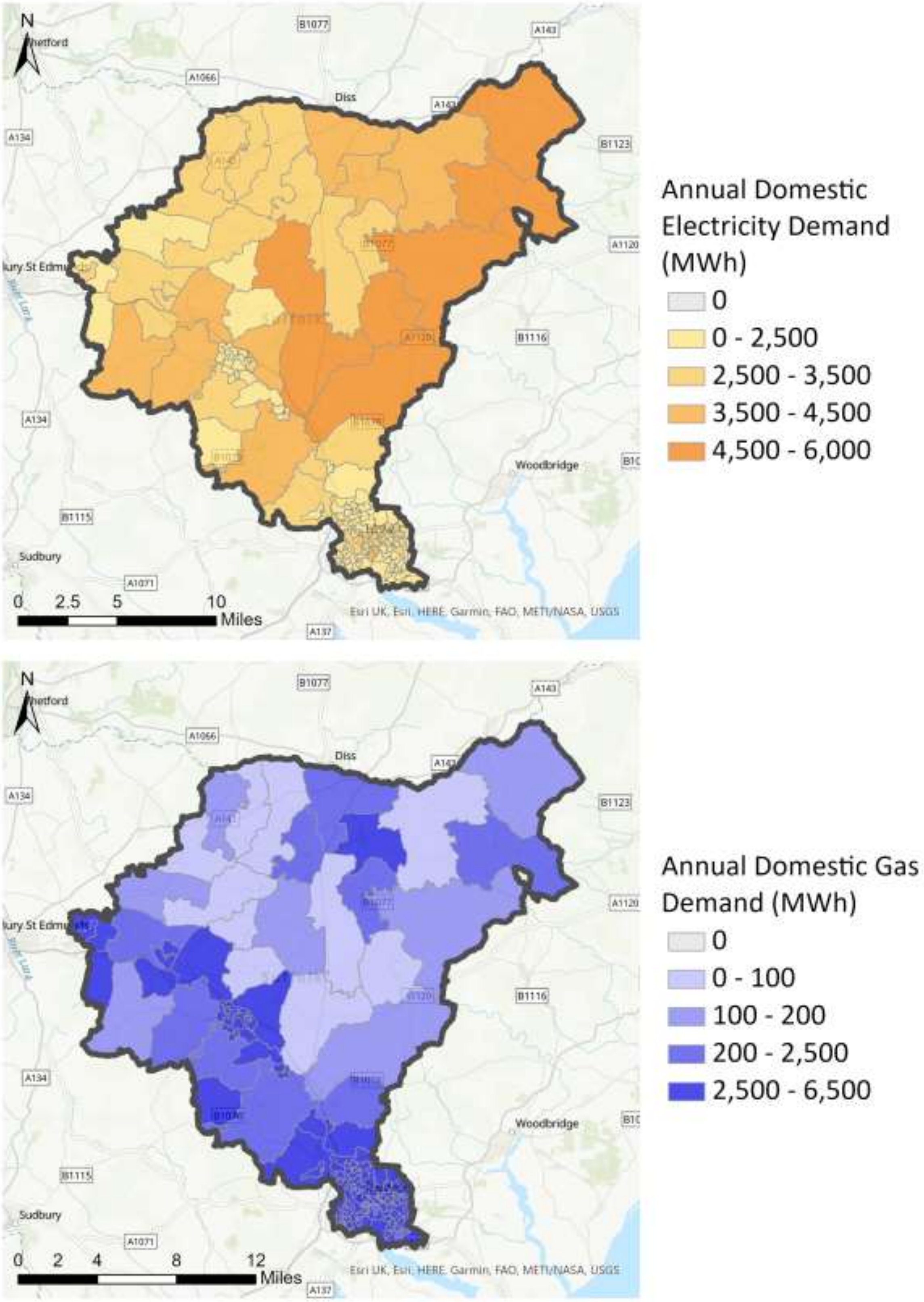


Figure 52: Estimated current domestic annual energy consumption by fuel and LSOA across the Suffolk Central sub-region.

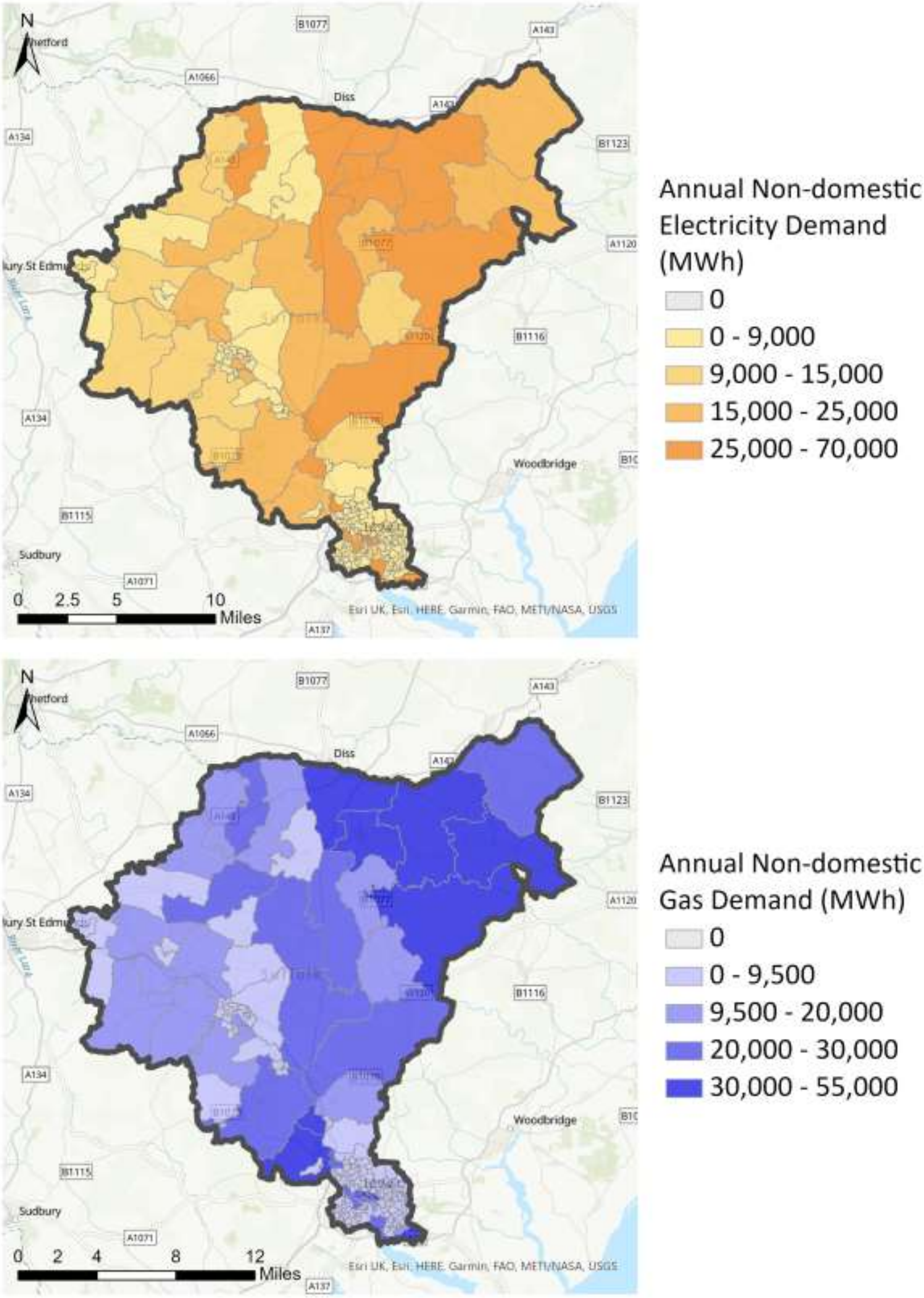
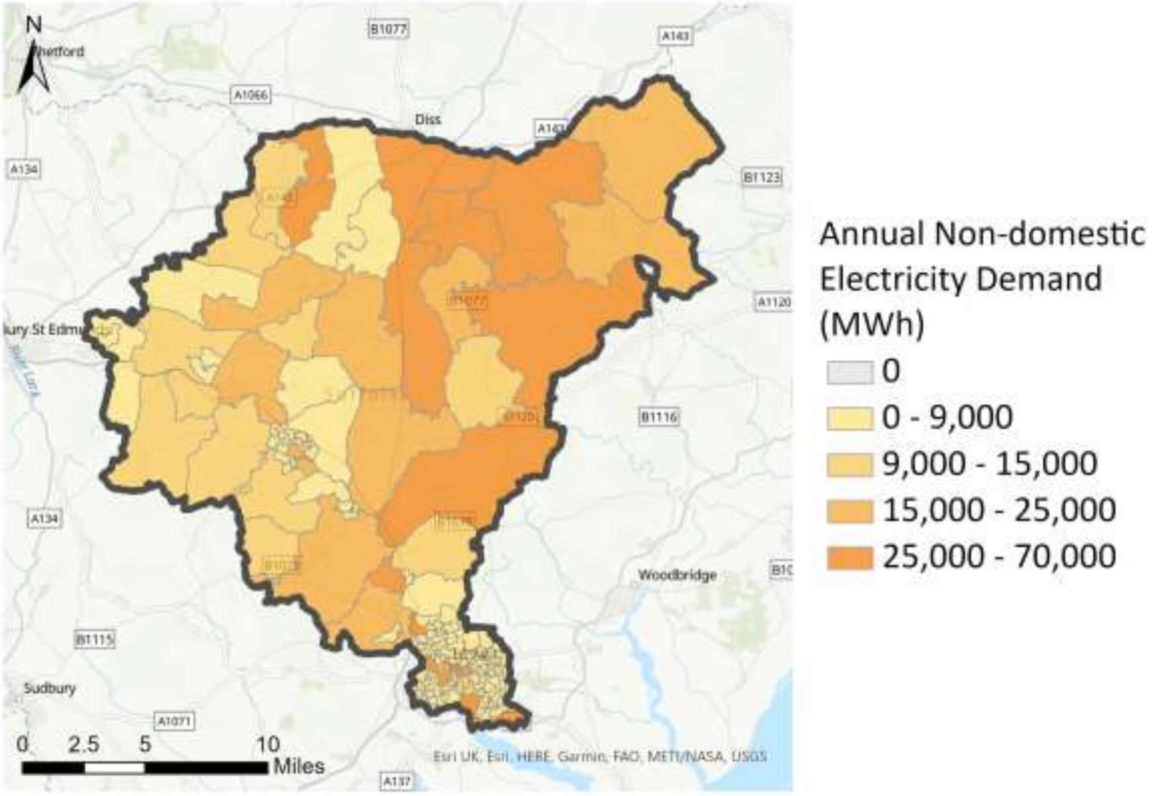


Figure 53: Estimated current non-domestic annual energy consumption by fuel and LSOA across the Suffolk Central sub-region.



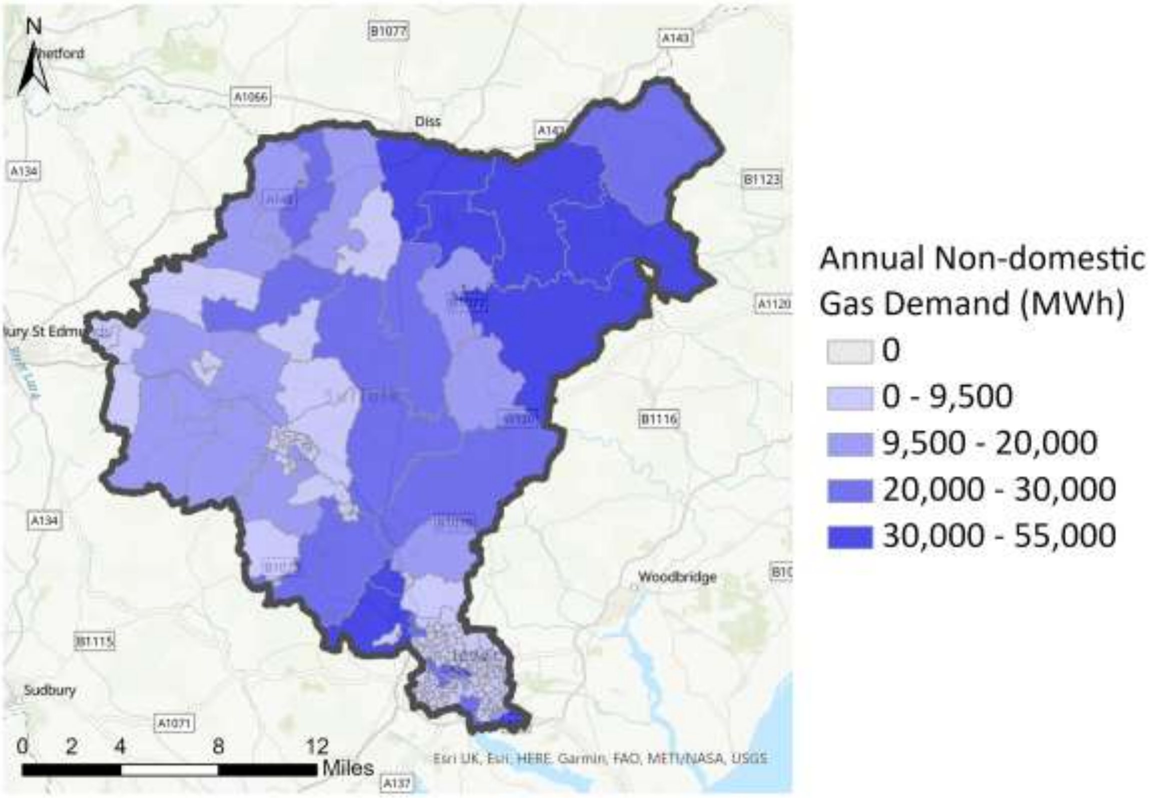


Figure 54: Estimated current domestic peak energy demand by fuel and LSOA across the Suffolk Central sub-region.

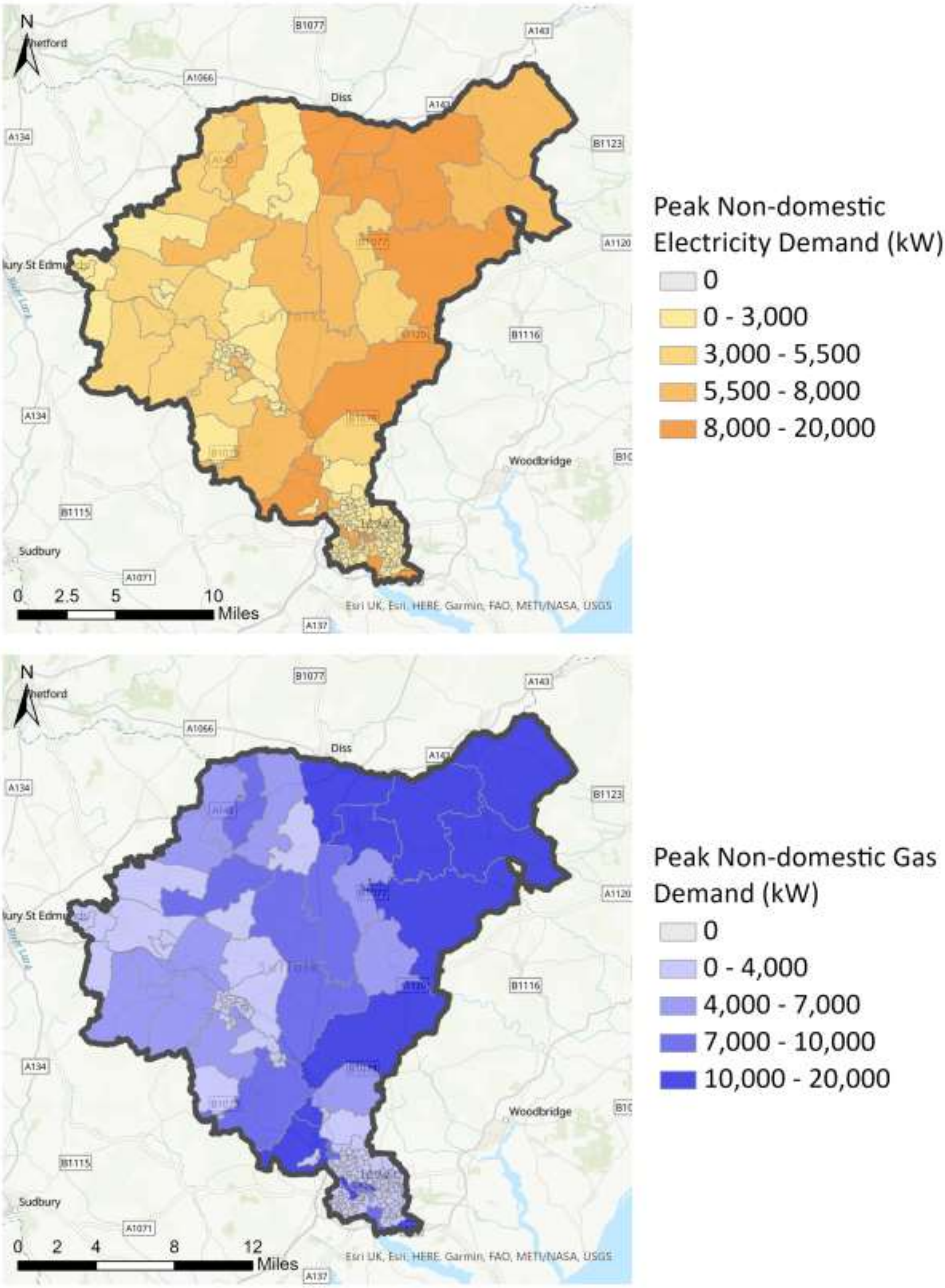


Figure 55: Estimated current non-domestic peak energy demand by fuel and LSOA across the Suffolk Central sub-region.

Figure 56 shows an estimate of the total electricity demand profile for the Suffolk Central sub-region for different days of the year representing the lowest typical demand and the highest. The peak day is also shown, which is used to determine a worst-case scenario on the network. Electricity demand includes heat, lighting, appliances, and electric vehicle charging when chargepoints are known to exist in the local area. The profile is for domestic and non-domestic buildings combined.

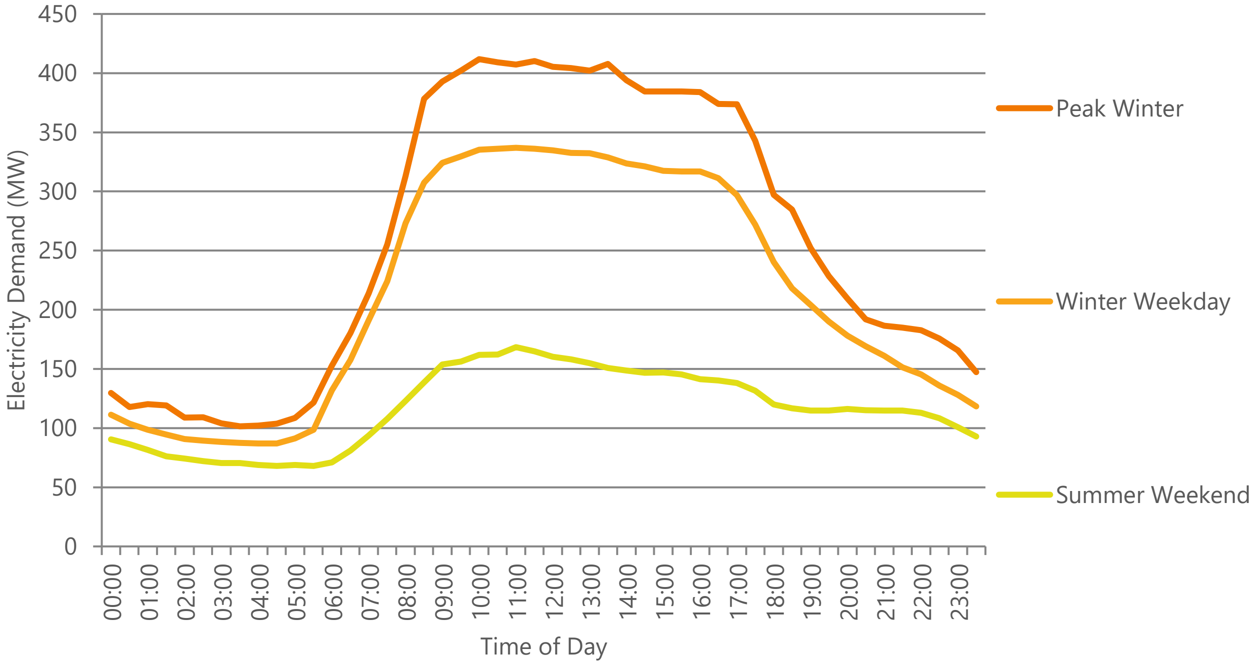


Figure 56: Estimated electricity demand profiles for different days of the year across the Suffolk Central sub-region.

As expected, the demand is far lower on a summer weekend when compared to a winter weekday.

Summer weekend represents the lowest end of demand profile; being summer means there is less need of heating, and weekend suggests that office/factory buildings are using less electricity, in contrast to a typical winter weekday.

The area between these two demand profiles demonstrates the typical demand i.e. the electricity demand will likely be within this middle section at any given time.

Figure 57 shows the estimated gas demand profile, and Figure 58 shows the estimated oil demand profile, for the Suffolk Central sub-region for the same days. Gas and oil demand include both heat and hot water and covers domestic and non-domestic buildings combined.

HM Government | Eastern NewEnergy | European Union European Regional Development Fund | Suffolk County Council | CATAPULT Energy Systems

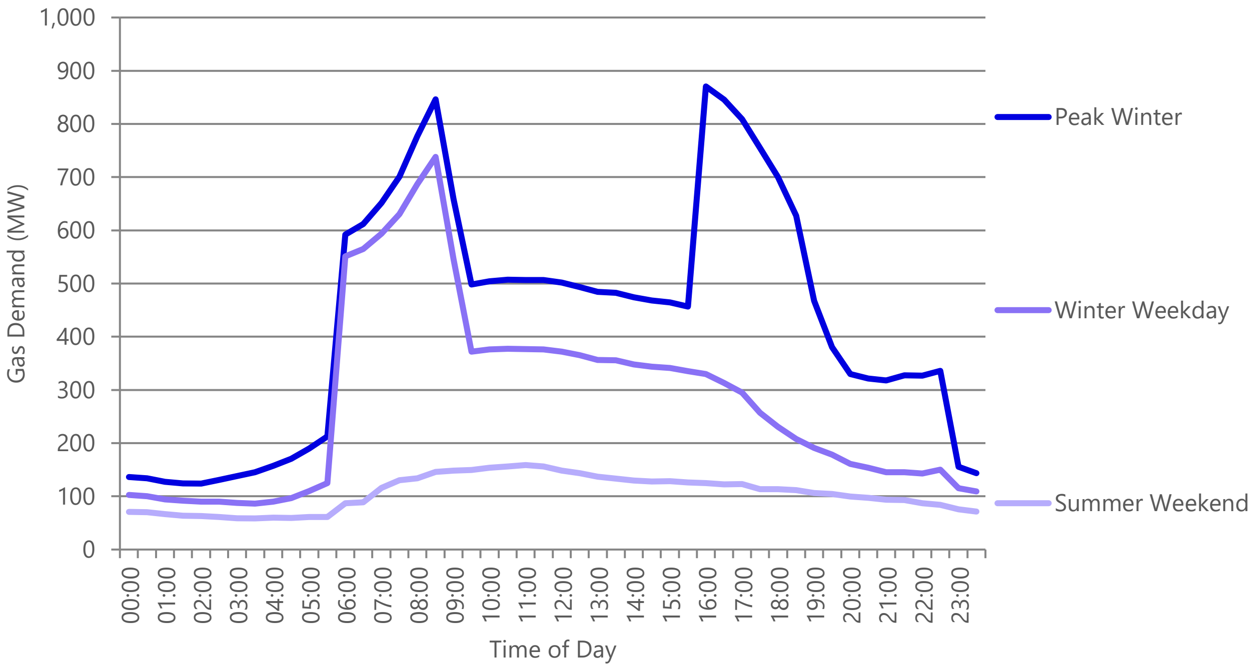


Figure 57: Estimated gas demand profiles for different days of the year across the Suffolk Central sub-region.

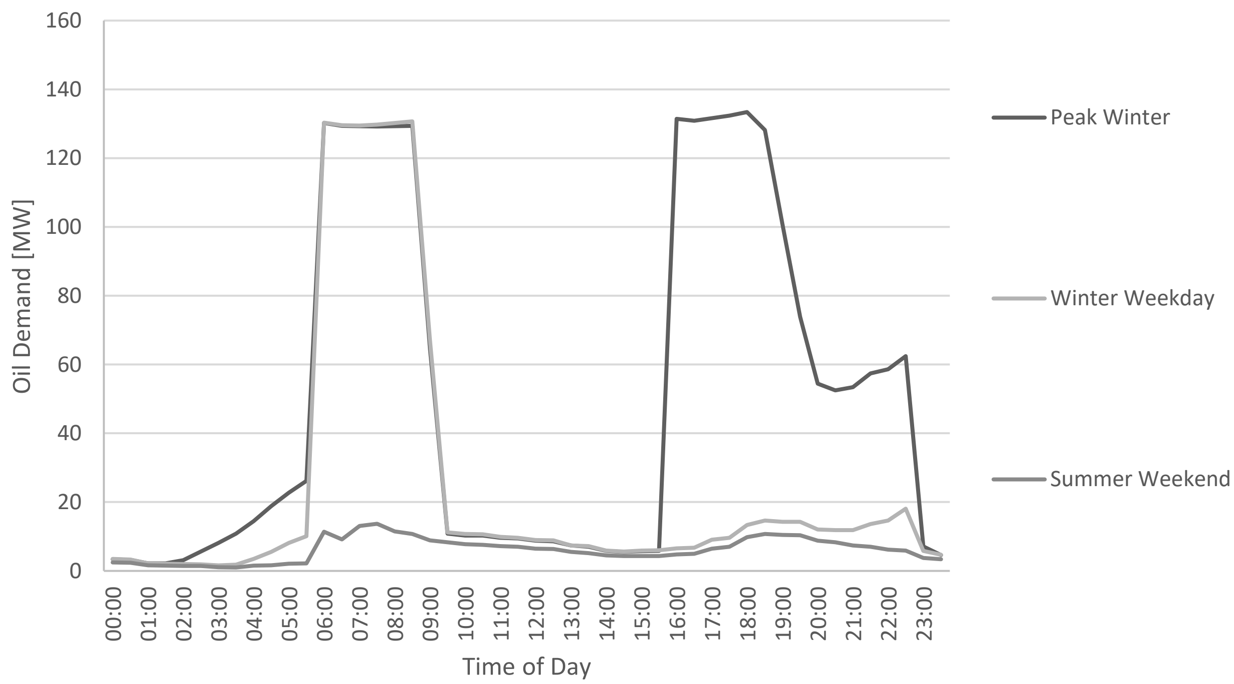


Figure 58: Estimated oil demand profiles for different days of the year across the Suffolk Central sub-region.

2.2.3. Energy Networks

A good understanding of the energy networks is vital to formulating a forward plan for the decarbonisation of any area. For example, identifying dwellings that are not on the gas network can help to focus a heat pump roll-out programme thus reducing the risk of competing heating vectors such as hydrogen or heat networks being a more financially viable option in the future. To identify those off-gas areas, Xoserve[20] postcode data was used (mapped in Figure 59) before being cross-referenced with Ordnance Survey records to calculate how many dwellings are estimated to be on- or off-gas (Table 17).

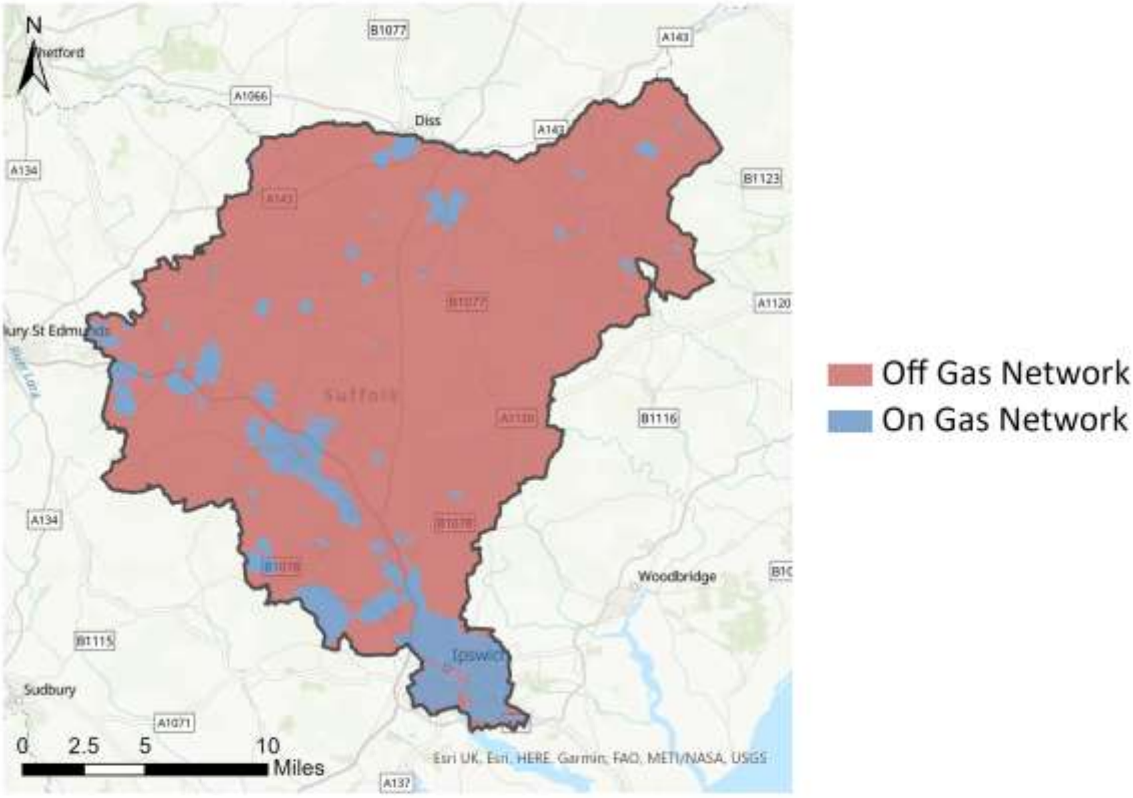


Figure 59: On-gas and off-gas areas of the Suffolk Central sub-region.

Table 17: Estimate of on-gas and off-gas dwellings across the Suffolk Central sub-region (rounded to nearest 5,000)

	Number
Off-Gas Dwellings	**25,000**
On-Gas Dwellings	**95,000**

Comparing Figure 59 and Table 17 leads to the conclusion that the off-gas grid areas are sparsely populated. This is confirmed by comparing to the location of the building stock.

[20] https://www.xoserve.com/wp-content/uploads/Off-Gas-Postcodes-V2.xlsx

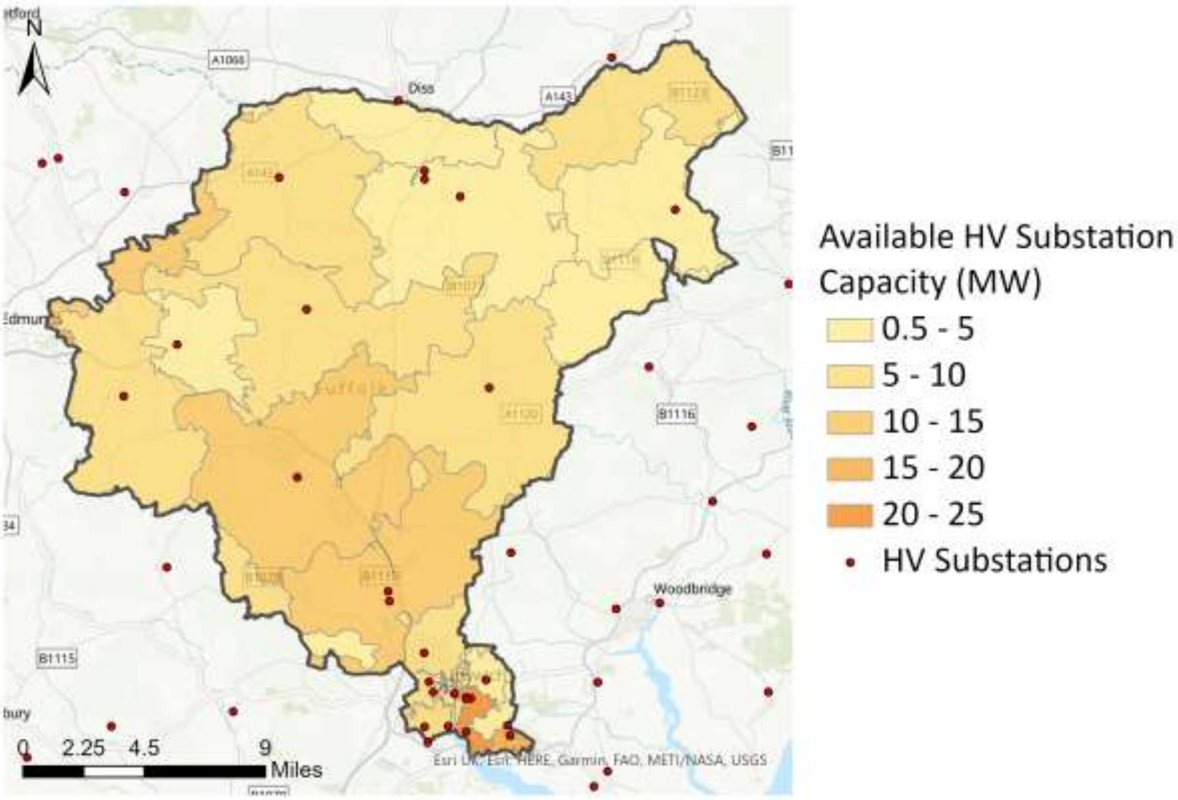


Figure 60: Available high-voltage substation capacity across the Suffolk Central sub-region.

Figure 60 shows an estimate of the available capacity on each 33kV-to-11kV substation and the extent of the area served by each substation. Capacity is calculated by subtracting the combined peak electrical demand on buildings in each area from the rated capacity of each substation. Those substations shown outside of the Suffolk Central boundary may serve buildings within it. Substations outside of the boundary have been included since it is likely some may serve assets within the project boundary. This is seen by new polygons that begin next to the project boundary. It should be noted that available capacity of areas on the boundary may be overestimated since the demands of buildings outside of the county have not been modelled.

Where network connection is important from a project planning perspective the actual areas served should be established in conversation with the local Distribution Network Operator, (DNO) UK Power Networks. These capacity estimates are intended to give an indication of the capacity available on different parts of the network within the local energy system representation area and are not a substitute for detailed network modelling and analysis conducted by the local DNO. Substations identified as generation only in the DNO data are assumed to have no available capacity. Substations are not included in the analysis where DNO data on locations and capacities are unavailable. Where capacity data is unavailable, but locations are available, the 11kV-to-400kV capacity was set to the most prevalent substation capacity across all of Suffolk. Where capacity data is only available in MVA, it is assumed that capacity in MVA is equal to capacity in MW, unless power factors are available.

Figure 61 shows an estimate of the number of buildings, both domestic and non-domestic connected to each 33kV-to-11kV substation. As with capacity, the extent has been calculated as the area closest to each substation.

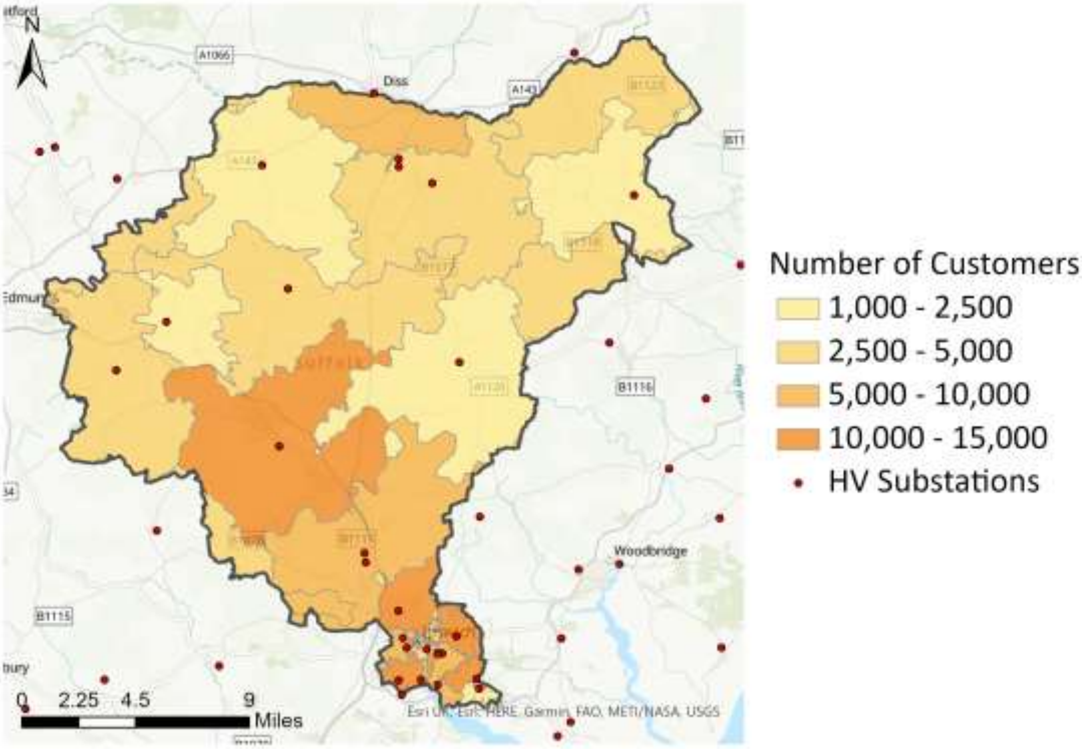


Figure 61: Number of buildings within the Suffolk Central sub-region served by each high-voltage substation.

In addition to the electrical considerations of the local network, there are physical considerations with planning. To assist with this, Ordnance Survey's definition of 'pylon' is shown below in Figure 62 within the local area. This can help to ensure assets are clear or aware of any existing network infrastructure in place.

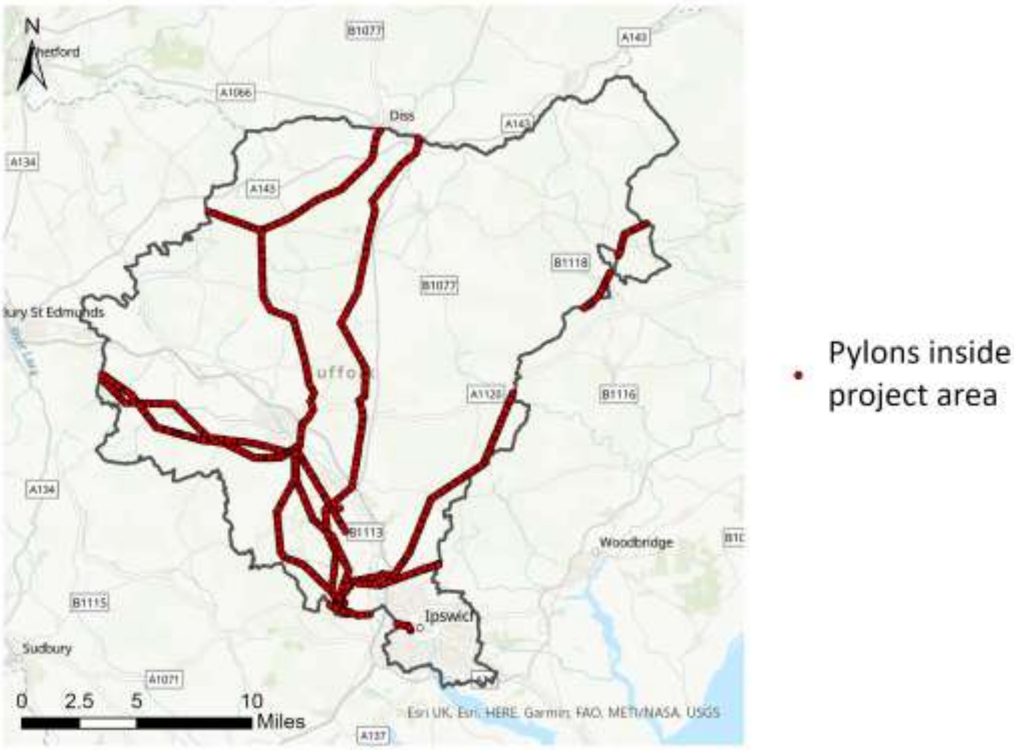


Figure 62: Ordnance Survey MasterMap classification of 'Pylon' within the Suffolk Central sub-region

2.2.4. Embedded Generation

The Renewable Energy Planning Database (REPD) was used to identify large scale embedded generation across the Suffolk Central sub-region. These sites, and the associated technologies, are shown in Figure 63. Data on domestic feed-in tariffs from BEIS are used to identify the amount of domestic solar photovoltaic (PV). The total installed capacity for each technology along with an estimate of the annual electricity generated in the local area is given in Table 18. This shows the proportion of annual electricity demand in the project area estimated to be met currently using local embedded generation. Additional embedded generation technologies may be present in the area but not reported here if they are not recorded in the REPD or if they are below 100kW.

Table 18: Estimated renewable energy capacity and estimated generation as a proportion of electricity demand in the Suffolk Central sub-region.

Renewable Tech	***Installed Capacity [MW]***	***Annual Generation [GWh]***	***Proportion of Annual Demand***
Domestic Solar PV	17.2	35	2.3%
Other Solar PV	4.8	4.35	0.3%
Onshore Wind	5	11.6	0.8%
Biomass	14.3	81	5.4%
Energy from Waste	20	64.5	4.3%
Landfill Gas	5.5	24.5	1.6%

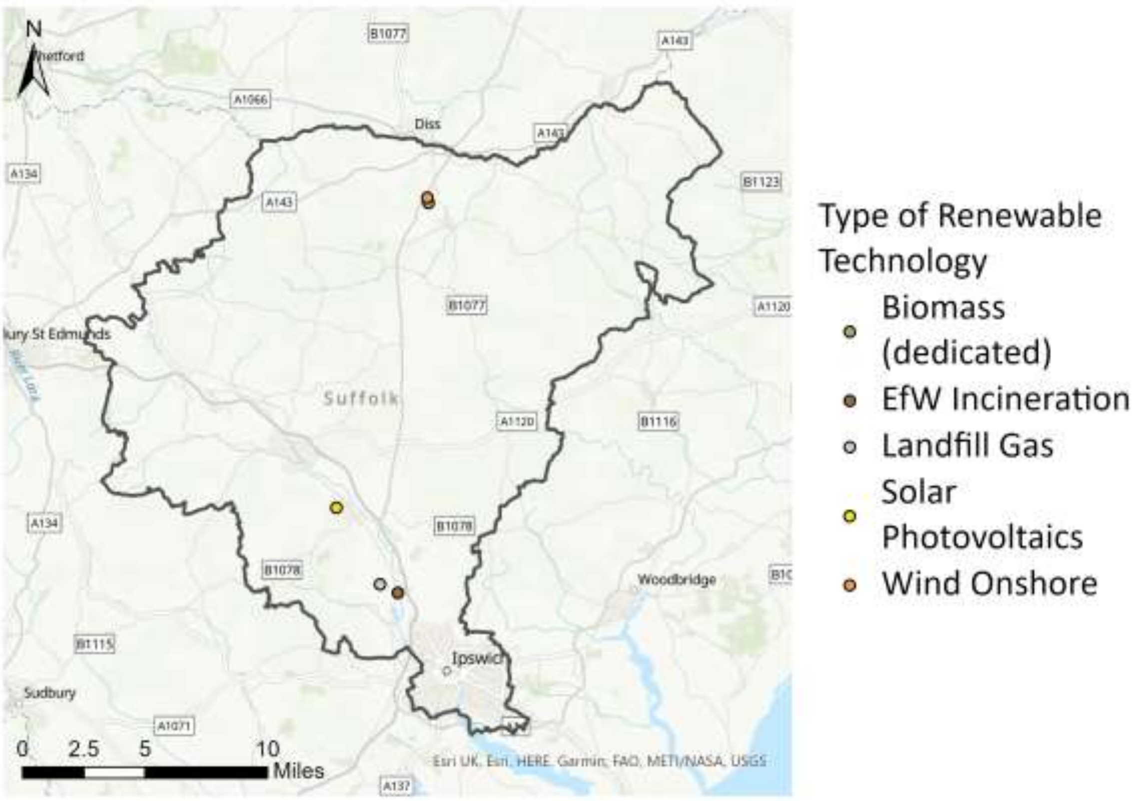


Figure 63: Existing embedded generation in the Suffolk Central sub-region according to REPD database (October 2020).

As can be seen from Table 18 domestic solar PV contributes over 2.5% to the annual demand of the sub-region. Although not all installations of solar PV are registered for the feed-in tariff (FIT), and not all FITs were given to solar PV, the majority will be and therefore Ofgem's Feed-in Tariff Installation Report[21] is a useful way of identifying the overall capacity and number of registrations in each LSOA. Figure 64 and Figure 65 show the installed capacity of renewables and number of registrations respectively.

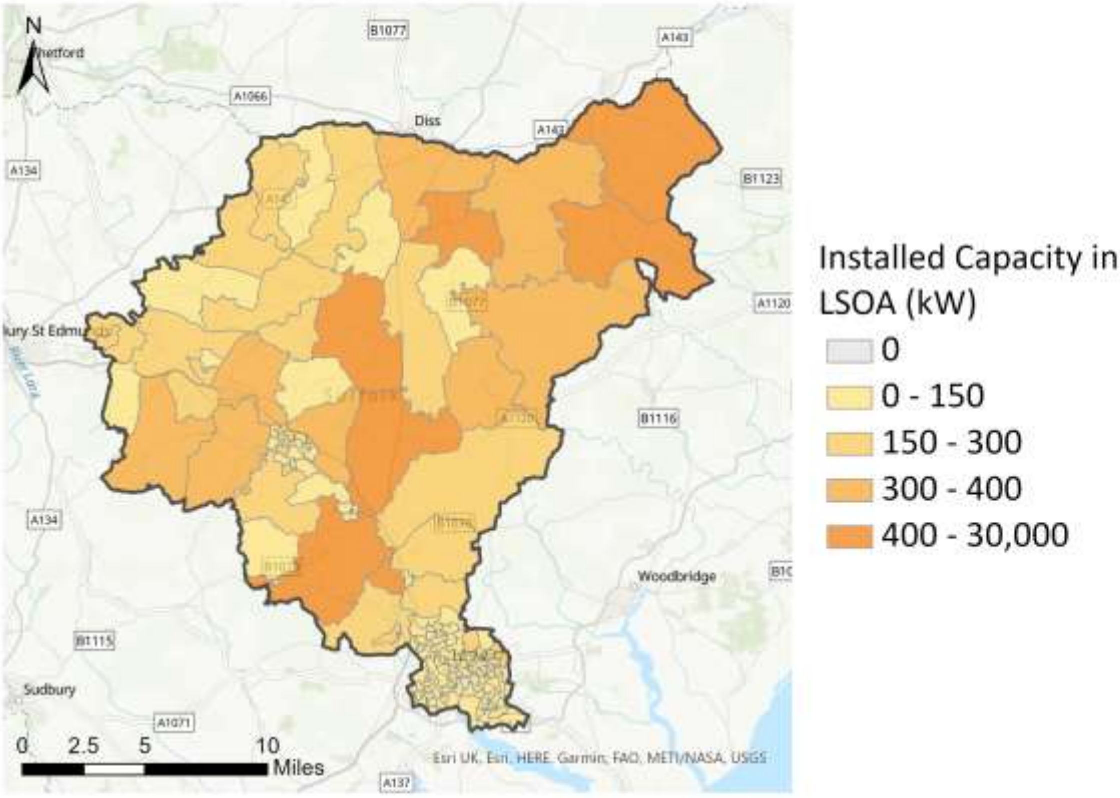


Figure 64: Aggregated capacity of renewable installations registered for FIT within each LSOA of the Suffolk Central sub-region.

[21] https://www.ofgem.gov.uk/environmental-programmes/fit/contacts-guidance-and-resources/public-reports-and-data-fit/installation-reports

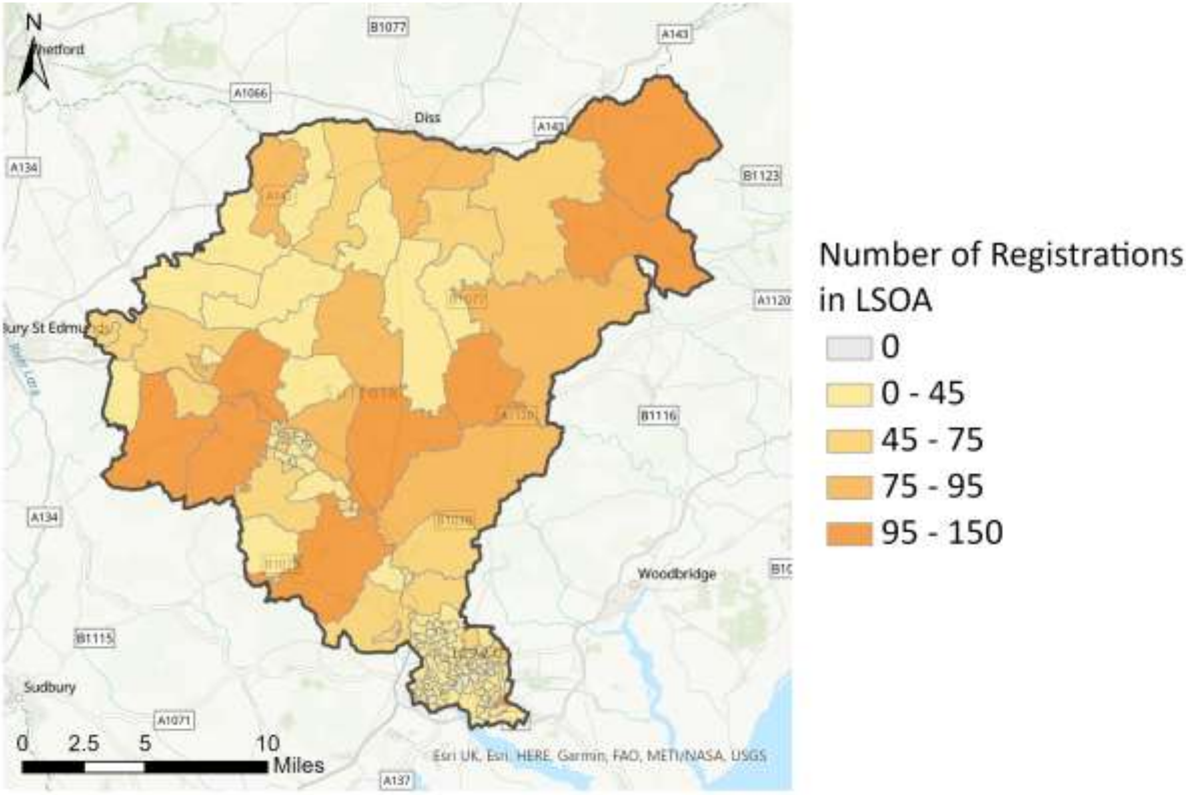


Figure 65: Number of renewable installations registered for FIT within each LSOA of the Suffolk Central sub-region.

To assess the potential for domestic on-roof solar PV within the Suffolk Central sub-region, the footprint and orientation of all dwellings have been analysed to calculate the potential generating capacity. These results are then aggregated to 200m radius areas to identify places best suited for mass deployment. The dwellings identified as suitable for rooftop solar PV in each of the three best areas are shown in Figure 66 to Figure 68.

As a purely spatial exercise this analysis does not consider local planning constraints and should not be used as a replacement for a detailed feasibility study or installation design.

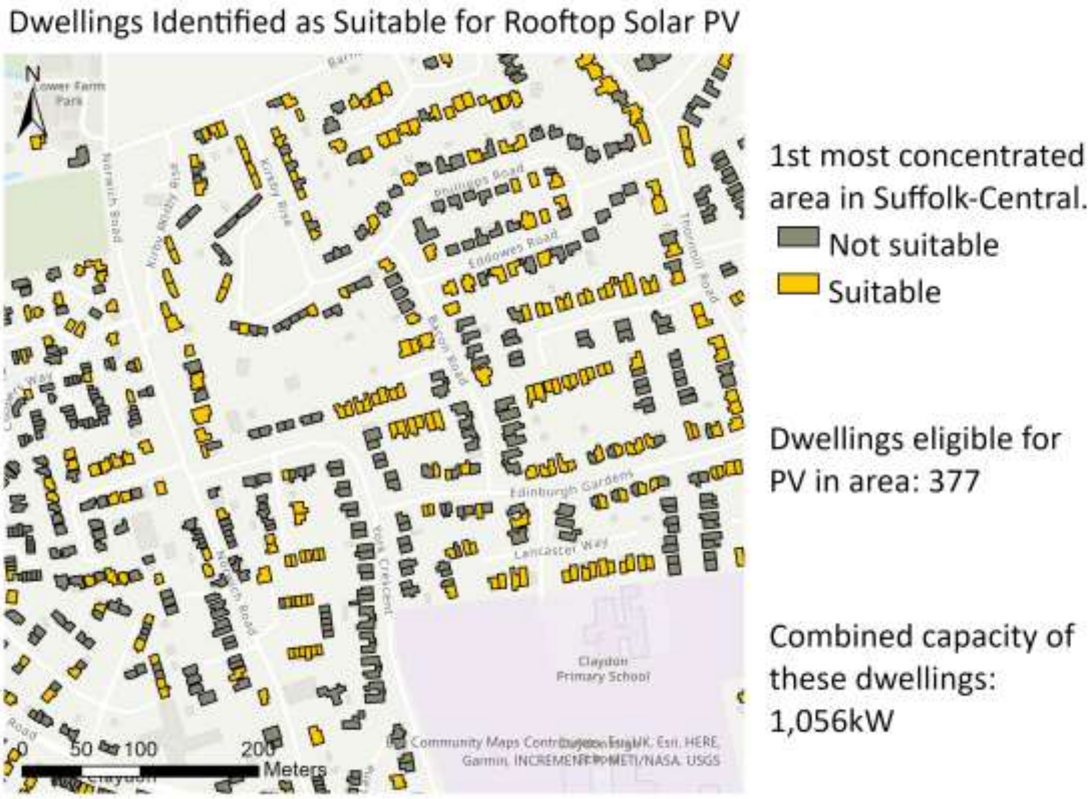


Figure 66: Dwellings identified as suitable for rooftop PV panels. (Location: Claydon, Ipswich)

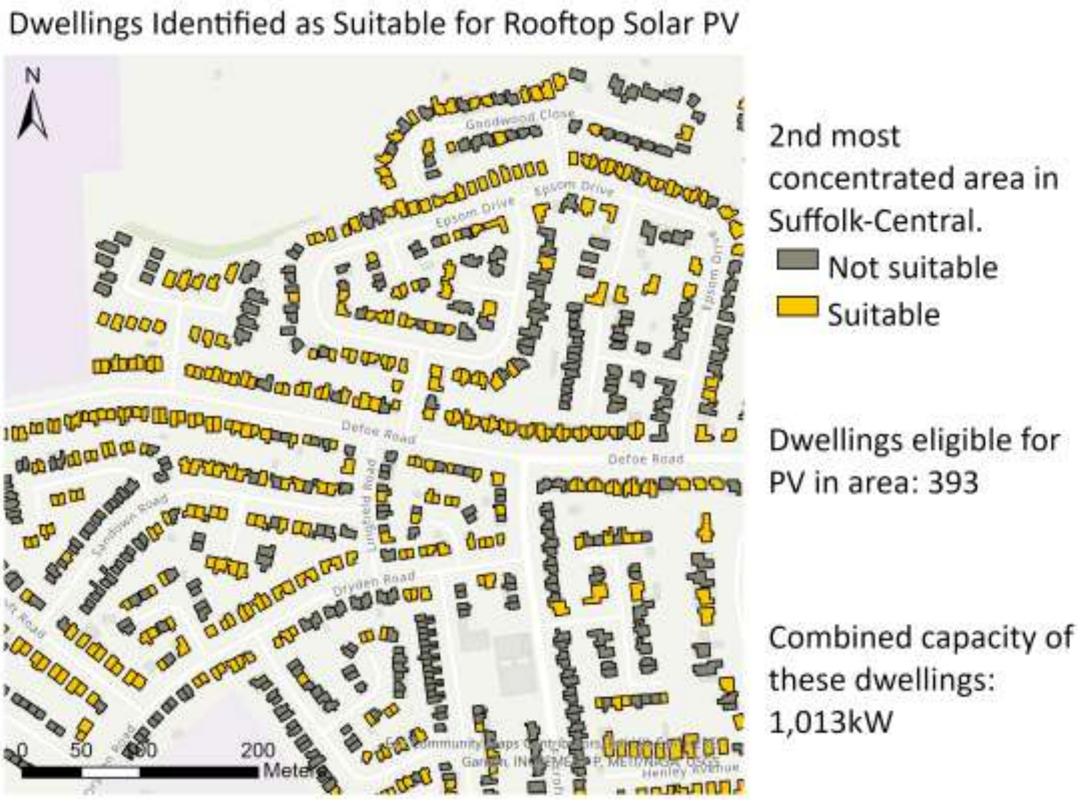


Figure 67: Dwellings identified as suitable for rooftop PV panels. (Location: Whitton, Ipswich)

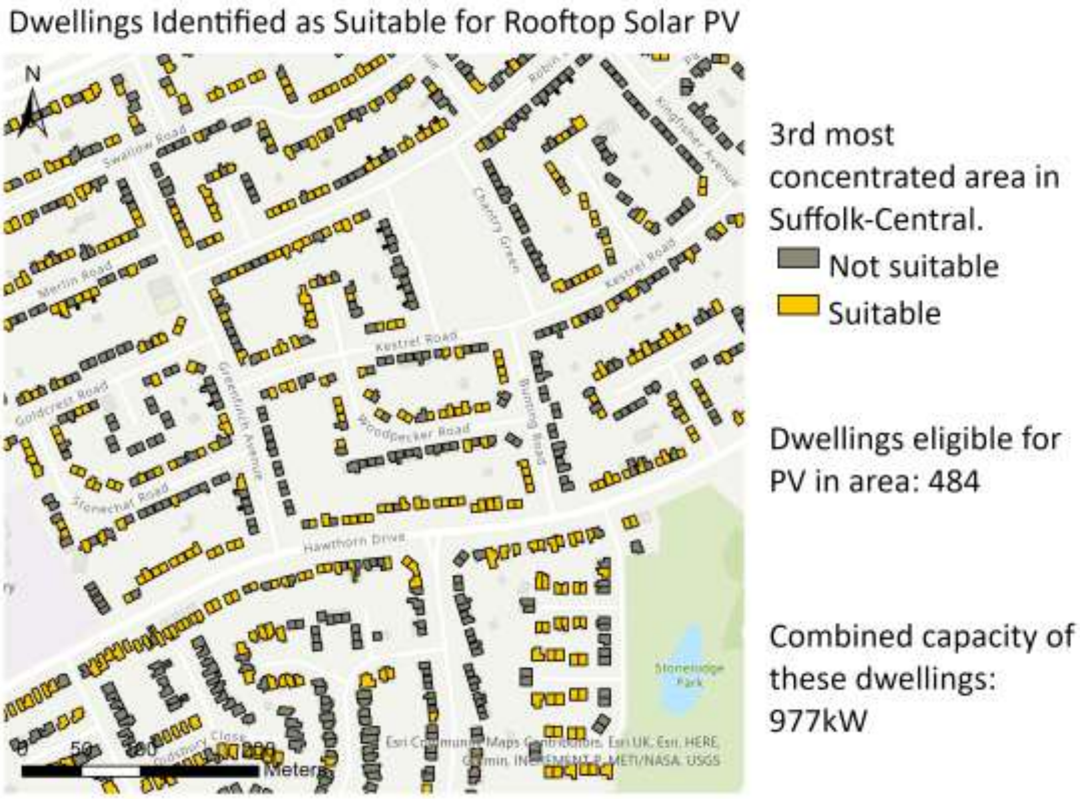


Figure 68: Dwellings identified as suitable for rooftop PV panels. (Location: Chantry, Ipswich)

In total these three areas alone have a total potential solar PV capacity of 3.046 MW.

2.2.5. Domestic & Public EV Charging

Data from the Zap-Map®[22] has been used to identify the locations and power outputs of public Electric Vehicle (EV) chargepoints across the Suffolk Central sub-region. The locations and the speed of the chargepoints are shown in Figure 69. In total there are 126 public chargepoints with a combined capacity of 2,306kW.

[22] https://www.zap-map.com/

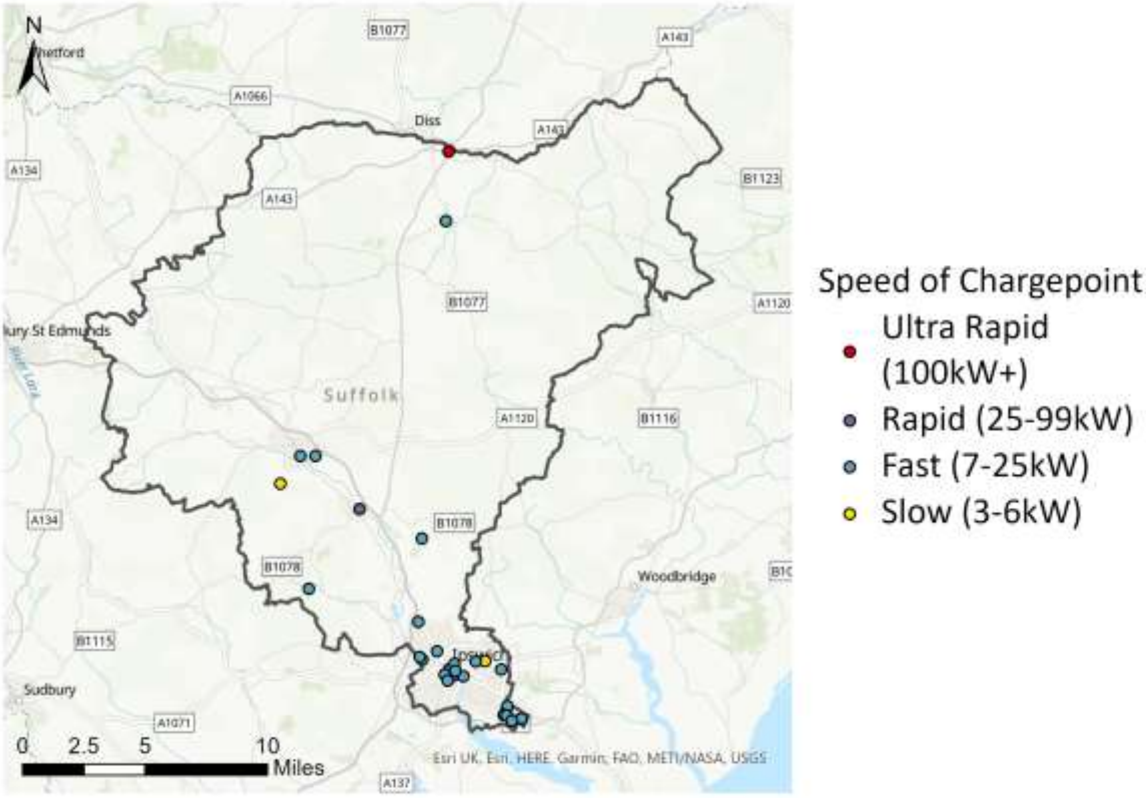


Figure 69: Location of public chargepoints according to Zap-Map® (December 2020)

Chargepoint data provided by Zap-Map®

The Driver and Vehicle Licensing Authority (DVLA) publishes data on the numbers and types of different vehicles registered within different Local Authority Areas. This figure is for all plug-in vehicles, which includes both 100% electric battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). This gives an indication of the number of EVs that might be registered within the sub-region as shown in Table 19.

It should be noted that leased vehicles will be registered to the leasing company which may not be based within the project area.

Using National Travel Survey data representative charge profiles have been generated for both public and domestic charge points. The estimated peak demands for domestic chargepoints are shown in Table 19.

Table 19: Summary of plug-in vehicles[23] registered in the Suffolk Central sub-region according to data from DfT

Number of Plug-in Vehicles	***Percentage of Total Vehicles***	***Estimated Peak Demand [kW]***
954	0.58%	1,642

[23] Plug-in vehicles are all models identified as being fully electric or plug-in hybrid.

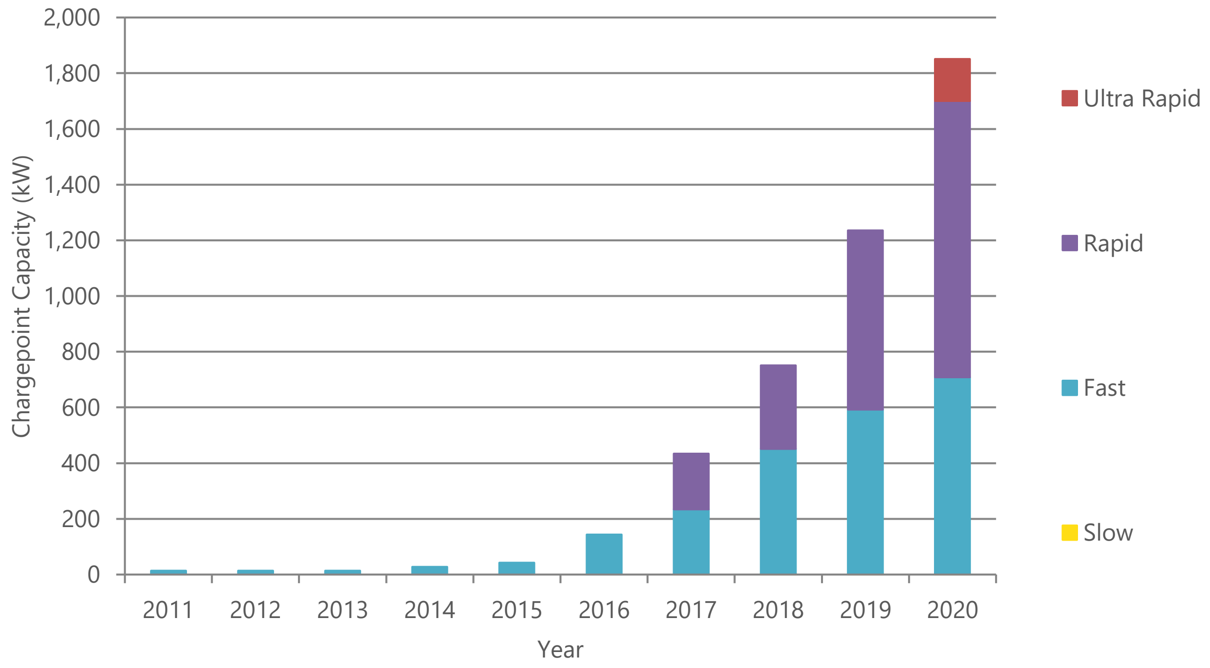


Figure 70: Chargepoint connector total capacity (kW) within the Suffolk Central sub-region over time.

Using the date that each chargepoint was added to the Zap-Map database the uptake of chargepoints in the area can be analysed. Figure 70 shows this uptake in total kW rating of connectors within the Suffolk Central sub-region by charger type.

Ordnance Survey MasterMap Topography and Land Registry INSPIRE polygons have been used to identify houses which have space for off-street parking. This is done by attempting to fit a standard UK parking space of 4.8m x 2.4m in the owned area between the house and its nearest road. This helps identify homes that may be able to charge an EV on a driveway, and areas that will require alternative charging solutions for on-street parking. Figure 71 shows the results of this analysis aggregated by road.

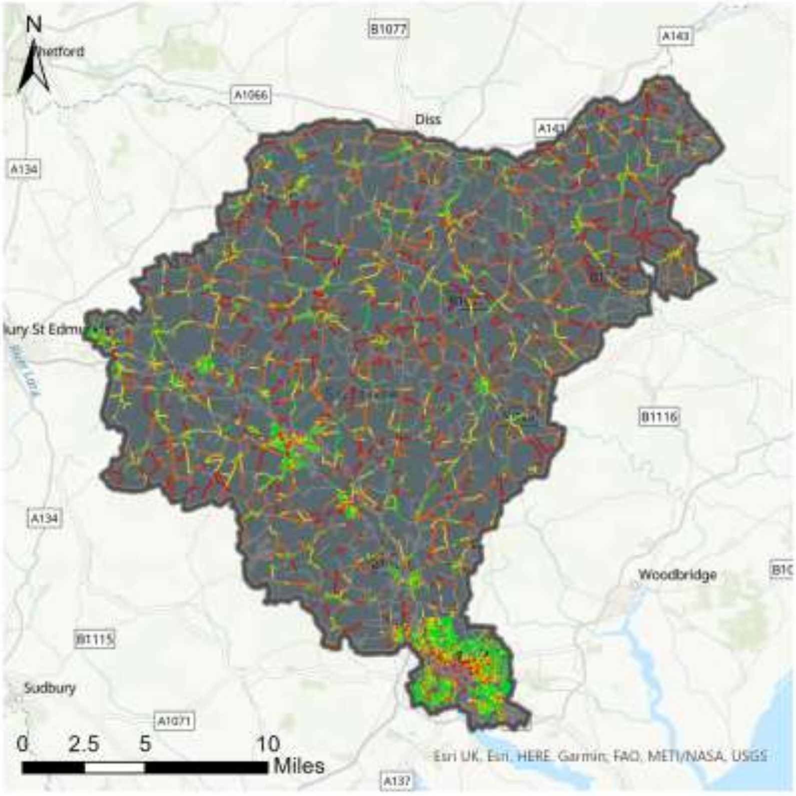


Figure 71: Percentage of dwellings with off-street parking on each road within the Suffolk Central sub-region.

As a purely spatial exercise this analysis does not consider local planning constraints and should not be used as a replacement for a detailed feasibility study.

2.2.6. Social Data

National data have been used to provide an indication of fuel poverty (Figure 72) and multiple deprivation (Figure 73) across the Suffolk Central sub-region.

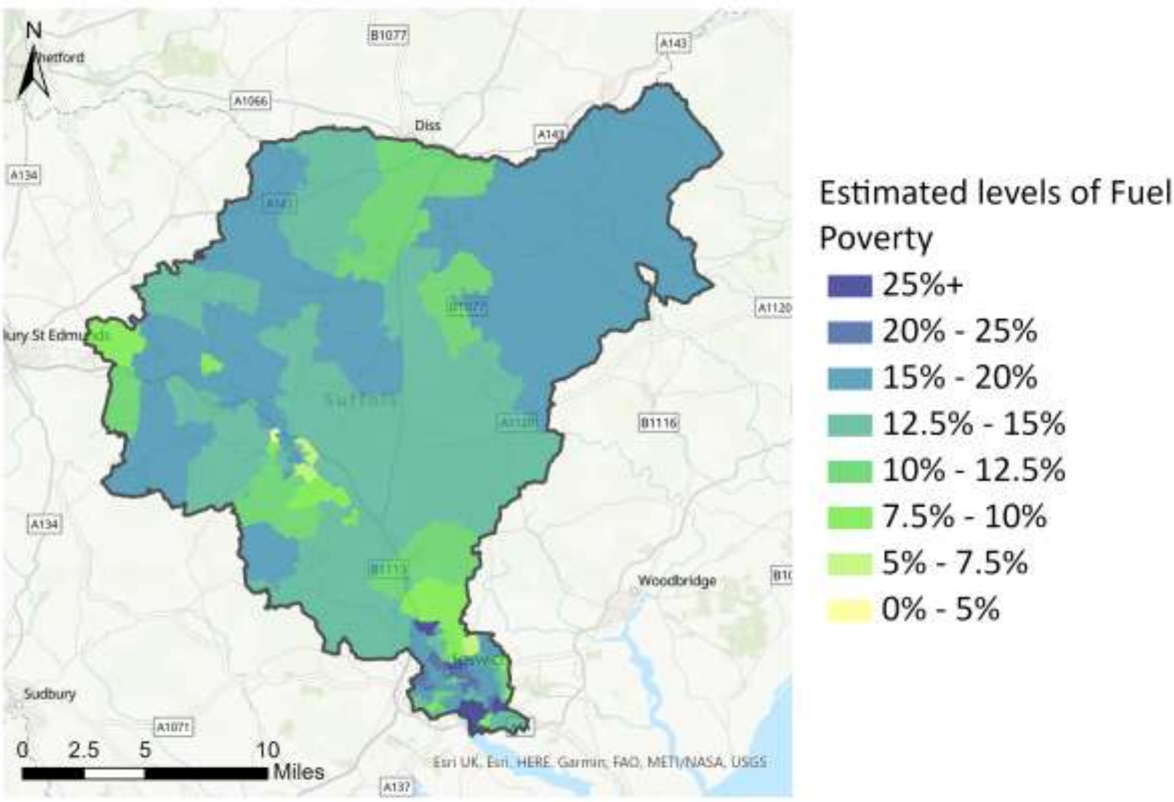


Figure 72: Estimated levels of fuel poverty according to 2020 BEIS data

Using the ranked Index of Multiple Deprivation[24] data published by The Department for Communities and Local Government (DCLG[25]) at LSOA level it is possible to compare localised levels of deprivation within the Suffolk Central sub-region against the rest of England. For mapping purposes these are shown by octile, with values falling in octile 1 being within the most deprived 1/8th of the country and values falling in octile 8 being within the least deprived 1/8th of the country.

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[24] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015
For descriptions of the underlying indicators used in the indices of deprivation please refer to this document: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/467775/File_8_ID_2015_Underlying_indicators.xlsx

[25] Now Department for Levelling-Up, Housing and Communities (DLUHC). Formerly Ministry for Housing, Communities and Local Government (MHCLG).

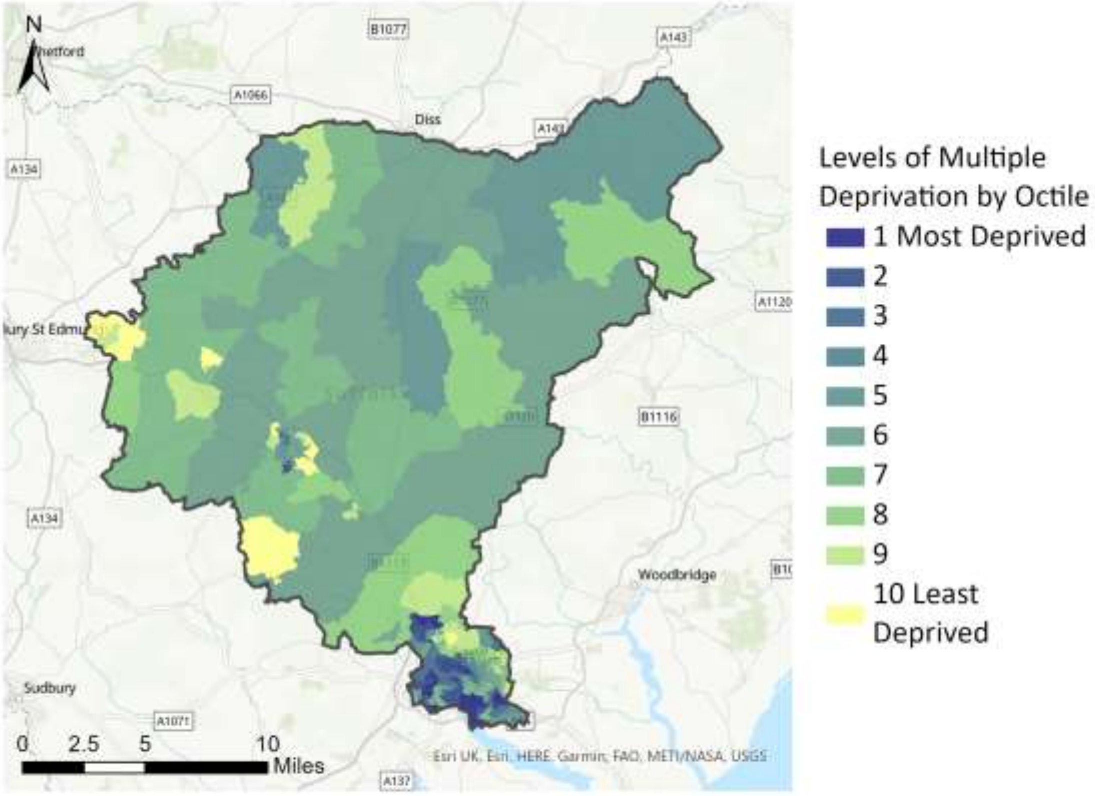

Figure 73: Ranking of English indices of deprivation 2020

The multiple indices that make up the IMD can be found in the accompanying data/maps to this report.

2.3. Suffolk East (East Suffolk)

The sub-regional area of 'Suffolk East' has been defined in this report as covering the local authority area of East Suffolk formerly Suffolk Coastal and Waveney. This local authority covers an area of around 510km^2 and has a population of around 244,000.

2.3.1. Building Stock

This section will provide an overview of the building stock – both domestic and non-domestic – across the Suffolk East sub-region. The geographical location of the building stock will be shown, as will the relative rurality across the sub-region, and breakdowns of the domestic and non-domestic stock by category.

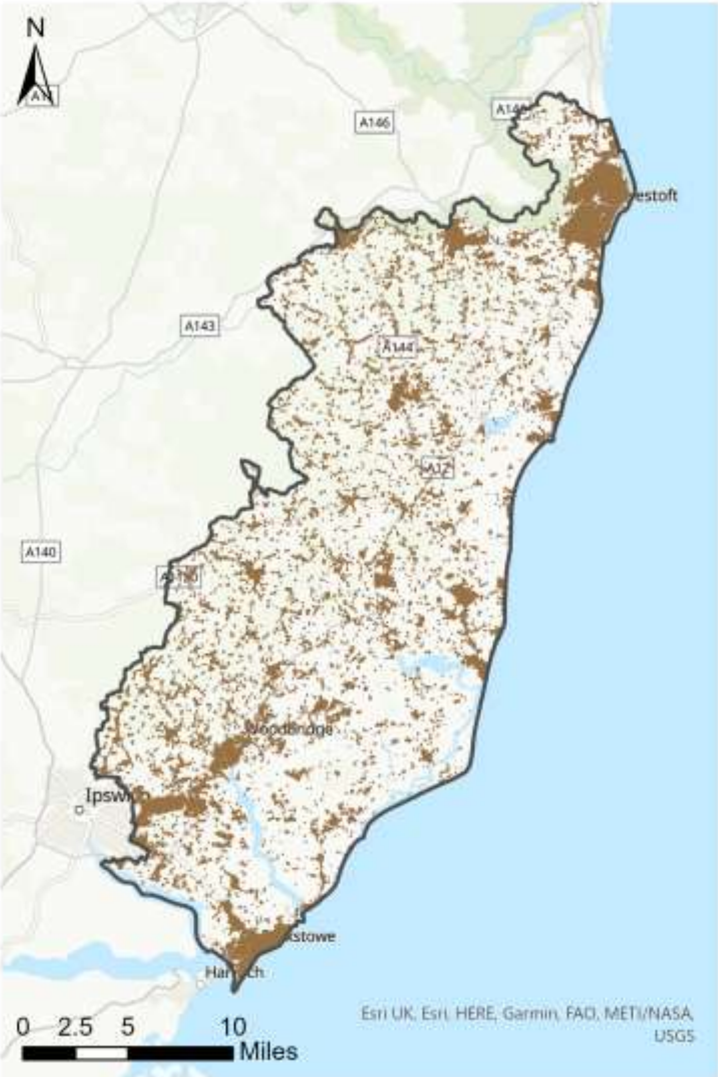

Figure 74: Building stock distribution across the Suffolk East sub-region.

Figure 74 shows that across the Suffolk East sub-region, the building stock is densely populated at the town of Lowestoft in the north and the town of Felixstowe in the south. The majority of remaining building stock is sparsely spread, with minor exceptions such as the market town of Woodbridge and the Kesgrave suburb of Ipswich.

These areas correlate well to the rural/urban classifications given in the rurality map (Figure 75).

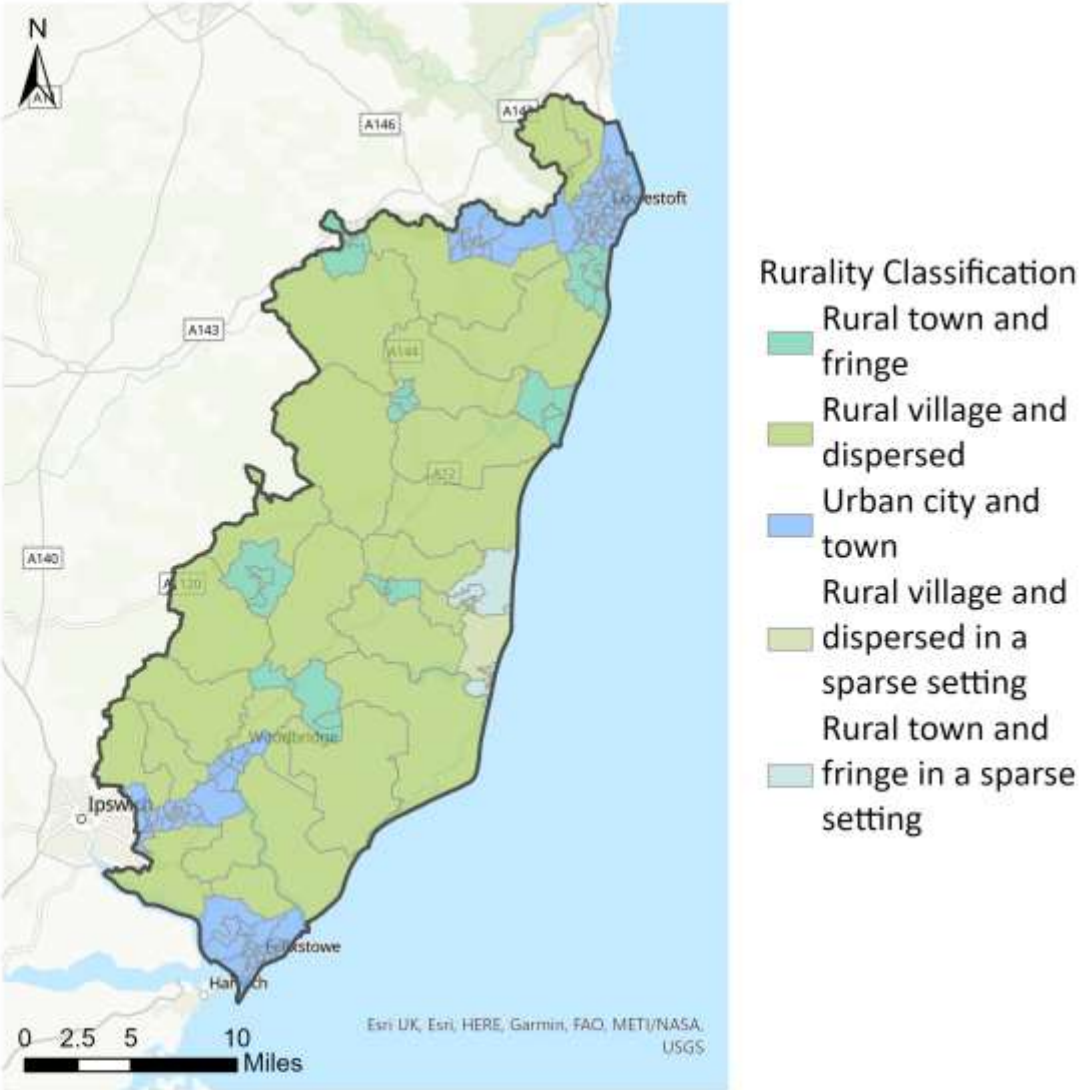

Figure 75: Rurality of the Suffolk East sub-region.

Figure 75 shows the rurality of the Suffolk East sub-region by Lower-level Super Output Area (LSOA). Most of the land area in the Suffolk East sub-region is classified as rural towns and dispersed with the more urban areas matching those noted in Figure 74.

Using data provided by Historic England[26], the location and grade of listed buildings; scheduled monuments; Battlefields; World Heritage Sites and Parks & Gardens can be mapped within the sub-region (Figure 76).

[26] https://historicengland.org.uk/listing/the-list/data-downloads

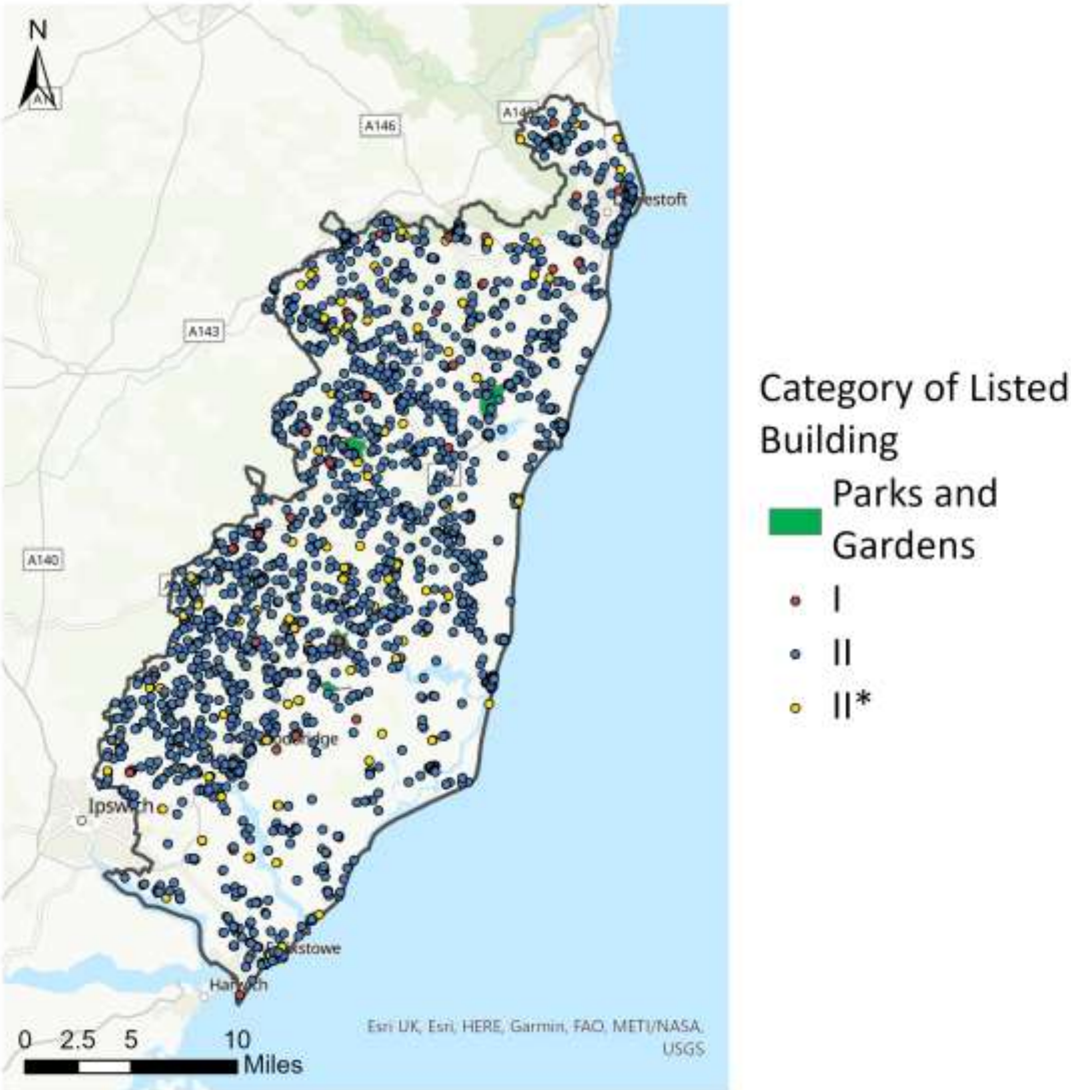

Figure 76: Location of listed buildings in the Suffolk East sub-region grouped by grading according to Historic England

Figure 76 shows the large number of listed buildings, scheduled monuments, and areas of interest clustered in similar locations to the building stock. This could all pose a challenge to decarbonising the building stock. Table 20 shows the Listed Status of the buildings and the number of occurrences.

Table 20: Summary of listed buildings across Suffolk East by grade category.

Grade Category	***Number***
Grade I	111
Grade II	3,243
*Grade II**	233
Scheduled Monument	147

To understand the housing stock in more detail, the domestic stock has been segmented by:

- Type (converted flat, detached, purpose-built flat, semi-detached, and terrace)
- Construction date (pre-1914, 1914-1944, 1945-1964, 1965-1979, post-1980)
- Floor area [m^2] (under 50, 50-70, 70-90, 90-110, 110-200, 200-300, over 300)
- Main heating system (ASHP, biomass, electric (no storage), electric storage, gas, GSHP, oil/LPG)
- Loft insulation level [mm] (no loft, no insulation, 1-99, 100-199, over 200)
- Wall type (filled cavity, unfilled cavity, solid with ESWI, solid with ISWI, uninsulated solid)
- Window type (single glazing, double glazing, triple glazing)

Table 21: Number and percentage of dwelling types across the Suffolk East sub-region.

Dwelling Type	***Number***	***Percentage***
Converted Flat	2,550	2%
Detached	43,000	35%
Purpose Built Flat	17,400	14%
Semi-detached	30,500	25%
Terrace	28,500	24%
Total	122,000	100%

Due to rounding, some totals may not correspond with the sum of the separate figures.

Table 21 shows that larger dwelling types are more prevalent across the sub-region. The prevalence of the dwelling types in each LSOA area (Figure 77) shows that detached dwellings are typically the most dominant in rural areas, whereas flats, terrace and semi-detached are more common in urban and town areas.

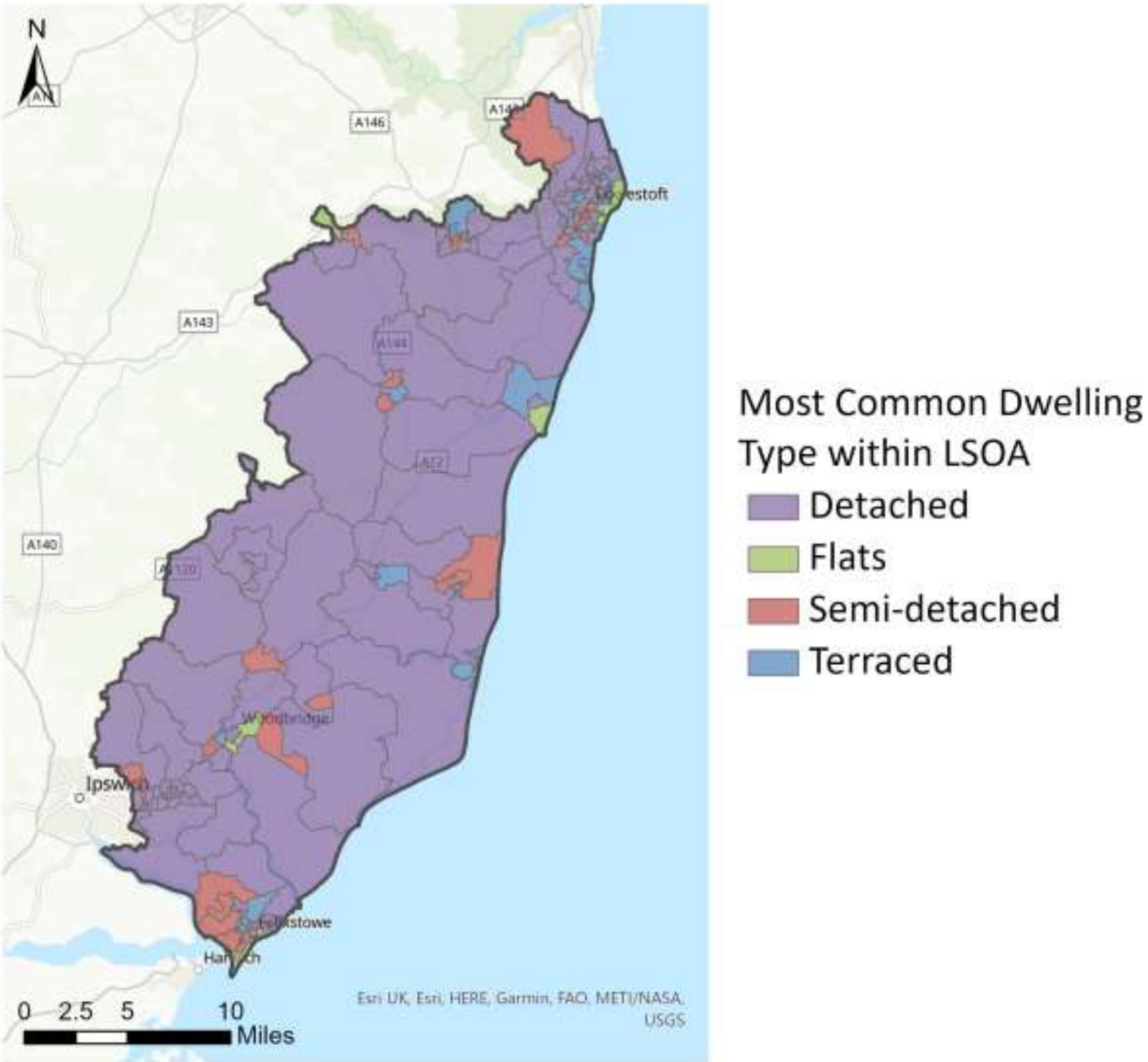

Figure 77: Most common dwelling type within each LSOA across the Suffolk East sub-region.

A notable finding, shown in Table 22 around one-fifth of all domestic dwellings are over a century old which will likely require more substantial intervention to bring their heat loss to a point where a heat pump could be considered.

Table 22: Number and percentage of dwellings constructed in different periods across the Suffolk East sub-region.

Dwelling Construction Period	Number	Percentage
Pre-1914	23,000	19%
1914-1944	8,700	7%
1945-1964	36,500	30%
1965-1979	31,000	25%
1980-present	23,000	19%
Total	**122,000**	**100%**

Due to rounding, some totals may not correspond with the sum of the separate figures.

By combining the dwelling type and the construction period, it can be seen in Figure 78Figure 79 that over half of the pre-1914 dwellings are terraced. Detached and semi-detached dwellings are more prevalent in the post-war (1945-1964) period.

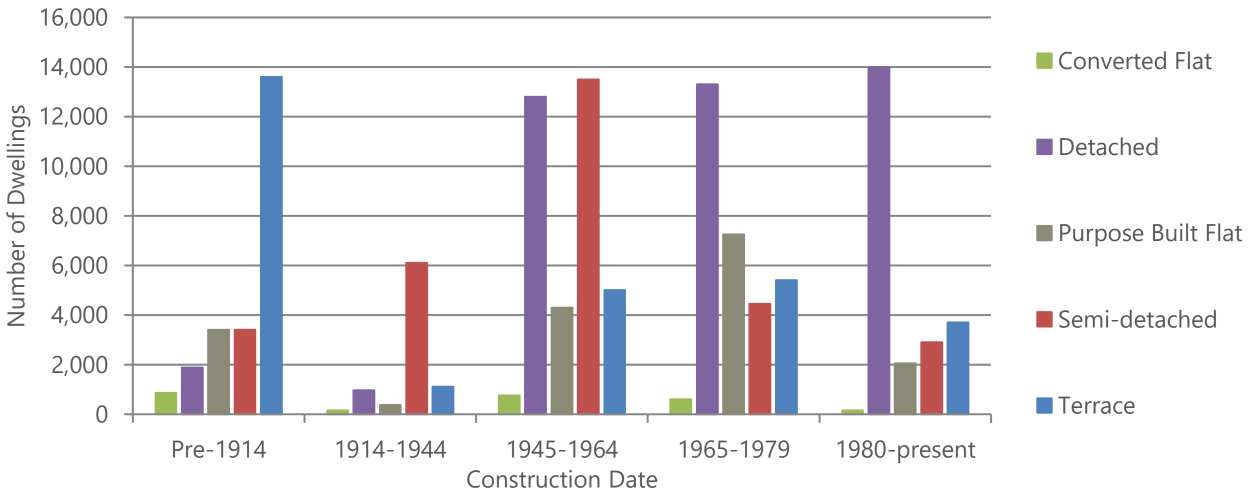

Figure 78: Estimated number of dwellings within each construction period (by dwelling type) across the Suffolk East sub-region.

This can be visualised spatially (Figure 79) to show the most prevalent construction year in each LSOA in the Suffolk East sub-region. Figure 79 shows a prevalence of 1945-1964 built dwellings in many of the larger LSOAs.

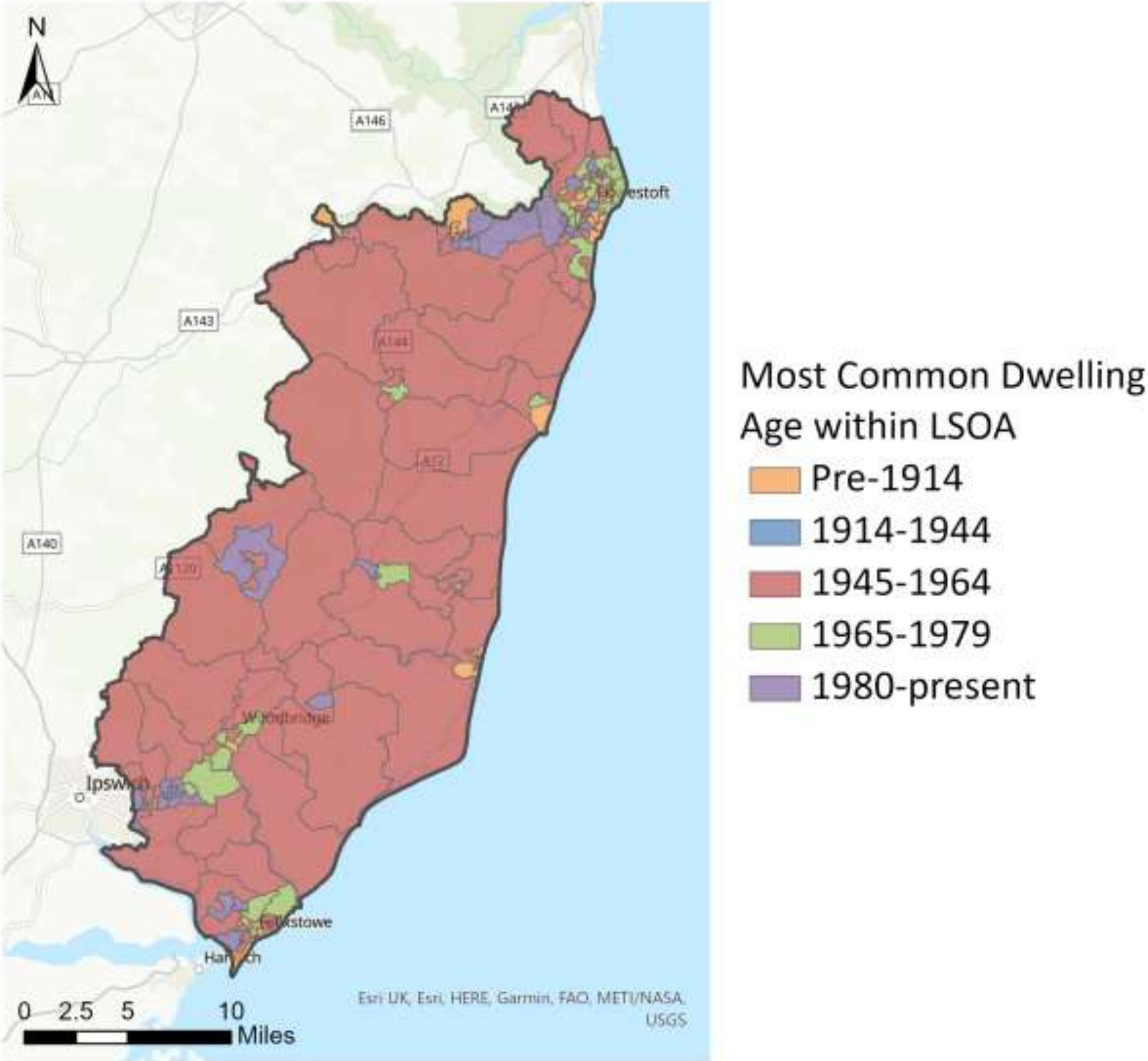

Figure 79: Most common construction period within each LSOA across the Suffolk East sub-region.

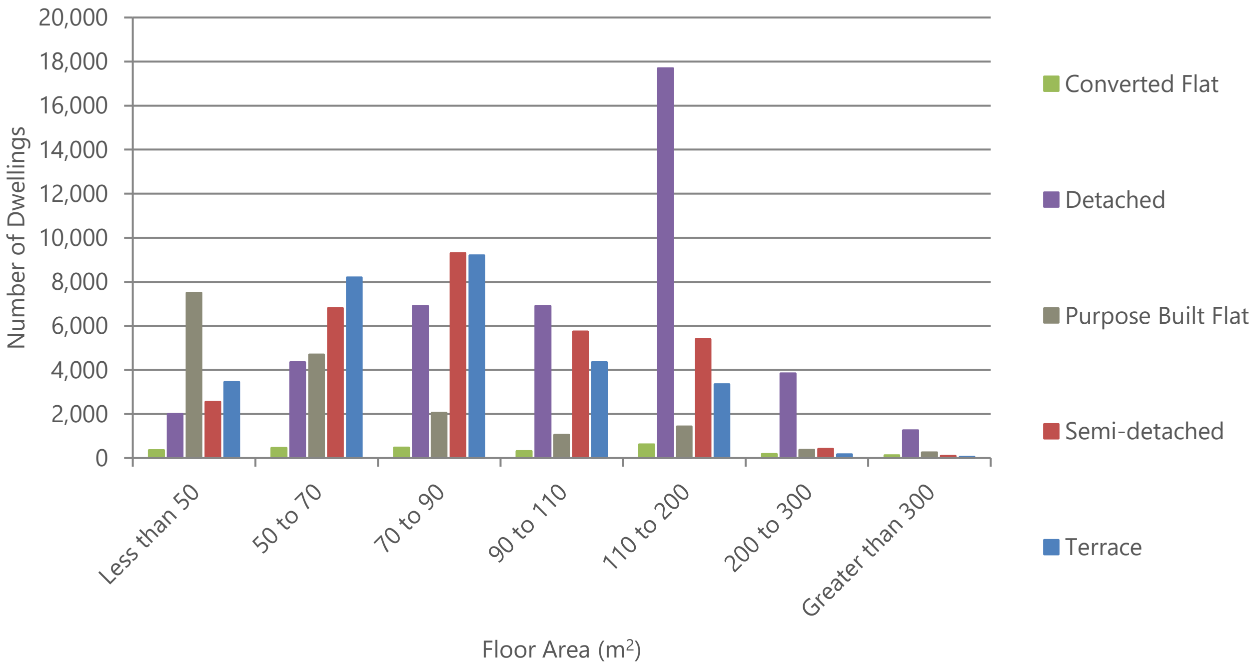

Figure 80: Estimated number of dwellings within each floor area band (by dwelling type) across the Suffolk East sub-region.

From Figure 80, as expected, flats (particularly purpose-built flats) typically have a lower floor area than other dwellings. More than half of purpose-built flats have a floor area of under 70m^2 whilst the majority of detached dwellings have a floor area of 110-200m^2.

Dwellings in the Suffolk East sub-region are overwhelmingly heated using a fossil fuel boiler (90%) with the remainder being made up from electric storage heaters (9%). Electric storage heaters are often used relatively high or medium-density housing areas where heat losses are low. Oil/LPG boilers are typically used in off-gas grid areas which in turn are often rural. Figure 81 below shows that almost one-fifth of detached dwellings use oil/LPG boilers as their main heating system. Gas boilers are prevalent throughout the housing stock.

While currently there are over 1,000 heat pumps installed, this makes up just 1% of dwellings within Suffolk East.

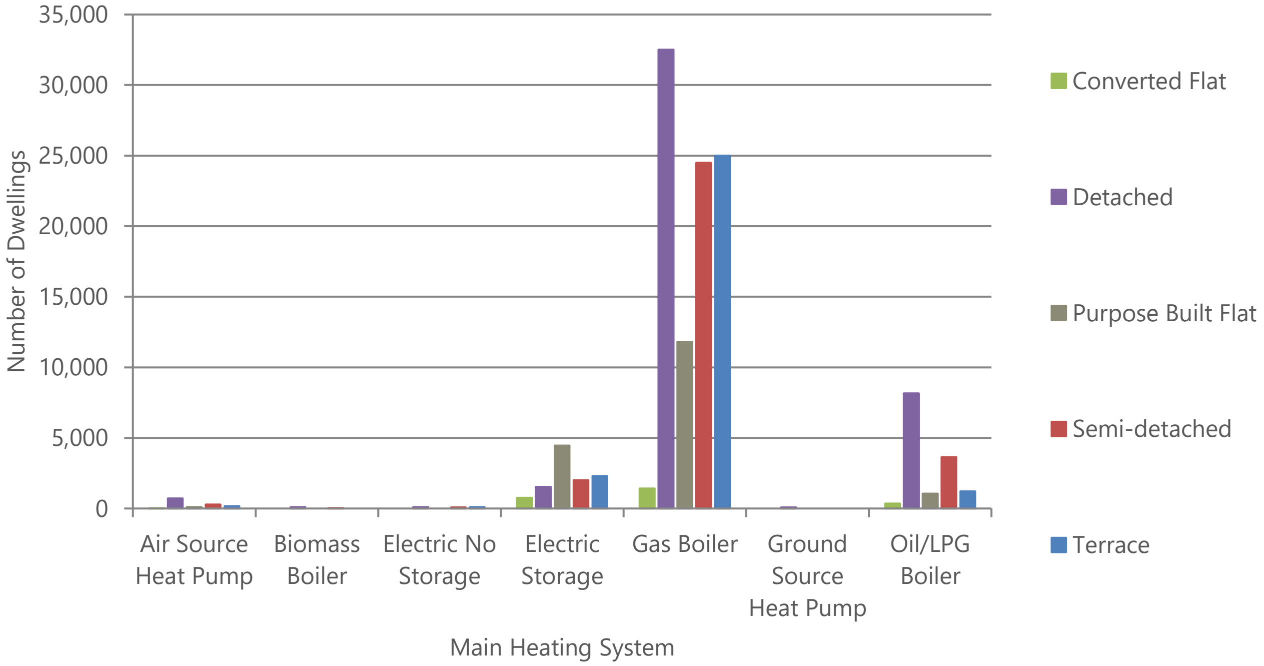

Figure 81: Estimated number of dwellings by main heating system (by dwelling type) across the Suffolk East sub-region.

To make a heating system as efficient as possible insulation is required to reduce the heat loss from a dwelling. Figure 82 shows the level of loft insulation in each dwelling type. Flats (both converted and purpose built) are assumed not to have a loft to insulate as even those on the top-floor are unlikely to be able to access the loft space in which to add insulation. There are also a small number of detached, semi-detached, and terraced properties that are classified as having no loft; this is usually due to them having a 'room-in-roof' where the loft has been converted into part of the living area.

The expected level of loft insulation in the UK is 270mm meaning that of dwellings with loft space, at least 75% in the Suffolk East sub-region that would benefit from additional loft insulation. In particular, where detached, semi-detached, and terraced dwellings have under 100mm of loft insulation (45%, 52% and 60% of dwellings respectively).

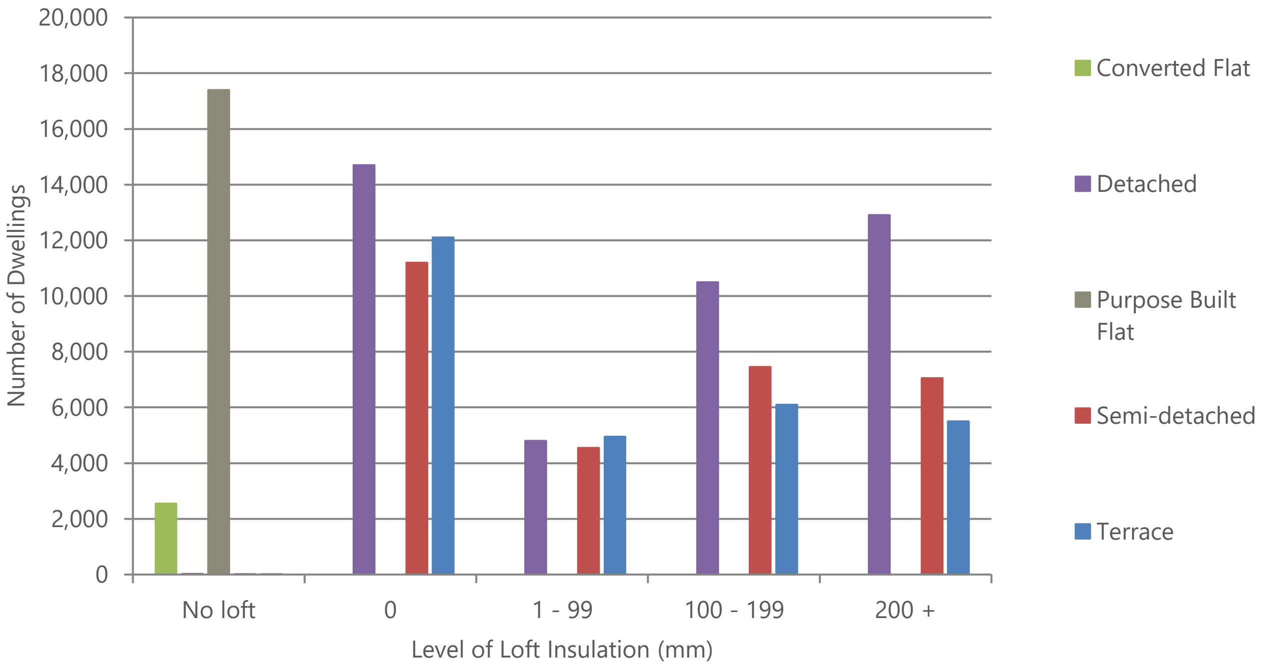

Figure 82: Estimated level of loft insulation (by dwelling type) across the Suffolk East sub-region.

Figure 83 shows that cavity walls are the most prominent wall type across the Suffolk East sub-region, of which 75% being insulated. Cavity wall insulation can be difficult on some archetypes where there are hung tiles or render on the external face of the brickwork, also around conservatories. Whilst these are deemed 'hard-to-treat' there are methods for ensuring that the cavity can be filled, albeit at a higher cost. Figure 83 also shows that 92% of the solid wall properties in the Suffolk sub-region are uninsulated. This may be due to listed status, other planning restrictions, occupant behaviour, preference, or cost.

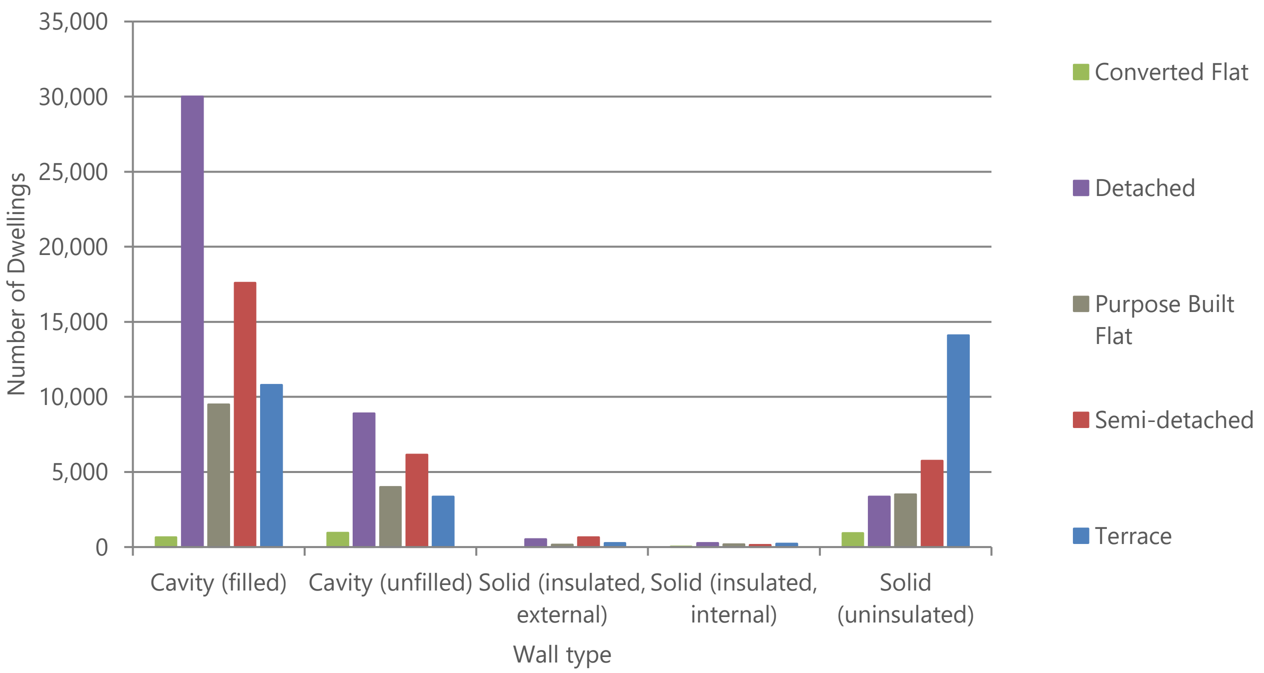

Figure 83: Estimated wall type and insulation level (by dwelling type) across the Suffolk East sub-region.

More than 94% of dwellings in the Suffolk East sub-region have double glazing, including over 96% of all detached dwellings (Figure 84). Converted flats have the highest prevalence of single glazing, with just 83% being double glazed. Triple glazing is not prevalent in the housing stock.

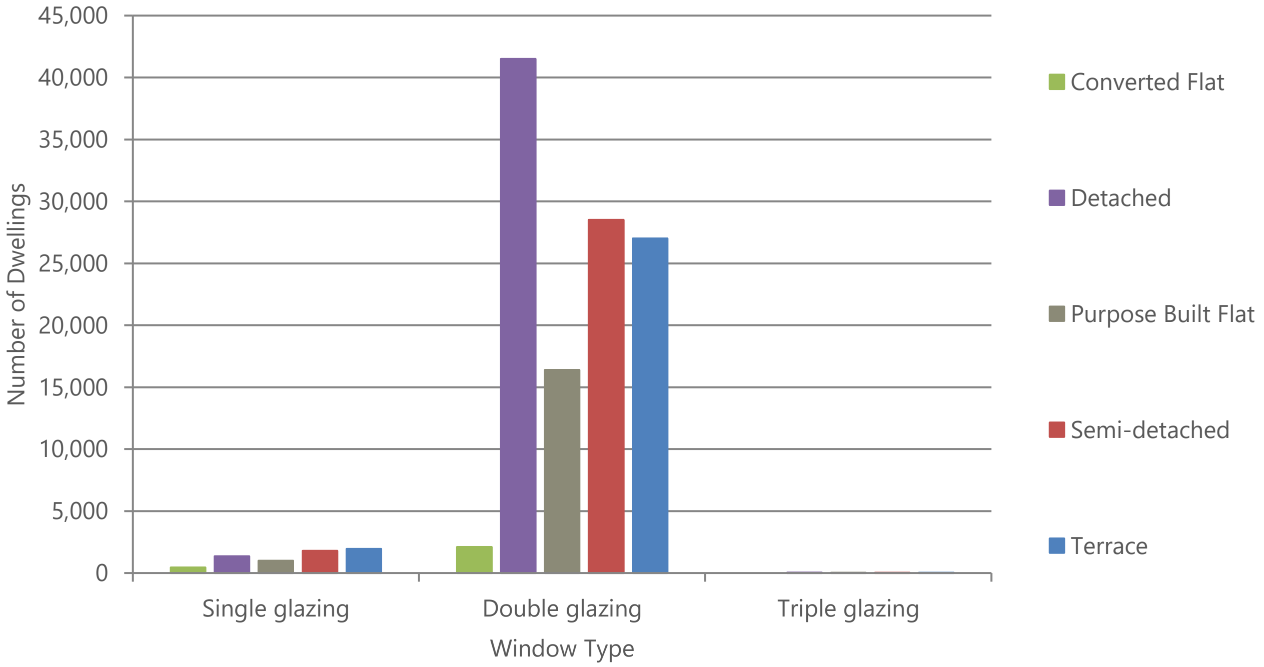

Figure 84: Estimated proportion of glazing type per dwelling type across the Suffolk East sub-region.

To give a visual representation of the current energy efficiency of dwellings within the region, the EPC rating of all properties within an LSOA has been averaged to show where the most and least efficient regions of houses lie. Figure 85 below shows the proportion of the most efficient dwellings in the area, those that have an EPC rating of C or above. Figure 86 on the other hand shows the least efficient dwellings in the area, those that have an EPC rating of E or below. This criterion allows for direct correlation with that of the Local Authority Delivery (LAD) scheme which has a focus on homes living in fuel poverty and an EPC rating of E, F or G.[27]

[27] https://www.gov.uk/government/publications/green-homes-grant-local-authority-delivery-scheme-phase-2-funding-allocated-to-local-energy-hubs

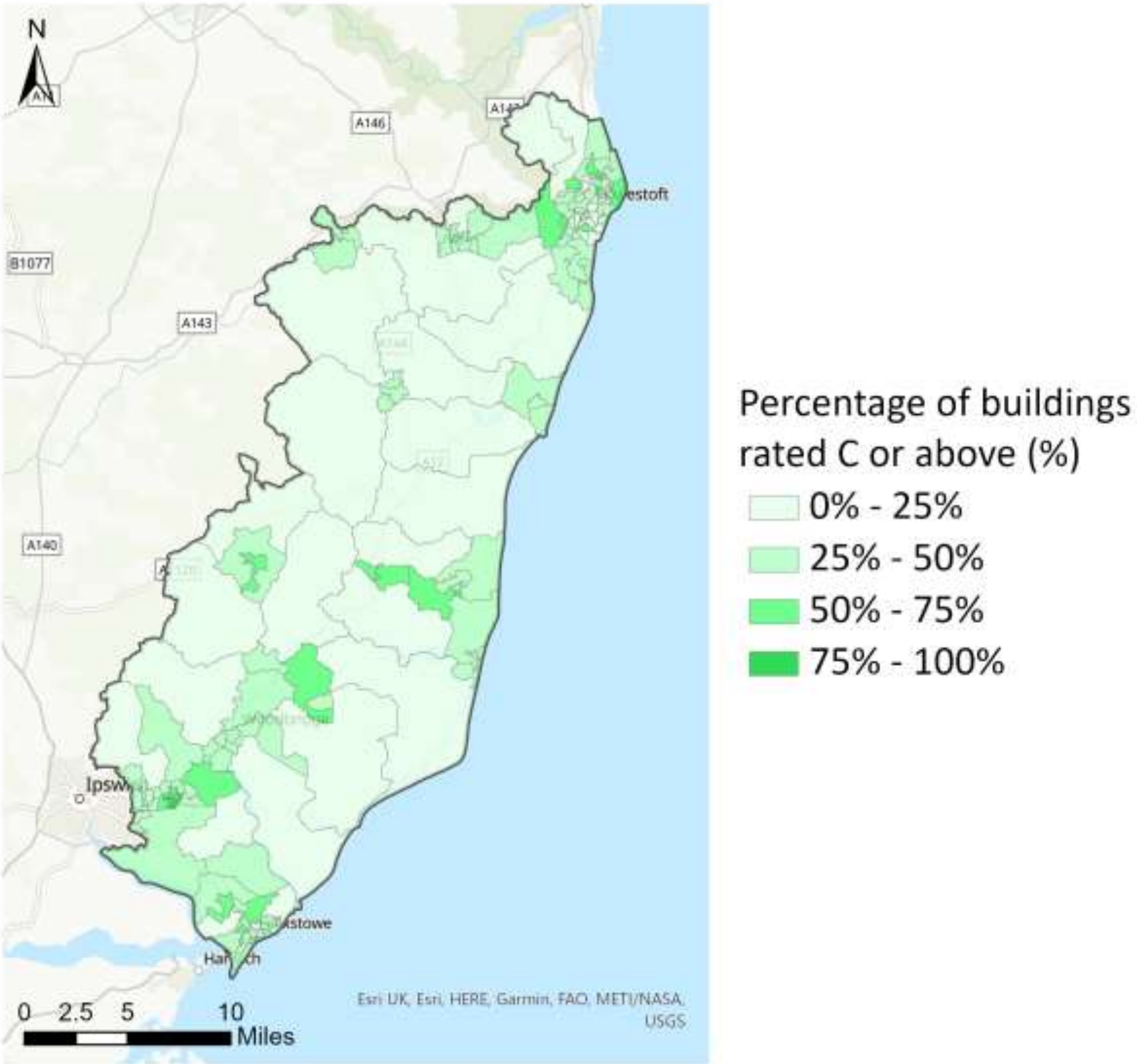

Figure 85: Proportion of dwellings rated EPC C or above across the Suffolk East sub-region.

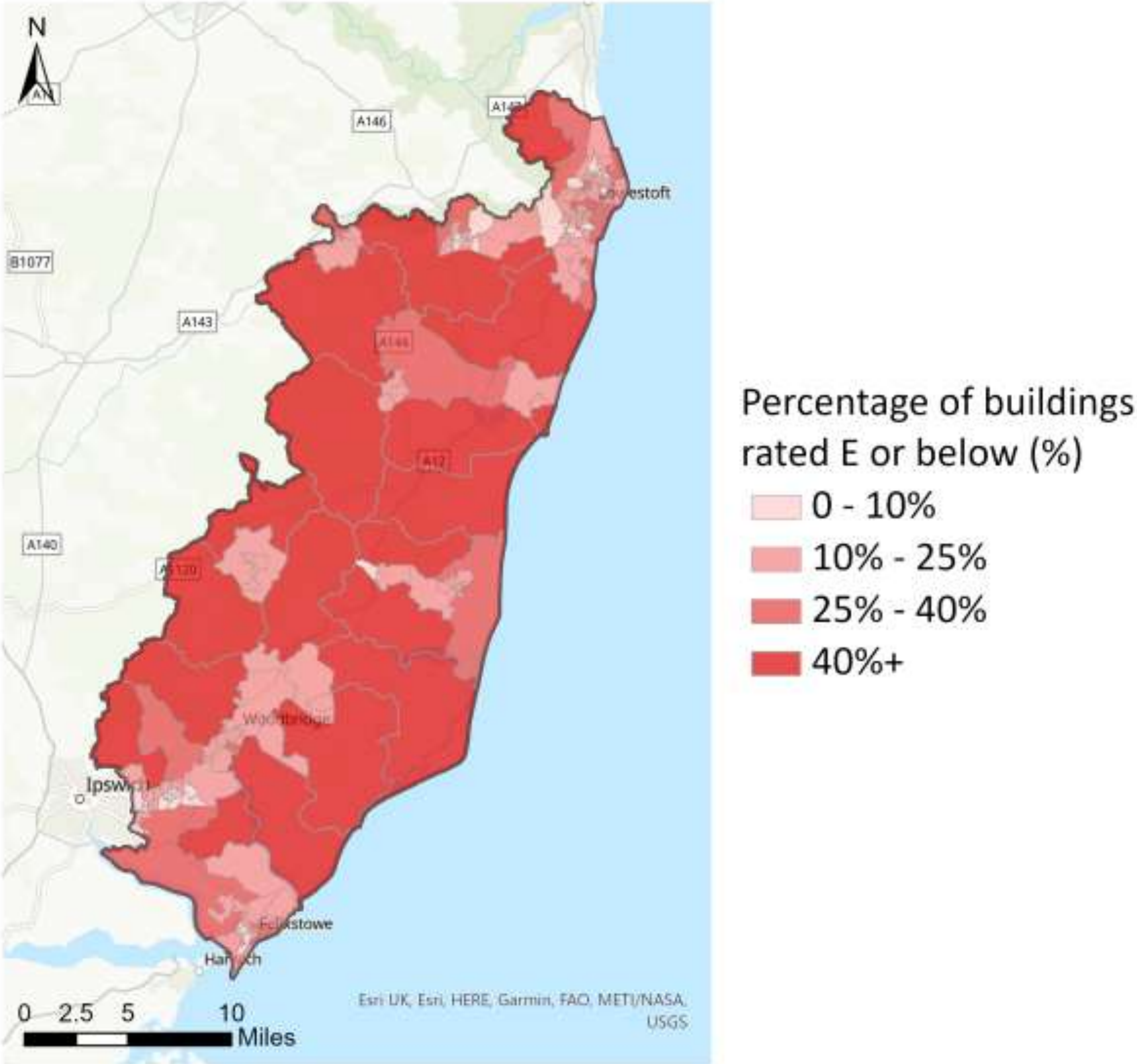

Figure 86: Proportion of dwellings rated EPC E or below across the Suffolk East sub-region.

As well as the domestic stock, the non-domestic stock needs to be considered. The breakdown of the non-domestic building stock across the Suffolk East sub-region is shown in Table 23.

Table 23: Breakdown of the non-domestic building stock by type across the Suffolk East sub-region.

Type	Floor Area [m²]	Percentage of total floor area	Number of non-domestic buildings	Percentage of non-domestic buildings
Retail	4,650,000	53%	27,500	64%
Factory	2,400,000	27%	6,900	16%
Education	505,000	6%	1,760	4%
Office	485,000	5%	3,550	8%
Other	410,000	5%	1,840	4%
Warehouse	400,000	5%	1,260	3%
Total	**8,850,000**	**100%**	**42,500**	**100%**

Due to rounding, some totals may not correspond with the sum of the separate figures.

Data from the National Atmospheric Emissions Inventory (NAEI)[28] has been used to identify large individual emission point sources i.e. emissions from a known location. As well as CO_2, this data shows air pollutants, heavy metals, and base cations[29], and greenhouse gases (GHGs)[30]. The point sources included within the project boundary are shown below in Figure 87. It should be noted that this dataset is for fixed emission sources only, and that non-fixed emissions such as those from road traffic are not included.

[28] https://naei.beis.gov.uk/
[29] https://naei.beis.gov.uk/overview/ap-overview
[30] https://naei.beis.gov.uk/overview/ghg-overview

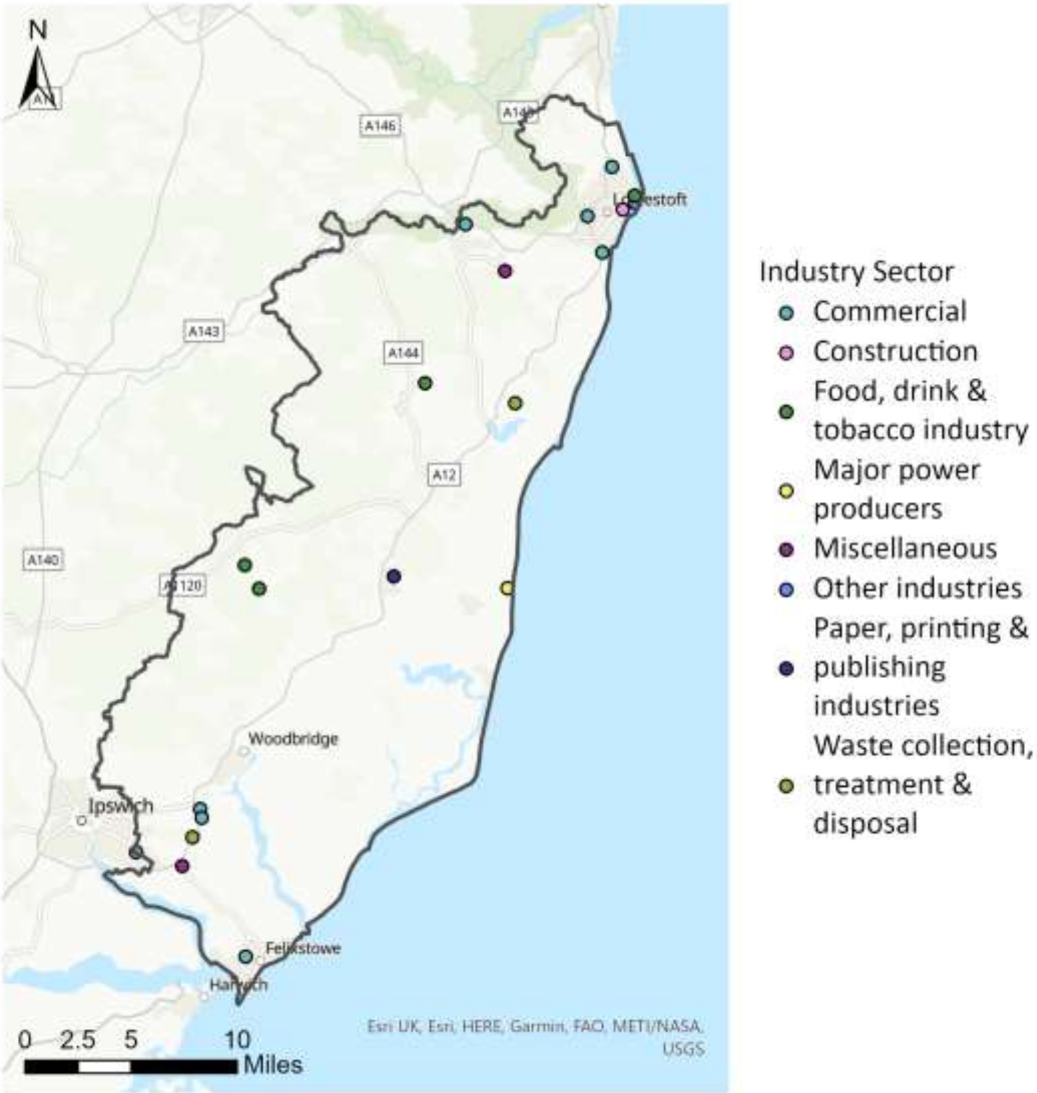

Figure 87: Individual emission sources identified by the National Atmospheric Emissions Inventory (NAEI) across the Suffolk East sub-region.

These sites suggest where prioritisation for hydrogen may be required to decarbonise industrial processes, or as potential heat sources for a local district heating network. The data pack accompanying this report contains the full background data providing more clarity.

2.3.2. Energy Demands

This section will show the estimated annual consumption and peak demands across the Suffolk East sub-region in the domestic and non-domestic sectors, and the geographic distribution by LSOA.

Table 24 and Table 25 below show the total figures for the sub-region. Please note: Electricity is supplied locally at 400V (three-phase) which is then connected to a dwelling at 230V (single-phase), therefore for the purposes of these calculations all domestic properties are assumed to be connected at 400V. Large non-domestic loads are assumed to be connected to the electricity network at 11kV; other non-domestic are connected at 400V. Total electricity demand is therefore the sum of demand at the 11kV level and 400V level. Demand from power generators and utilities are not included in these figures.

Table 24: Annual energy consumption [MWh] across the Suffolk East sub-region.

Energy Type	Domestic Annual Consumption [MWh]	Non-Domestic Annual Consumption [MWh]	Total Annual Consumption [MWh]
Electricity (11kV)	0	240,000	240,000
Electricity (400V)	380,000	1,010,000	1,390,000
Gas	500,000	1,180,000	1,680,000
Oil	90,500	0	90,500

Table 25: Annual peak demand [MW] across the Suffolk East sub-region.

Energy Type	Domestic Peak Demand [MW]	Non-Domestic Peak Demand [MW]	Total Peak Demand [MW]
Electricity (11kV)	0	75	75
Electricity (400V)	120	330	405
Gas	535	460	950
Oil	100	0	100

The total peak demand is not the sum of the peak demands for domestic and non-domestic buildings since the peak demands of the different sectors occur at different times.

The following maps (Figure 88 to Figure 91) show the distribution of estimated peak and annual energy consumption for both domestic and non-domestic buildings across the Suffolk East sub-region. Peak demands shown on these maps may not all occur at the same time of day or time of year. For example, an area predominantly made up of domestic dwellings is likely to have a peak energy demand during the early evening in winter. In contrast, an area that is mainly made up of commercial offices will have maximum energy demand around the middle of the day. Mixed-use areas could have a different peak time depending upon the nature of their buildings.

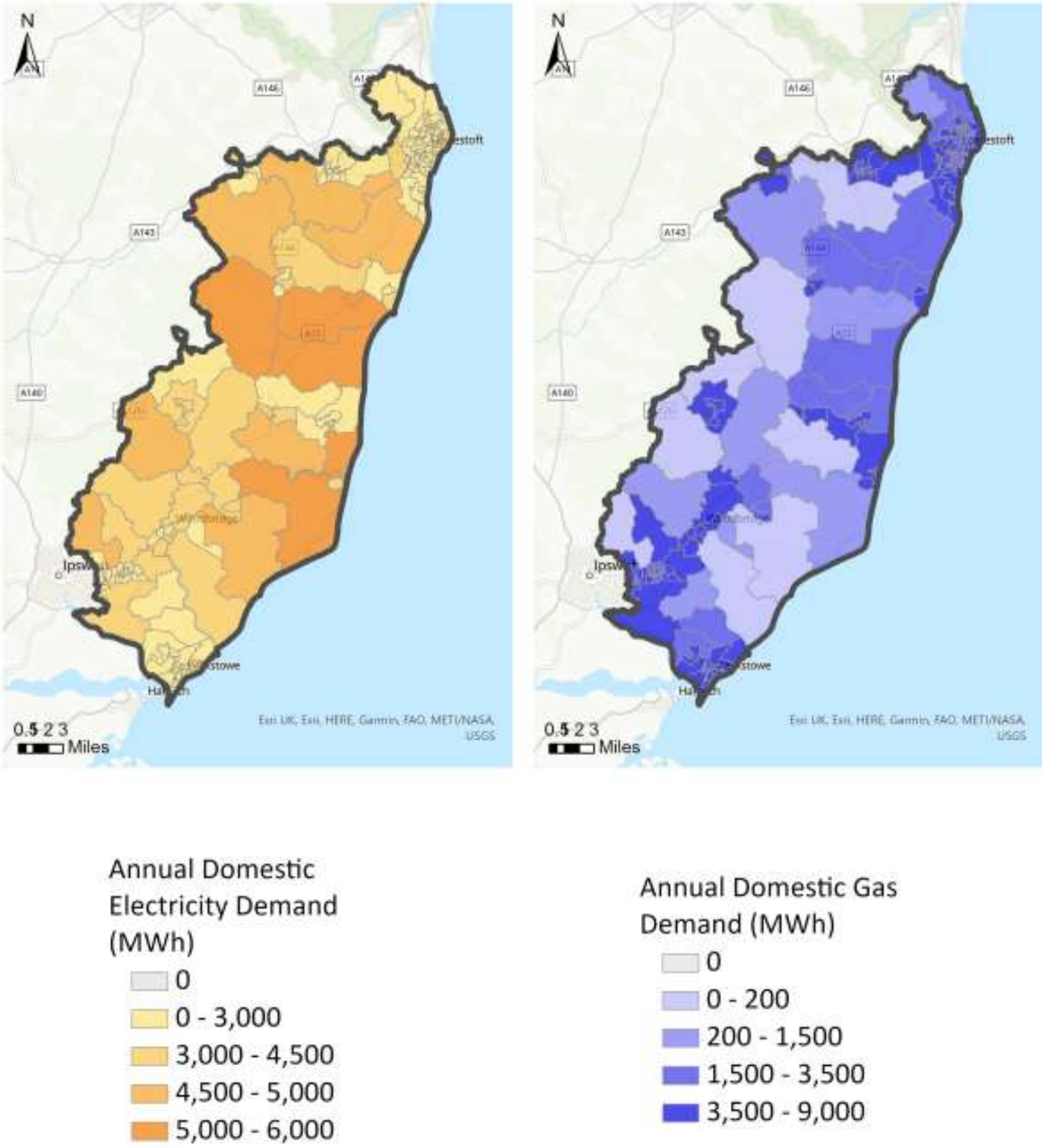

Figure 88: Estimated current domestic annual energy consumption by fuel and LSOA across the Suffolk East sub-region.

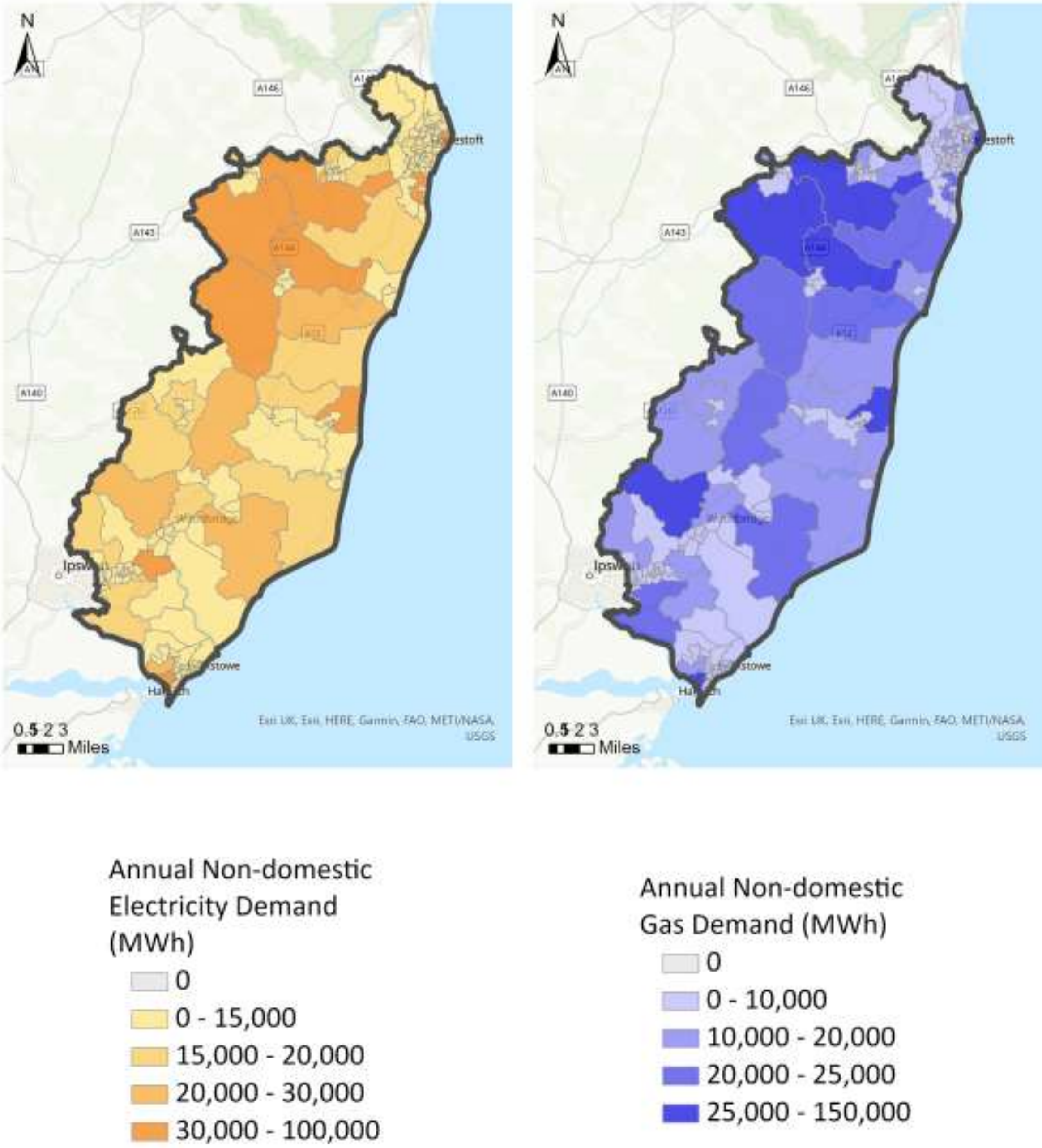

Figure 89: Estimated current non-domestic annual energy consumption by fuel and LSOA across the Suffolk East sub-region.

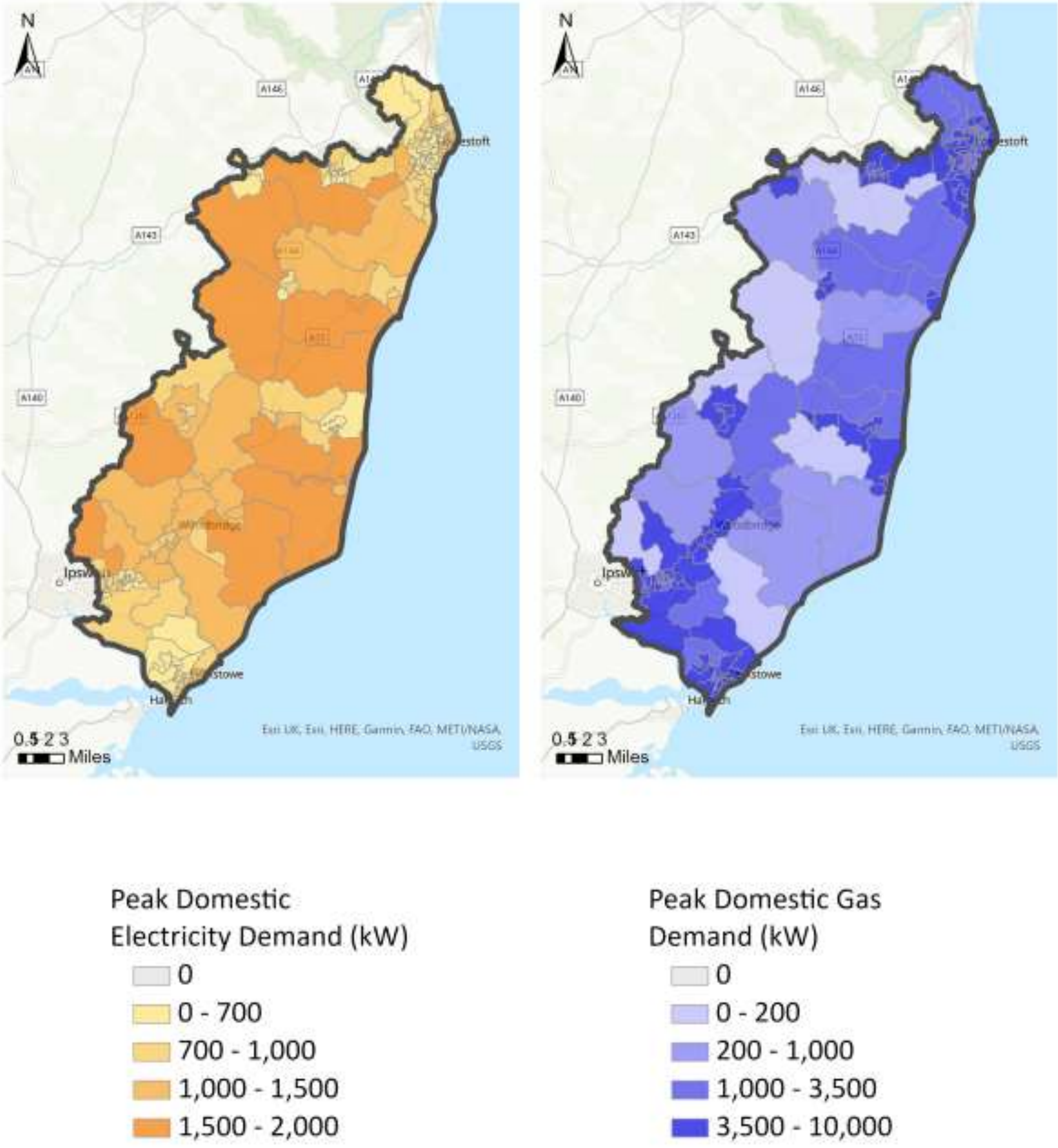

Figure 90: Estimated current domestic peak energy demand by fuel and LSOA across the Suffolk East sub-region.

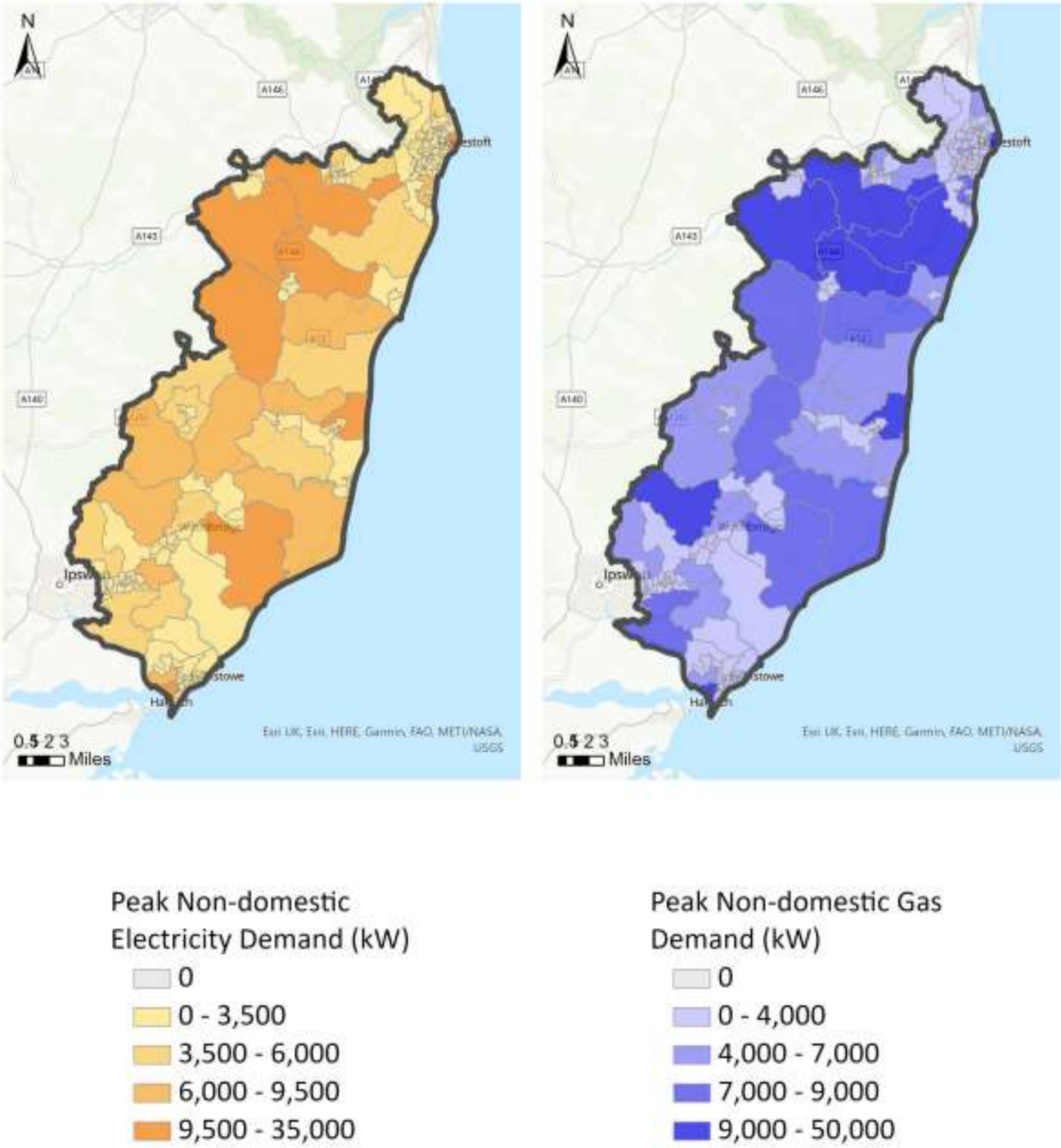

Figure 91: Estimated current non-domestic peak energy demand by fuel and LSOA across the Suffolk East sub-region.

Figure 92 shows an estimate of the total electricity demand profile for the Suffolk East sub-region for different days of the year representing the lowest typical demand and the highest. The peak day is also shown, which is used to determine a worst-case scenario on the network. Electricity demand includes heat, lighting, appliances, and electric vehicle charging when chargepoints are known to exist in the local area. The profile is for domestic and non-domestic buildings combined.

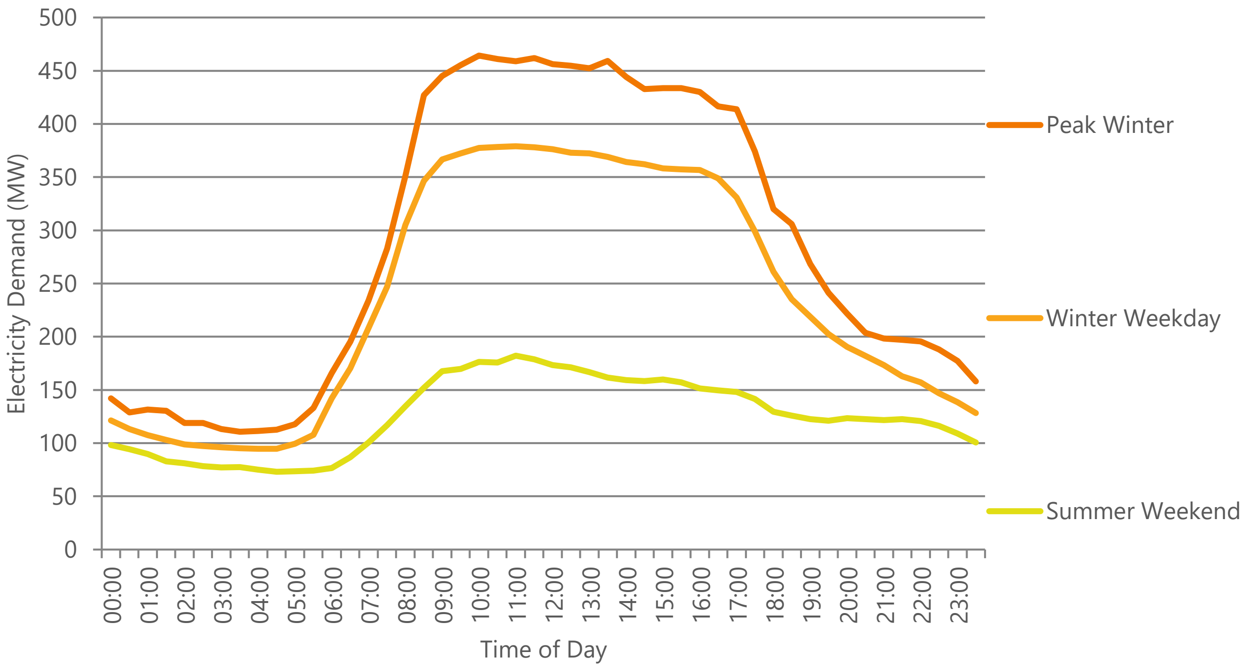

Figure 92: Estimated electricity demand profiles for different days of the year across the Suffolk East sub-region.

As expected, the demand is far lower on a summer weekend when compared to a winter weekday.

Summer weekend represents the lowest end of demand profile; being summer means there is less need of heating, and weekend suggests that office/factory buildings are using less electricity, in contrast to a typical winter weekday.

The area between these two demand profiles demonstrates the typical demand i.e. the electricity demand will likely be within this middle section at any given time.

Figure 93 shows the estimated gas demand profile, and Figure 94 shows the estimated oil demand profile, for the Suffolk East sub-region for the same days. Gas and oil demand include both heat and hot water and covers domestic and non-domestic buildings combined.

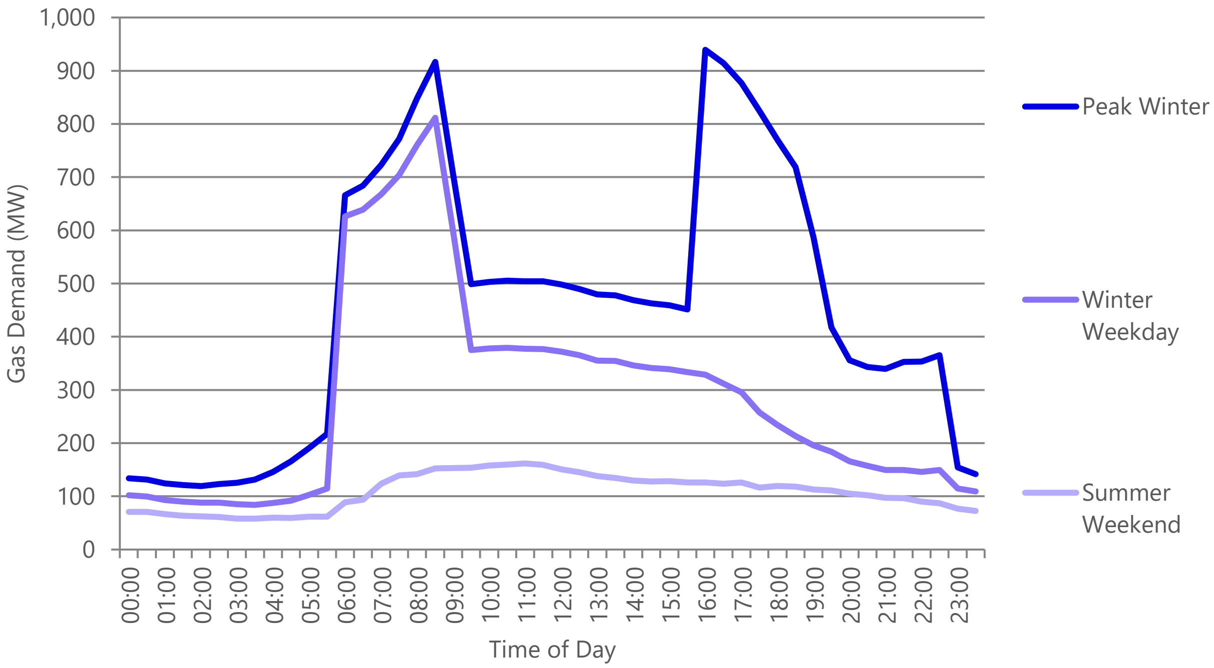

Figure 93: Estimated gas demand profiles for different days of the year across the Suffolk East sub-region.

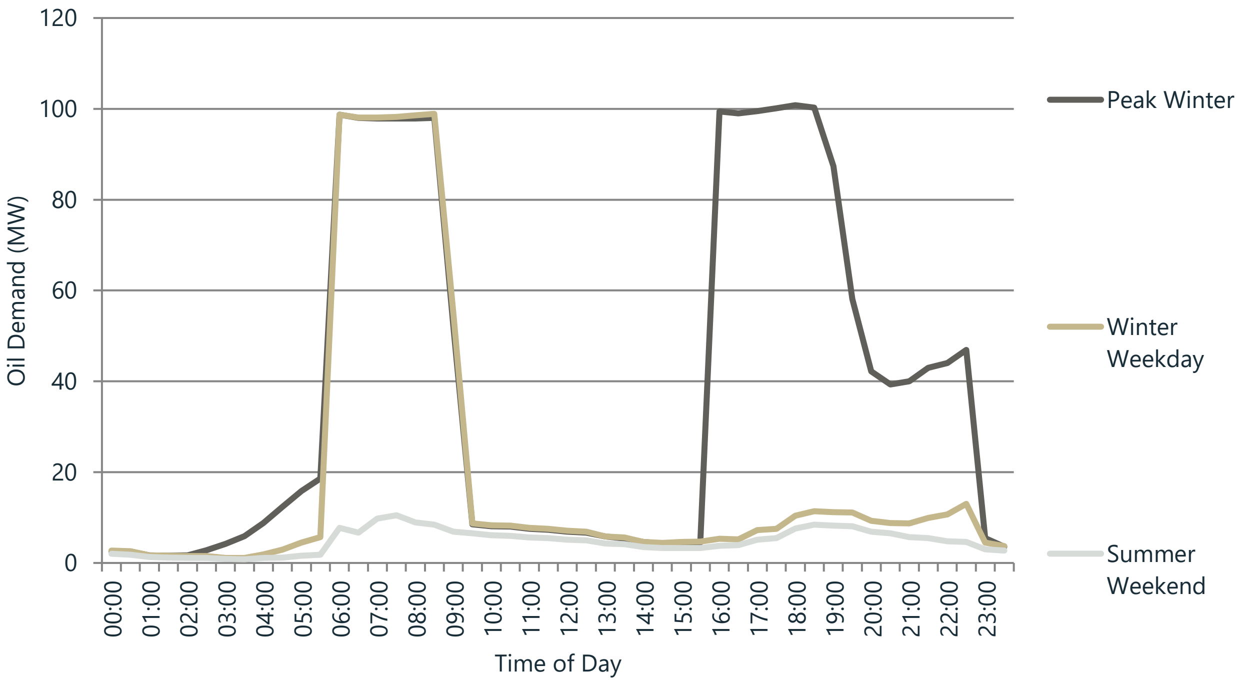

Figure 94: Estimated oil demand profiles for different days of the year across the Suffolk East sub-region.

2.3.3. Energy Networks

A good understanding of the energy networks is vital to formulating a forward plan for the decarbonisation of any area. For example, identifying dwellings that are not on the gas network can help to focus a heat pump roll-out programme thus reducing the risk of competing heating vectors such as hydrogen or heat networks being a more financially viable option in the future. To identify those off-gas areas, Xoserve[31] postcode data was used (mapped in Figure 95) before being cross-referenced with Ordnance Survey records to calculate how many dwellings are estimated to be on- or off-gas Table 26).

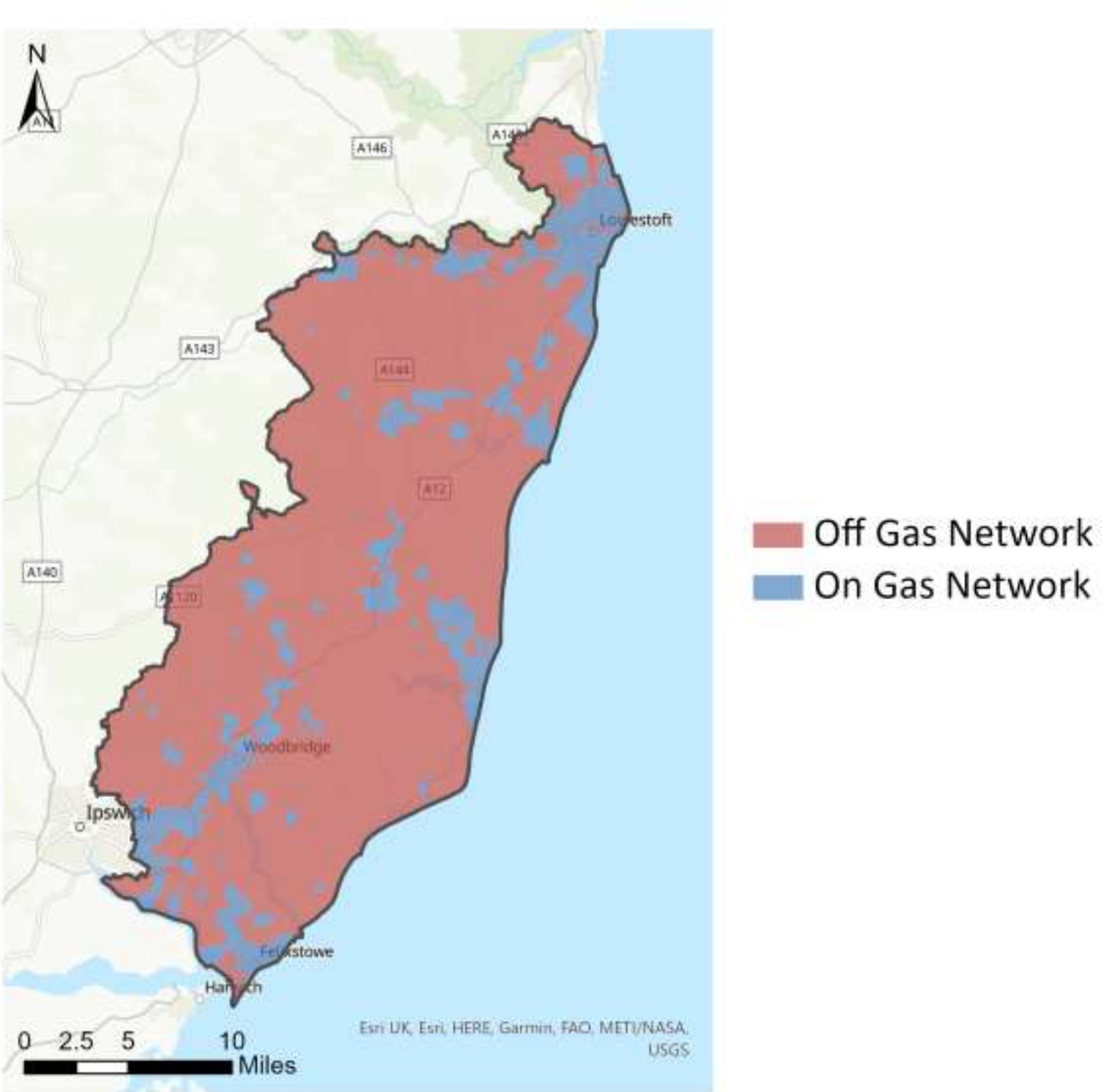

Figure 95: On-gas and off-gas areas of the Suffolk East sub-region.

[31] https://www.xoserve.com/wp-content/uploads/Off-Gas-Postcodes-V2.xlsx

Table 26: Estimate of on-gas and off-gas dwellings across the Suffolk East sub-region (rounded to nearest 5,000)

	Number
Off-Gas Dwellings	**27,000**
On-Gas Dwellings	**95,000**

Comparing Figure 95 and Table 26 leads to the conclusion that the off-gas grid areas are sparsely populated. This is confirmed by comparing to Figure 74 showing the location of the building stock.

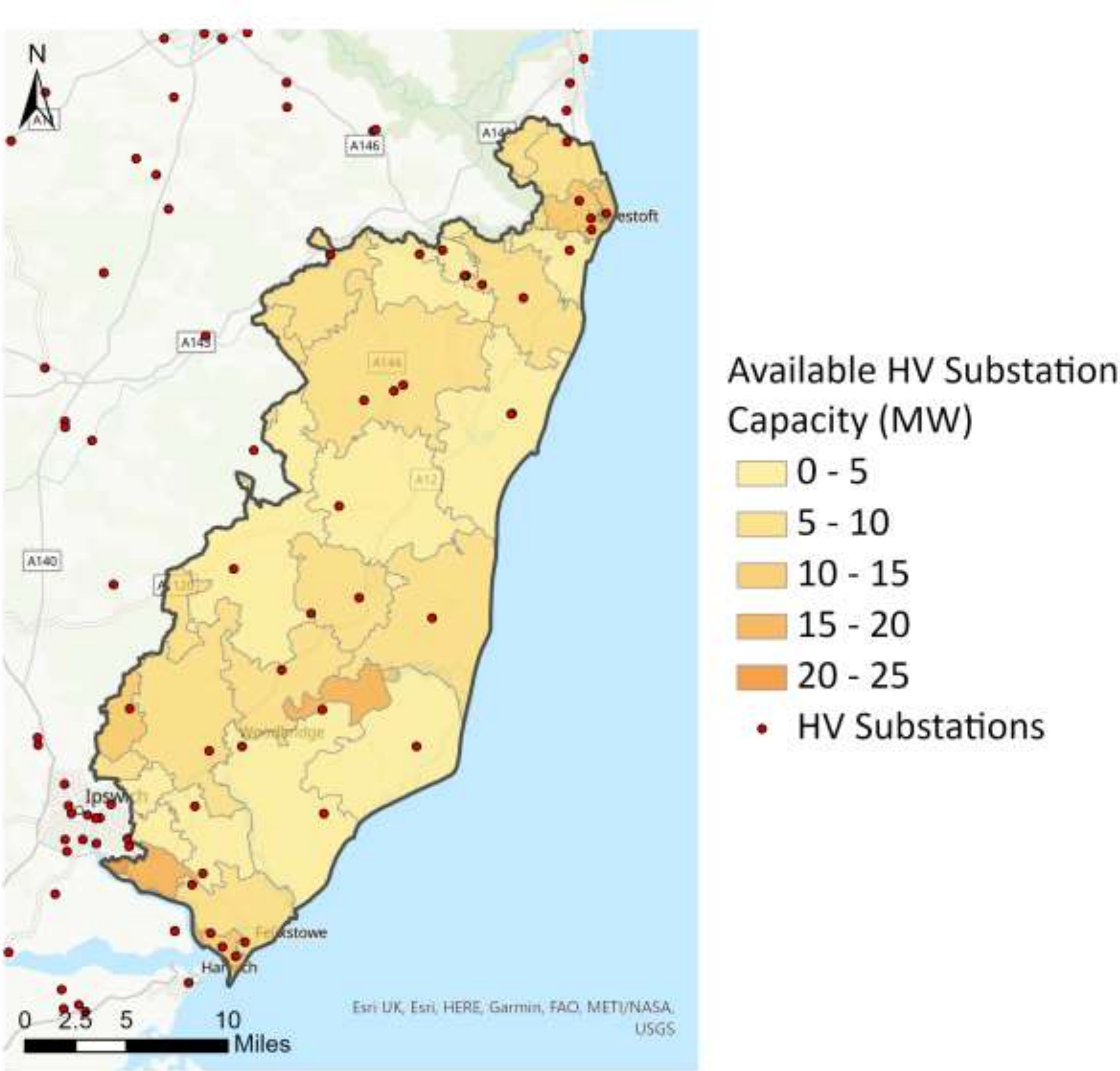

Figure 96: Available high-voltage network capacity across the Suffolk East sub-region.

Figure 96 shows an estimate of the available capacity on each 33kV-to-11kV substation and the extent of the area served by each substation. Capacity is calculated by subtracting the combined peak electrical demand on buildings in each area from the rated capacity of each substation. Those substations shown outside of the Suffolk East boundary may serve buildings within it. Substations outside of the boundary have been included since it is likely some may serve assets within the project boundary. This is seen by new polygons that begin next to the project boundary. It should be noted that available capacity of areas on the

Suffolk boundary may be overestimated since the demands of buildings outside of the county have not been modelled.

Where network connection is important from a project planning perspective the actual areas served should be established in conversation with the local Distribution Network Operator (DNO) UK Power Networks. These capacity estimates are intended to give an indication of the capacity available on different parts of the network within the local energy system representation area and are not a substitute for detailed network modelling and analysis conducted by the local DNO. Substations identified as generation only in the DNO data are assumed to have no available capacity. Substations are not included in the analysis where DNO data on locations and capacities are unavailable. Where capacity data is unavailable, but locations are available, the 11kV-to-400kV capacity was set to the most prevalent substation capacity across all of Suffolk. Where capacity data is only available in MVA, it is assumed that capacity in MVA is equal to capacity in MW, unless power factors are available.

Figure 97 shows an estimate of the number of buildings, both domestic and non-domestic connected to each 33kV-to-11kV substation. As with capacity, the extent has been calculated as the area closest to each substation.

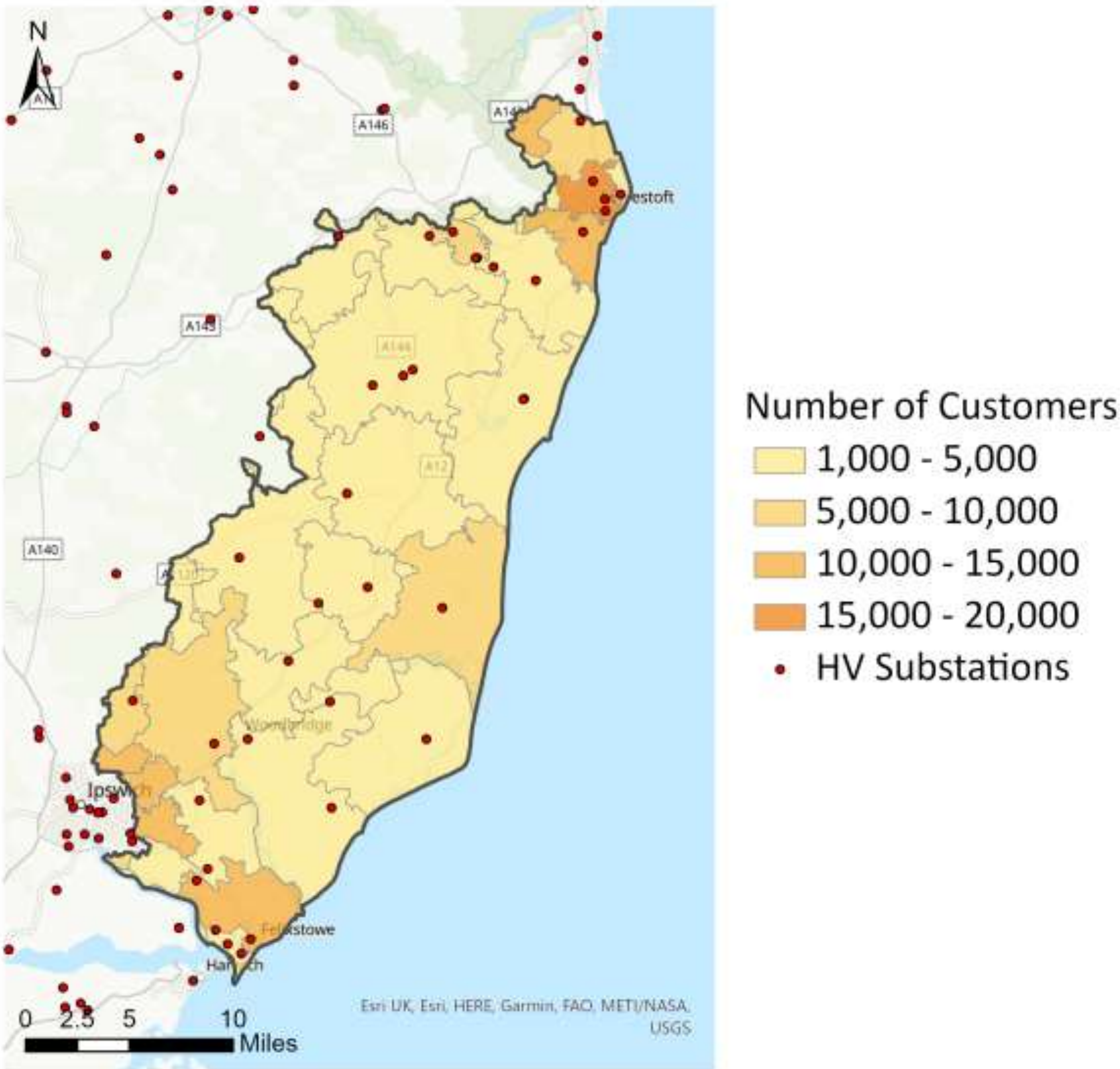

Figure 97: Number of buildings within the Suffolk East sub-region served by each high-voltage substation.

In addition to the electrical considerations of the local network, there are physical considerations with planning. To assist with this, Ordnance Survey's definition of 'pylon' is shown below in Figure 98 within the local area. This can help to ensure assets are clear or aware of any existing network infrastructure in place.

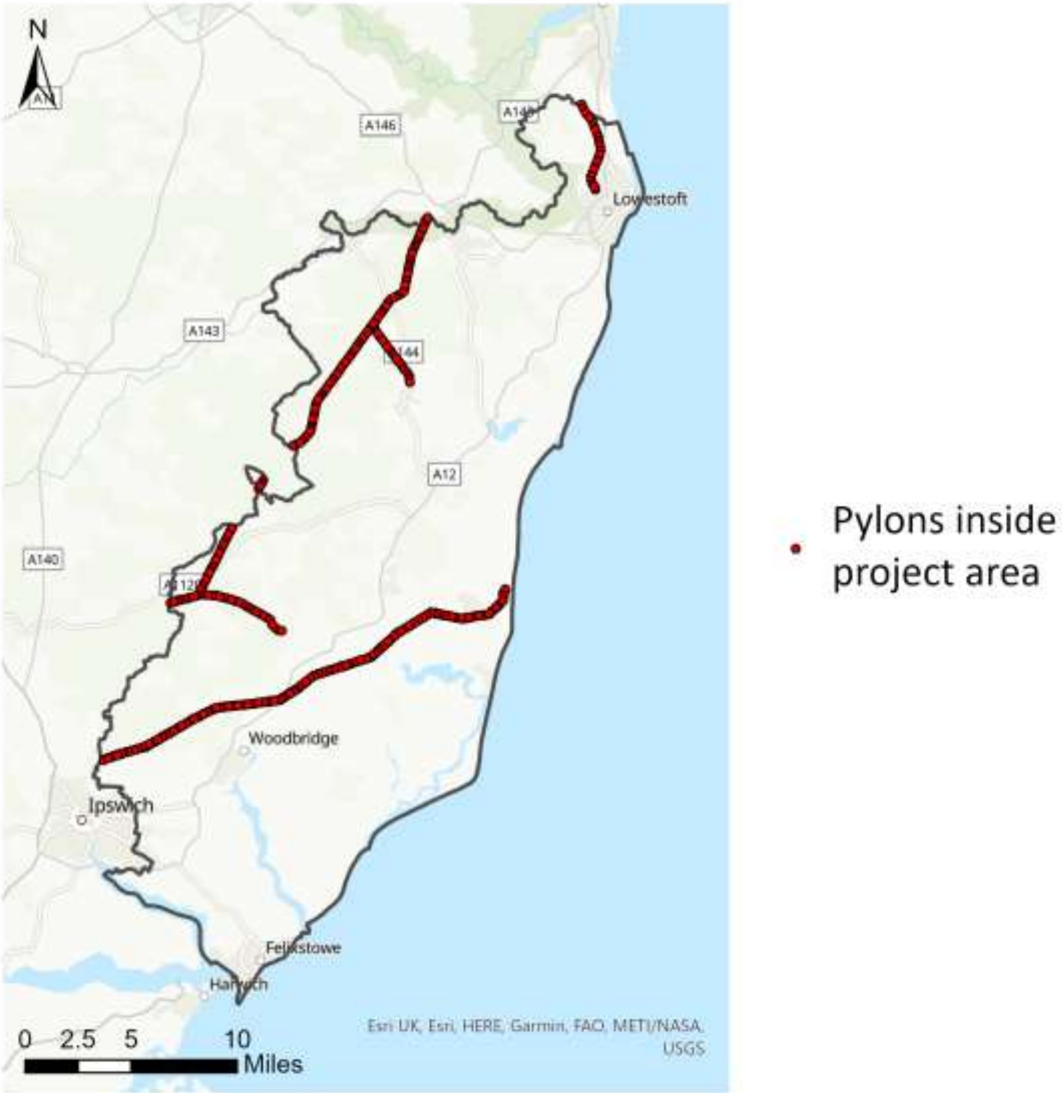

Figure 98: Ordnance Survey MasterMap classification of 'Pylon' within the Suffolk East sub-region

2.3.4. Embedded Generation

The Renewable Energy Planning Database (REPD) was used to identify large scale embedded generation across the Suffolk East sub-region. These sites, and the associated technologies, are shown in Figure 99. Data on domestic feed-in tariffs from BEIS are used to identify the amount of domestic solar photovoltaic (PV). The total installed capacity for each technology along with an estimate of the annual electricity generated in the local area is given in Table 27. This shows the proportion of annual electricity demand in the project area estimated to be met currently using local embedded generation. Additional embedded generation technologies may be present in the area but not reported here if they are not recorded in the REPD or if they are below 100 kW.

Table 27: Estimated renewable energy capacity and estimated generation as a proportion of electricity demand in the Suffolk East sub-region.

Renewable Tech	***Installed Capacity [MW]***	***Annual Generation [GWh]***	***Proportion of Annual Demand***
Domestic PV	16.8	34	2.2%
Solar Photovoltaics	176.2	160	10.1%
Wind Onshore	2.5	5.75	0.4%
Anaerobic Digestion	2	10.4	0.7%

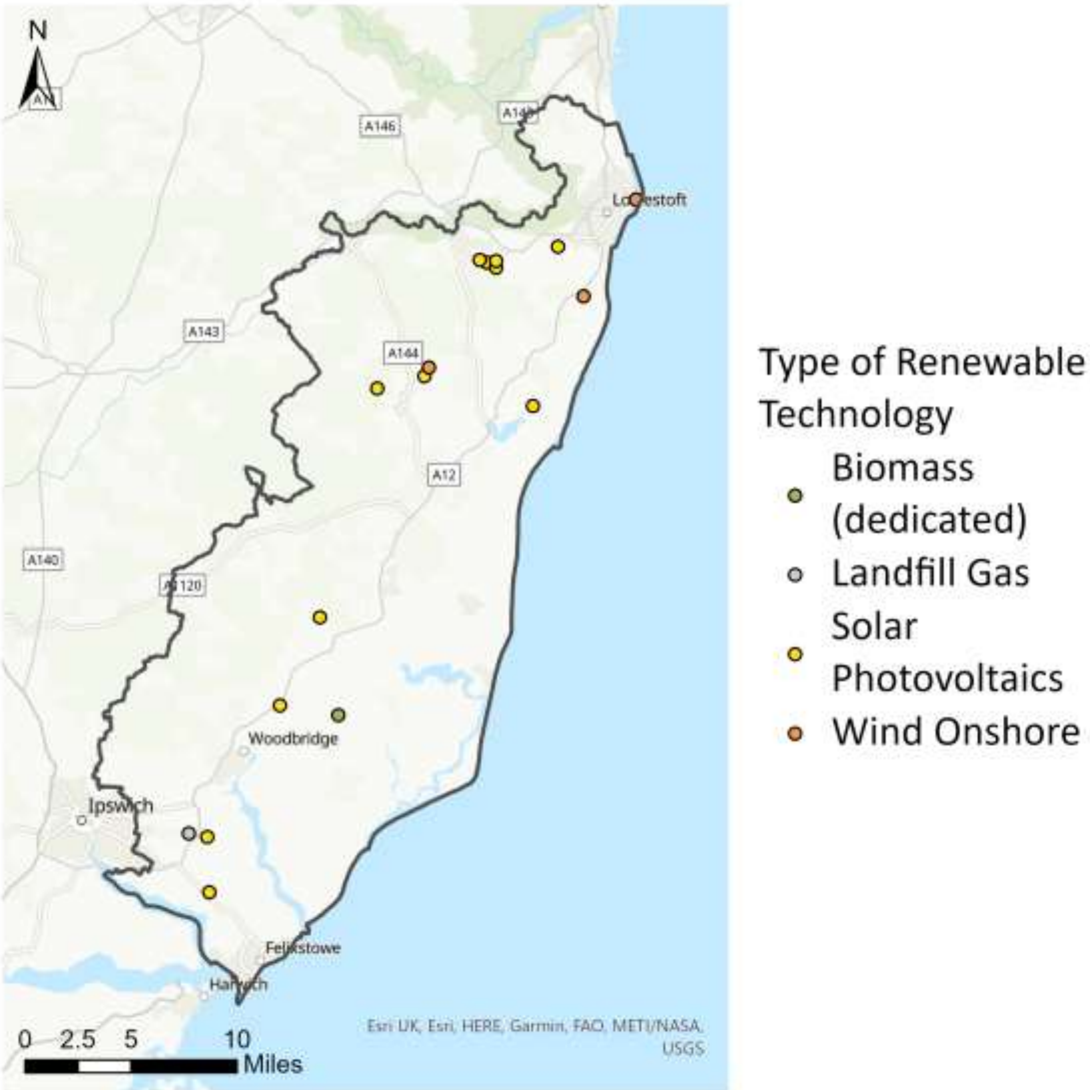

Figure 99: Existing embedded generation in the Suffolk East sub-region according to REPD database (October 2020).

As can be seen from Table 27, domestic solar PV is a significant contributor towards meeting the annual demand. Although not all installations of solar PV are registered for the feed-in tariff (FIT), and not all FITs were given to solar PV, the majority will be and therefore Ofgem's Feed-in Tariff Installation Report[32] is a

[32] https://www.ofgem.gov.uk/environmental-programmes/fit/contacts-guidance-and-resources/public-reports-and-data-fit/installation-reports

useful way of identifying the overall capacity and number of registrations in each LSOA. Figure 100 and Figure 101 show the installed capacity of renewables and number of registrations respectively.

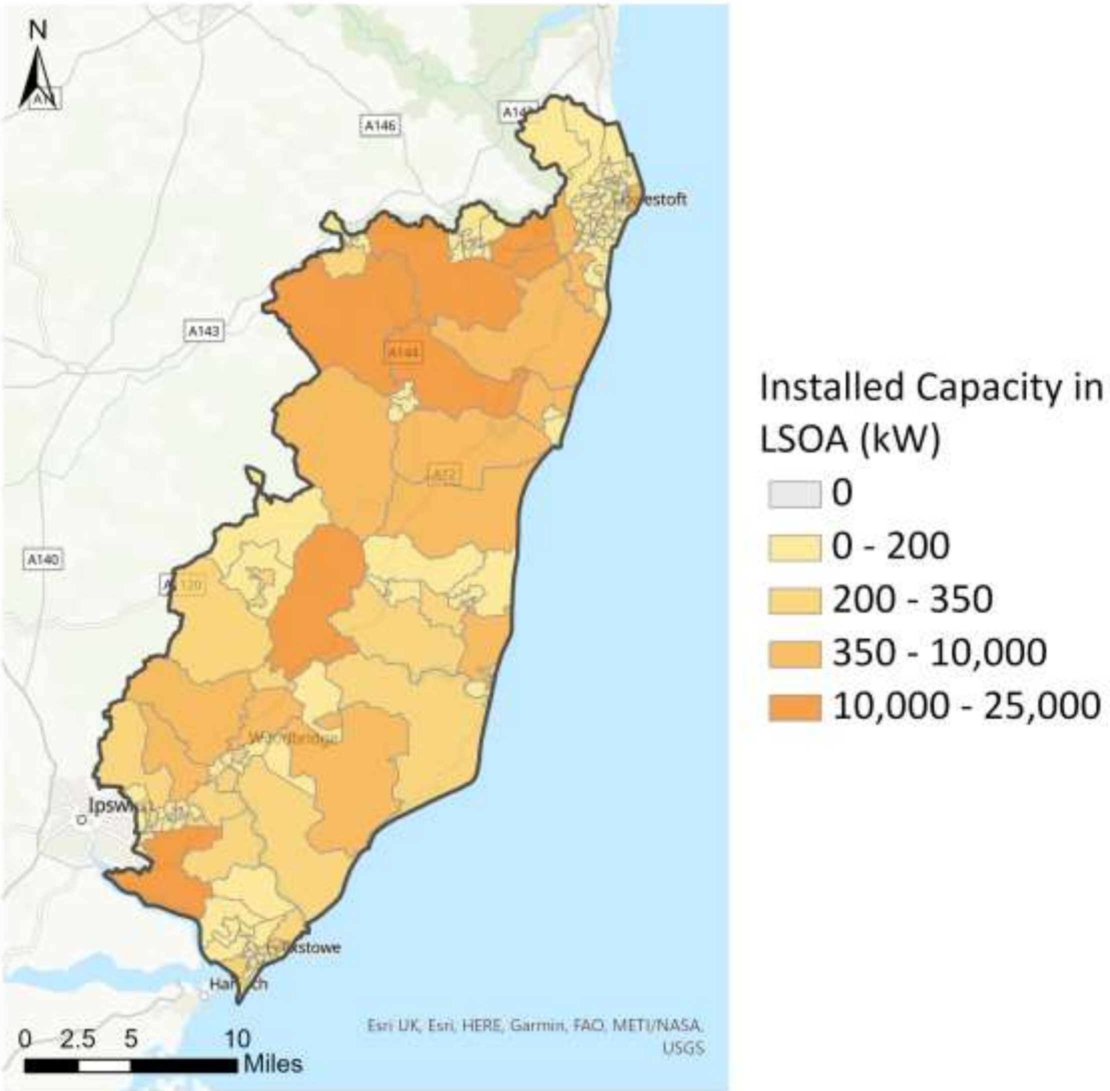

Figure 100: Aggregated capacity of renewable installations registered for FIT within each LSOA of the Suffolk East sub-region.

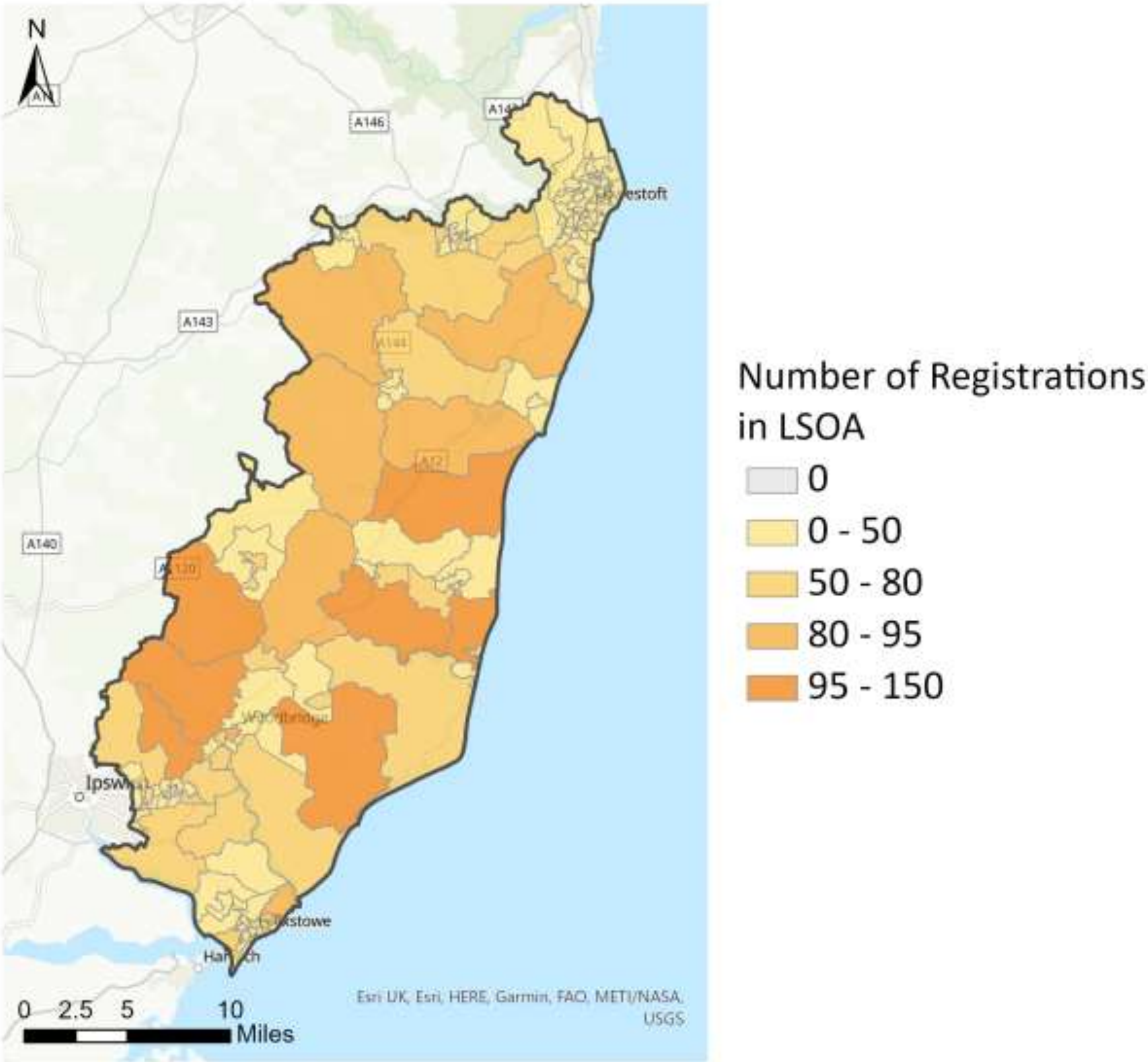

Figure 101: Number of renewable installations registered for FIT within each LSOA of the Suffolk East sub-region.

To assess the potential for domestic on-roof solar PV within the Suffolk East sub-region, the footprint and orientation of all dwellings have been analysed to calculate the potential generating capacity. These results are then aggregated to 200m radius areas to identify places best suited for mass deployment. The dwellings identified as suitable for rooftop solar PV in each of the three best areas are shown in Figure 102 to Figure 104.

As a purely spatial exercise this analysis does not consider local planning constraints and should not be used as a replacement for a detailed feasibility study or installation design.

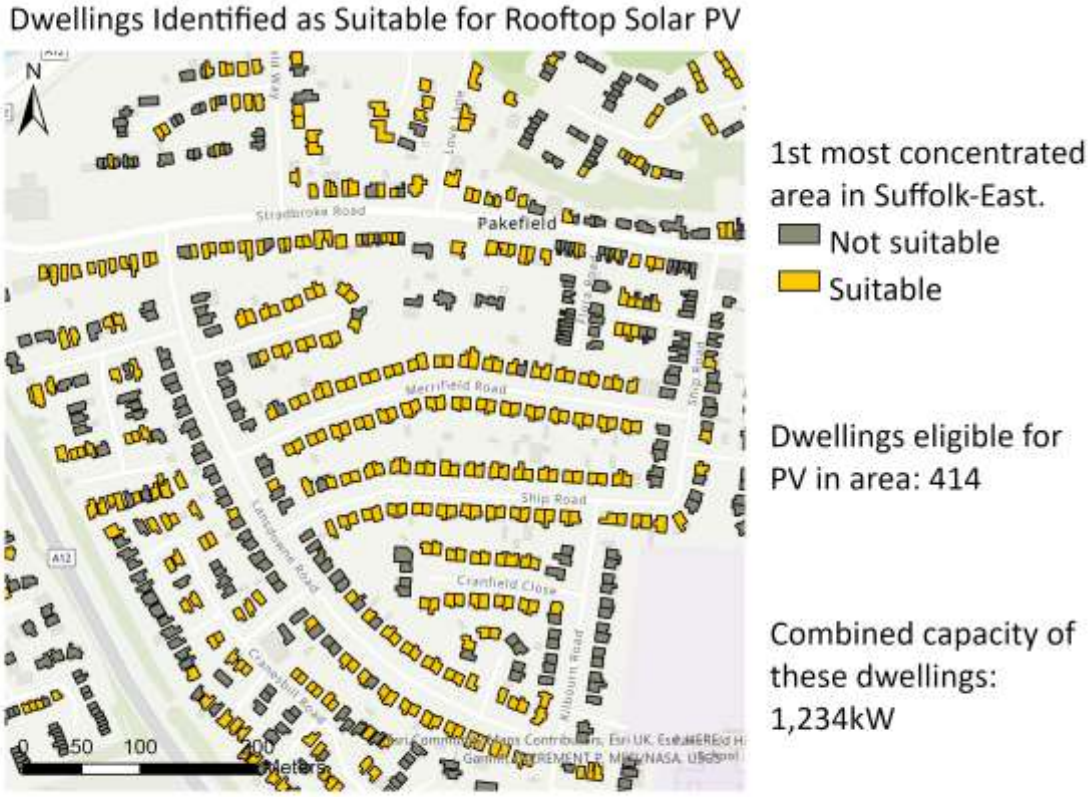

Figure 102: Dwellings identified as suitable for rooftop PV panels. (Location: Pakefield, Lowestoft)

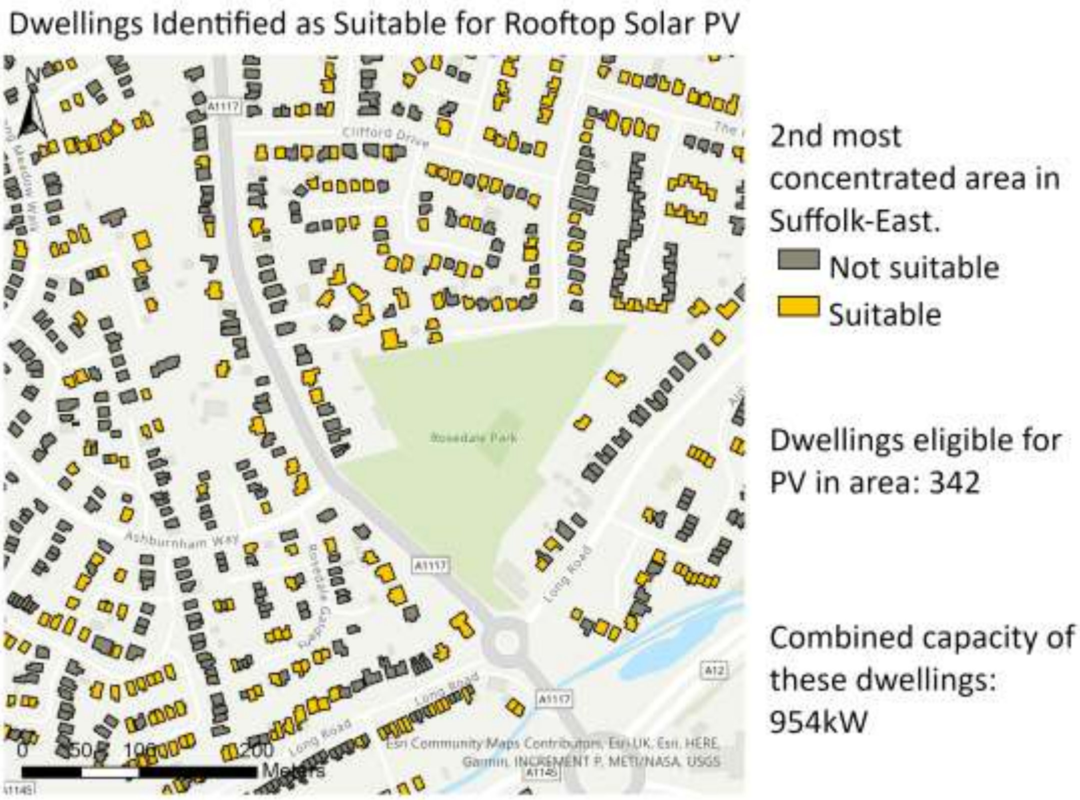

Figure 103: Dwellings identified as suitable for rooftop PV panels. (Location: Rosedale Park, Lowestoft)

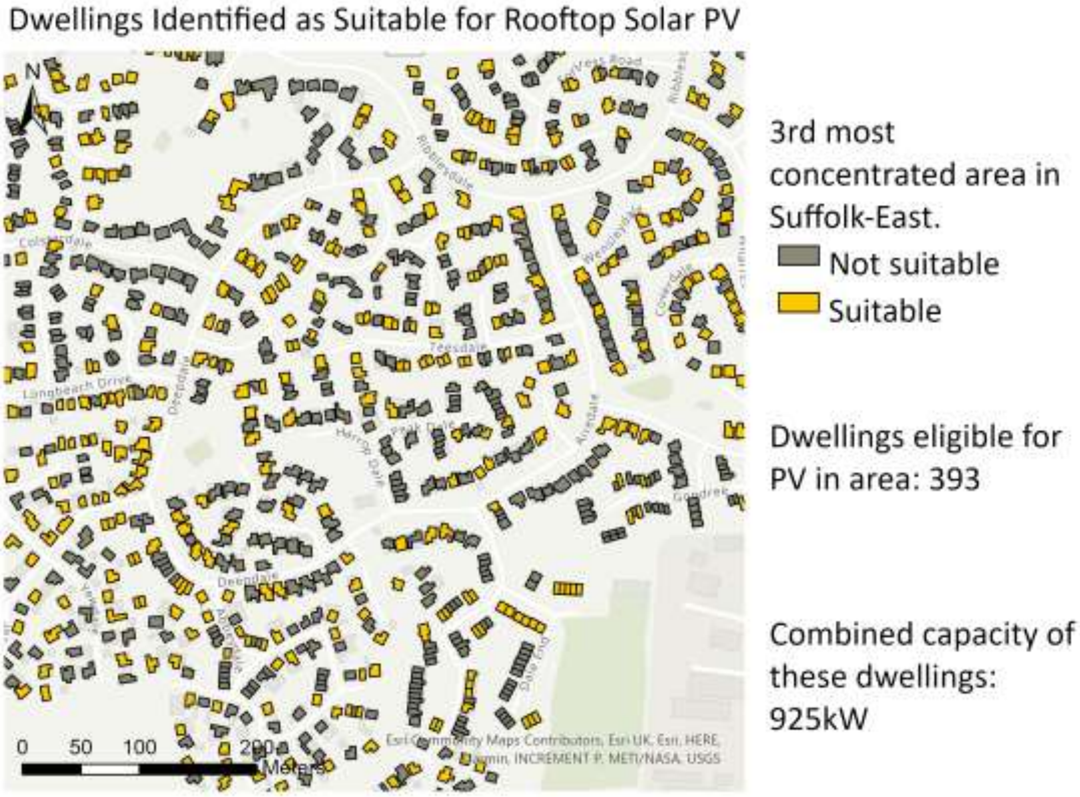

Figure 104: Dwellings identified as suitable for rooftop PV panels. (Location: Carlton Colville, Lowestoft)

In total these three areas alone have a total potential solar PV capacity of over 3MW. Pakefield contains a large number of south facing dwellings that are more ideal for solar than anywhere else in Suffolk East by a margin of over 20%.

2.3.5. Domestic & Public EV Charging

Data from the Zap-Map®[33] has been used to identify the locations and power outputs of public Electric Vehicle (EV) chargepoints across the Suffolk East sub-region. The locations and the speed of the chargepoints are shown in Figure 105. In total there are 75 public chargepoint connections with a combined peak capacity of 1,851kW.

[33] https://www.zap-map.com/

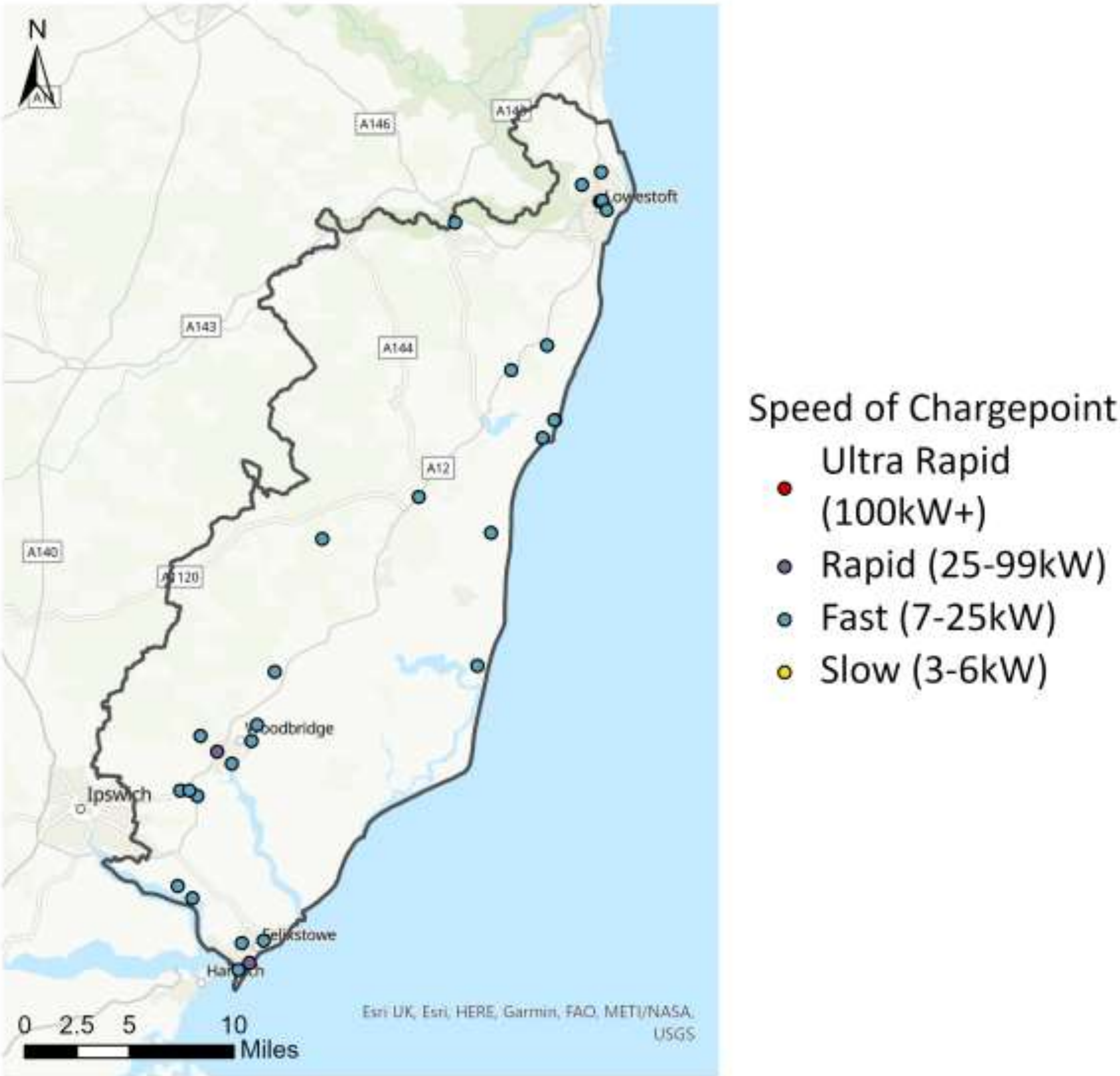

Figure 105: Location of public chargepoints according to Zap-Map® (December 2020)

ZAP MAP®

Chargepoint data provided by Zap-Map®

The Driver and Vehicle Licensing Authority (DVLA) publishes data on the numbers and types of different vehicles registered within different Local Authority Areas. This figure is for all plug-in vehicles, which includes both 100% electric battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). This gives an indication of the number of EVs that might be registered within the sub-region as shown in Table 28.

It should be noted that leased vehicles will be registered to the leasing company which may not be based within the project area.

Using National Travel Survey data representative charge profiles have been generated for both public and domestic charge points. The estimated peak demands for domestic chargepoints are shown in Table 28.

Table 28: Summary of plug-in vehicles registered in the Suffolk East sub-region according to data from DfT

Number of Plug-in Vehicles	***Percentage of Total Vehicles***	***Estimated Peak Demand [kW]***
999	0.57%	**1,311**

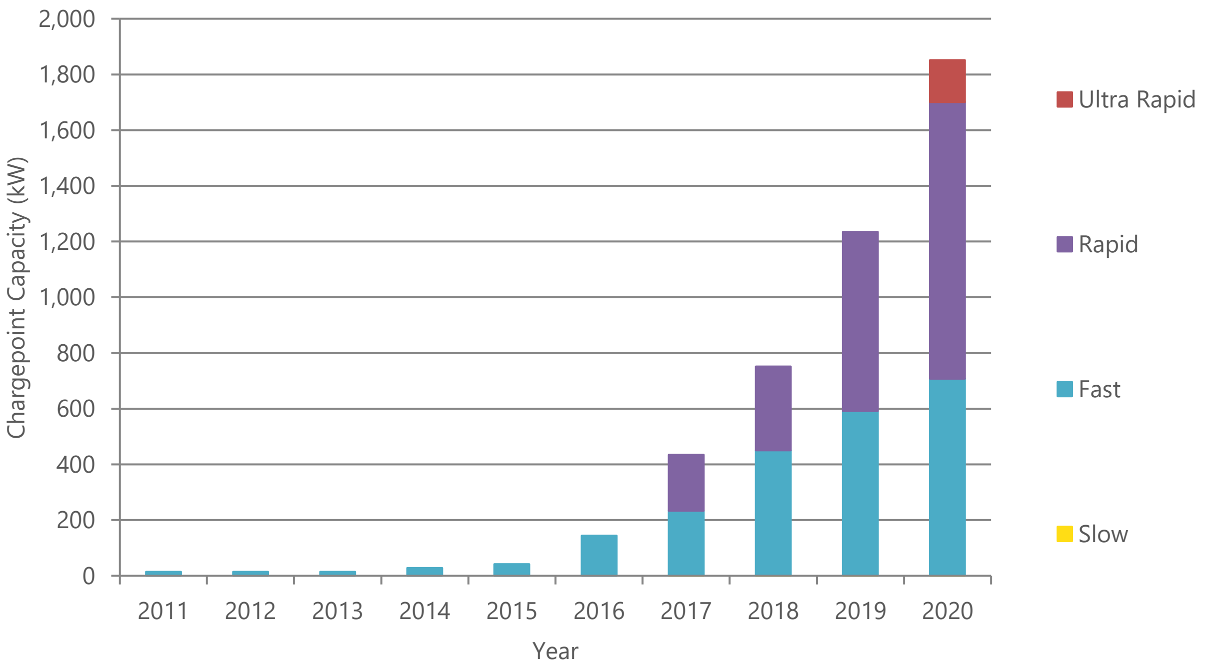

Figure 106: Chargepoint connector total capacity (kW) within the Suffolk East sub-region over time.

Using the date that each chargepoint was added to the Zap-Map database the uptake of chargepoints in the area can be analysed. Figure 106 shows this uptake in total kW rating of connectors within the Suffolk East sub-region by charger type.

Ordnance Survey MasterMap Topography and Land Registry INSPIRE polygons have been used to identify houses which have space for off-street parking. This is done by attempting to fit a standard UK parking space of 4.8m x 2.4m in the owned area between the house and its nearest road. This helps identify homes that may be able to charge an EV on a driveway, and areas that will require alternative charging solutions for on-street parking. Figure 107 shows the results of this analysis aggregated by road.

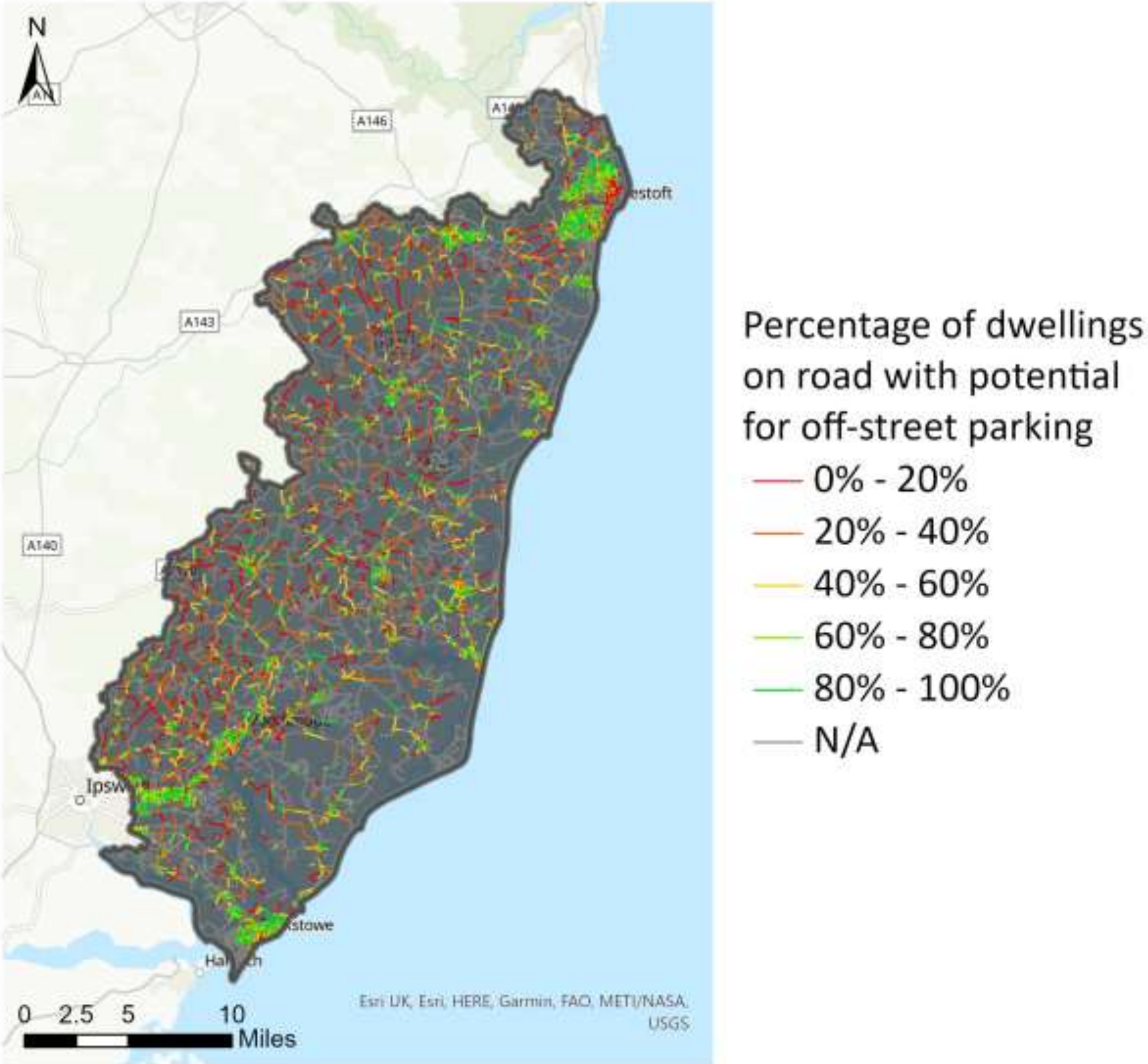

Figure 107: Percentage of dwellings with off-street parking on each road within the Suffolk East sub-region.

It can be seen that suburban areas around towns contain more dwellings with off street parking than those towards the town centres. For full utilisation of this data, it should be zoomed into to assist with more granular planning.

As a purely spatial exercise this analysis does not consider local planning constraints and should not be used as a replacement for a detailed feasibility study.

2.3.6. Social Data

National data have been used to provide an indication of fuel poverty (Figure 108) and multiple deprivation (Figure 109) across the Suffolk East sub-region.

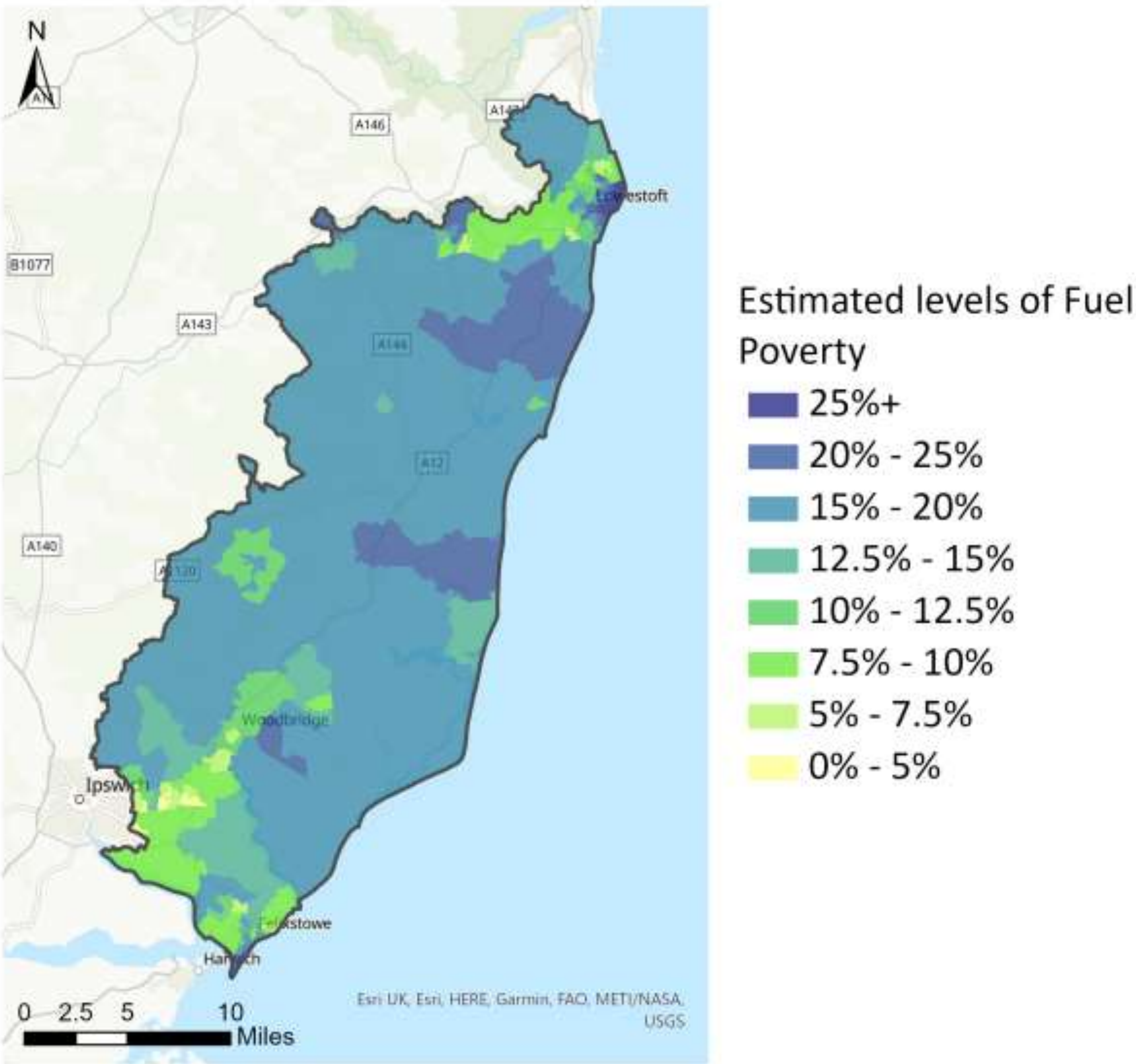

Figure 108: Estimated levels of fuel poverty according to 2020 BEIS data

Using the ranked Index of Multiple Deprivation[34] data published by The Department for Communities and Local Government (DCLG[35]) at LSOA level it is possible to compare localised levels of deprivation within the Suffolk East sub-region against the rest of England. For mapping purposes these are shown by octile, with values falling in octile 1 being within the most deprived 1/8th of the country and values falling in octile 8 being within the least deprived 1/8th of the country.

[34] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015
For descriptions of the underlying indicators used in the indices of deprivation please refer to this document: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/467775/File_8_ID_2015_Underlying_indicators.xlsx

[35] Now Department for Levelling-Up, Housing and Communities (DLUHC). Formerly Ministry for Housing, Communities and Local Government (MHCLG).

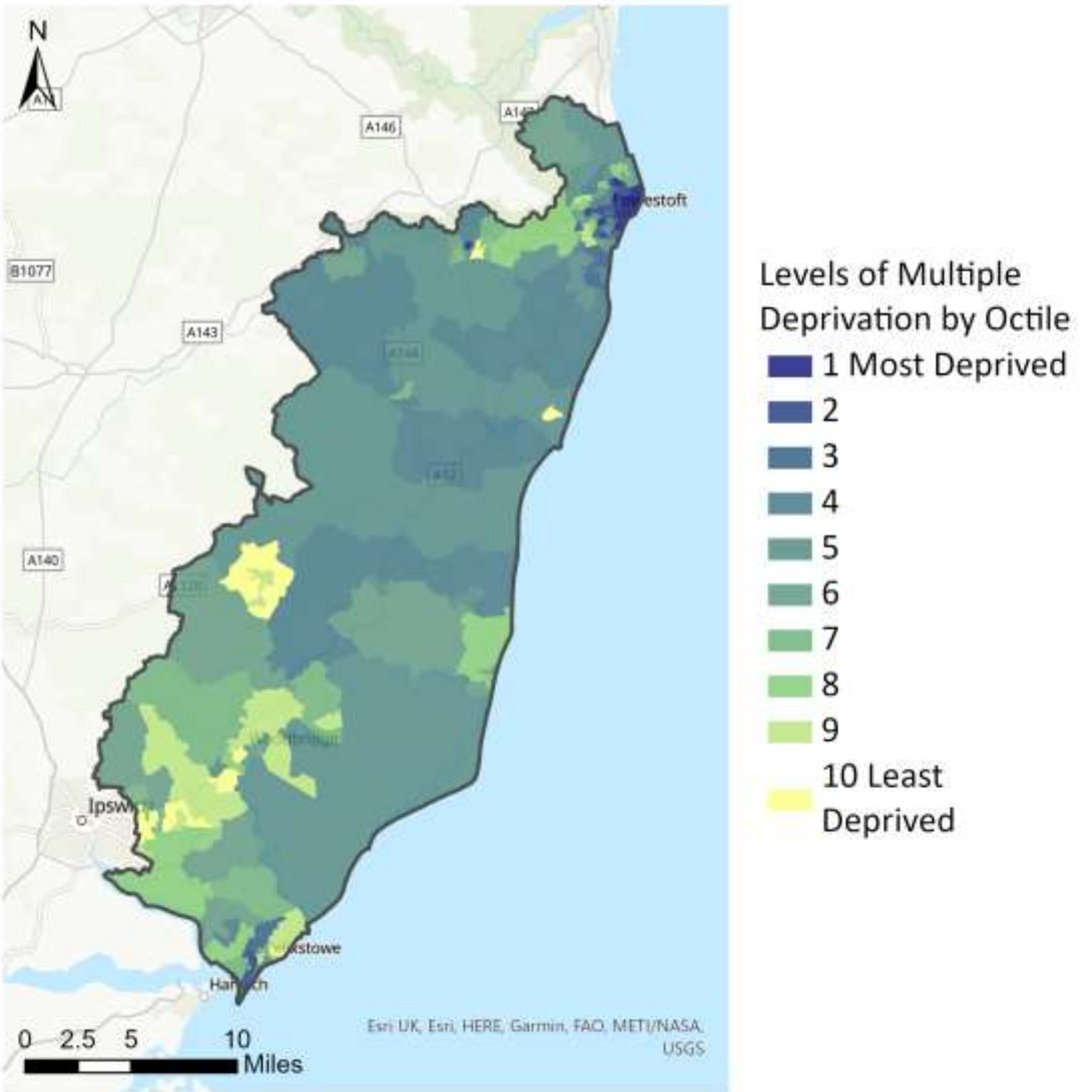

Figure 109: Ranking of English indices of deprivation 2020

The multiple indices that make up the IMD can be found in the accompanying data/maps to this report.

3. Local Insights

3.1. Flood Risk Areas

Data has been provided showing the areas most at risk of flooding with Suffolk, for both a 1-in-30-year likelihood and a 1-in-100. A summary of this data is seen below in Figure 110, which as a high-level overview shows a large area of the Suffolk West & Babergh region is not as much at risk of flooding, while big urban areas within the other regions such as Lowestoft and Ipswich are.

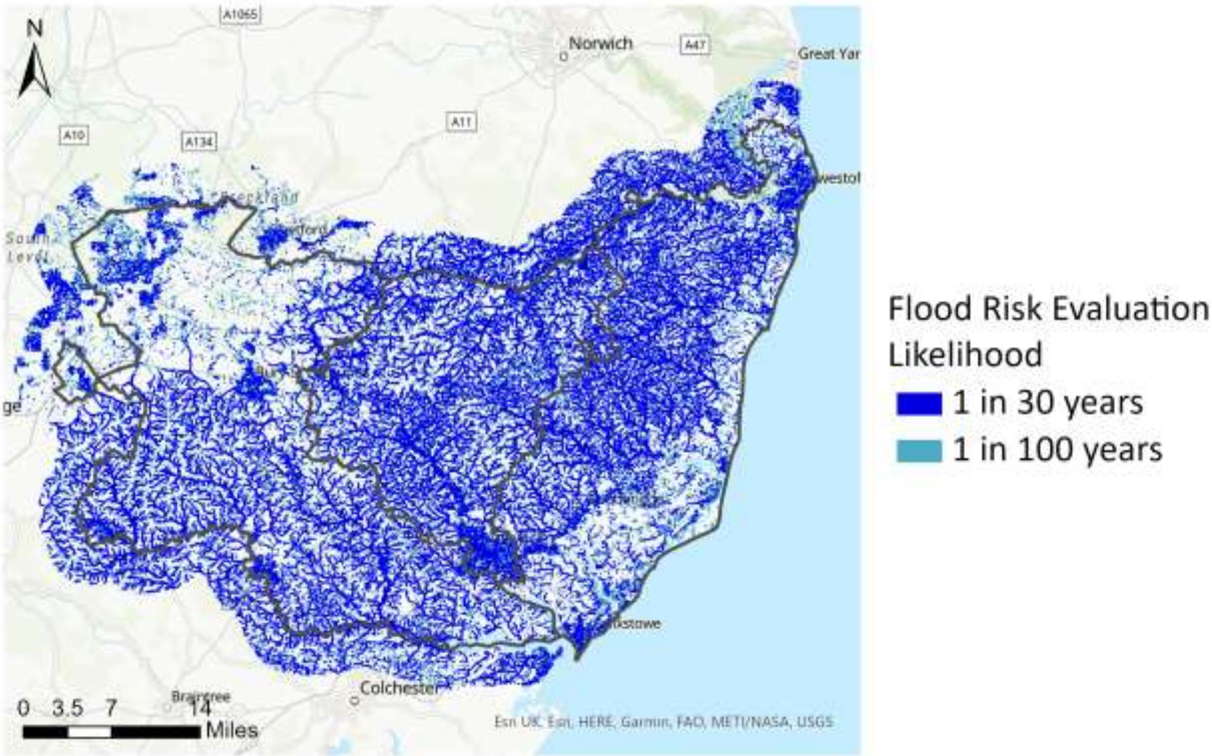

Figure 110: Floor risk data used within analysis for the whole Suffolk region.

To better understand the effect of these areas on the local area, the building stock of Suffolk has been compared directly with these areas as seen below in Table 29. This shows that despite what the map may show, only a very small number of domestic buildings comparatively (0.3%) within Suffolk are within a flood risk zone.

Table 29: Sum of dwellings within a flood risk area by likelihood and study area.

Flood Risk	Suffolk Central	Suffolk East	Suffolk West & Babergh
1 in 30	356	126	221

Broken down by dwelling type in Figure 111 this shows a large proportion are flats, primarily in the Suffolk Central region which contains comparatively larger number of riverside complexes within Ipswich and Stowmarket.

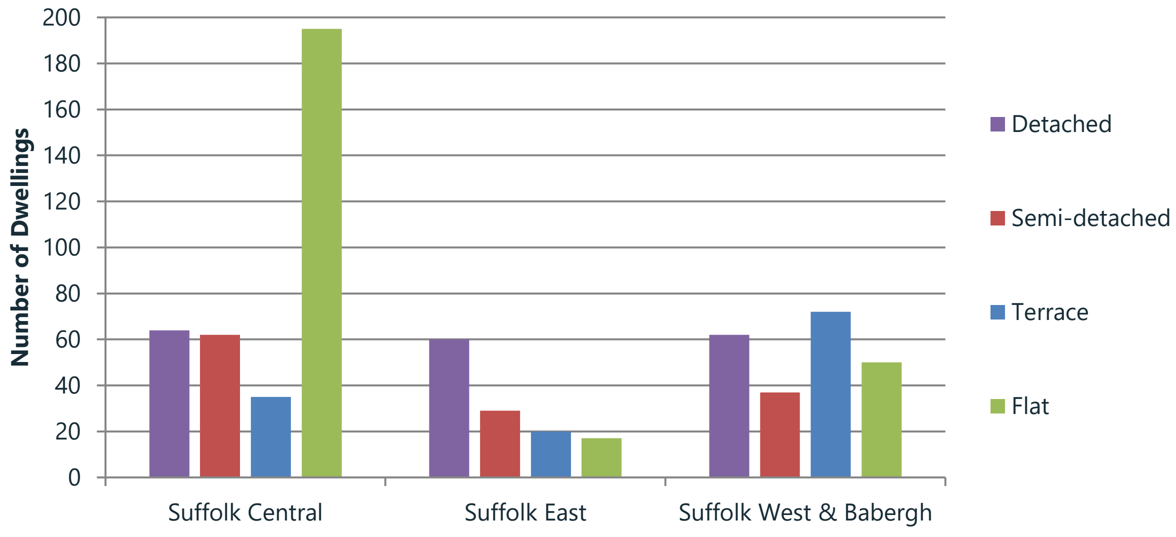

Figure 111: Dwellings within 1-in-30-year floor risk by area and type.

3.2. Solar PV

Figure 112 shows the top three areas in the Ipswich local authority area whose domestic housing stock have the highest suitability for solar PV.

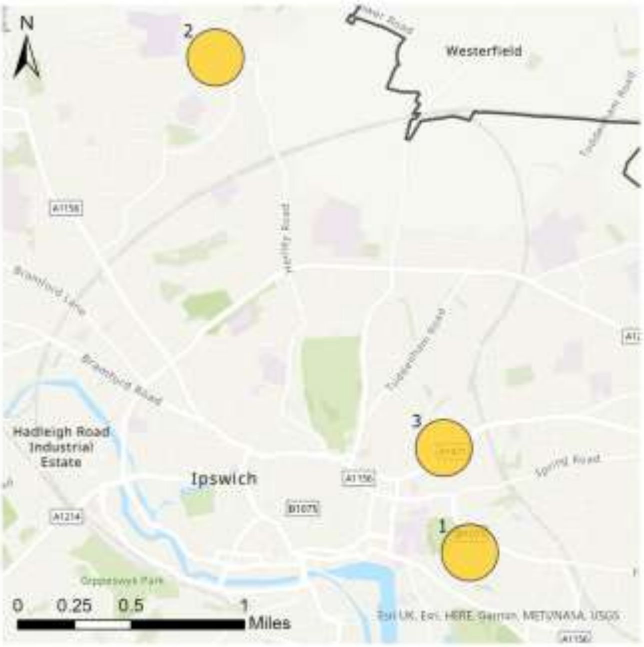

Figure 112: Solar PV suitability around Ipswich

Two of the three areas with the highest PV suitability are in central Ipswich with the other being in the Castle Hill area in the north of the town. The Castle Hill area has an average level of fuel poverty, however the area to the east of the town centre has a high level of fuel poverty (>15%) (see Figure 113) and high levels of income deprivation (Figure 114).

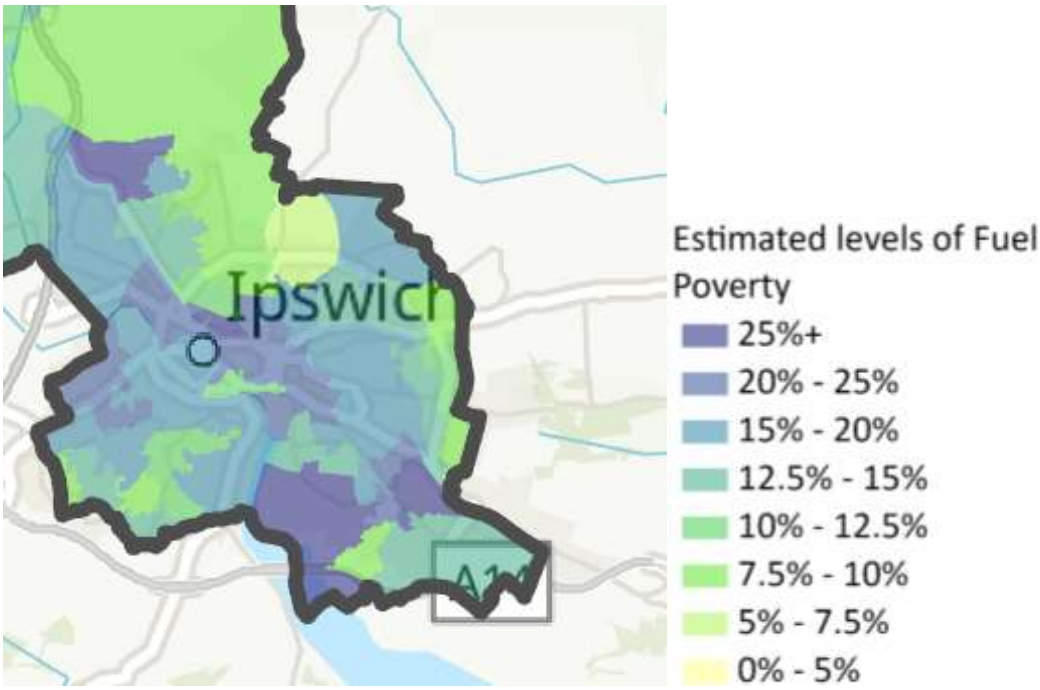

Figure 113: Estimated levels of fuel poverty around Ipswich

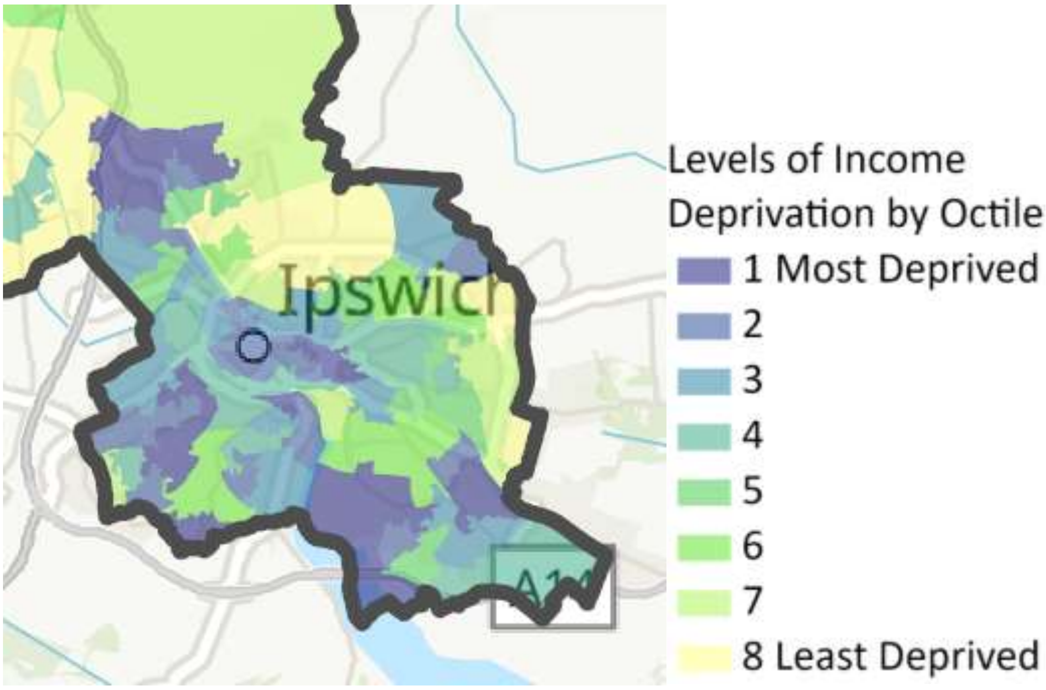

Figure 114: Income deprivation levels around Ipswich.

It can be seen that the dwellings in this area identified as suitable for solar PV are mainly terraced, and they predominantly have a south-easterly orientation making them ideal for capturing solar irradiation.

Figure 115: Solar PV suitability in an area east of Ipswich town centre with an area highlighted for further investigation

The red box in Figure 115 is focussed on the Bramley Hill development and a row of terraced three-storey town houses built in 2008/9. Figure 116 shows that the dwellings that have been selected by the model are southwest facing with clear unobstructed roofs.

Figure 116: Aerial image taken from Google Earth of the Bramley Hill development as shown in the red box in Figure 115.

Interestingly, these dwellings were not chosen to have solar PV installed at the construction stage even though others on the development have. Their orientation and lack of shading would produce a good yield for the homeowner however scaffolding costs may be higher than typical due to being three-storeys.

Whilst it is likely that the dwellings in Figure 116 are owned by some of the wealthier in the area, those in the Alexandra Park area are likely to be more representative of the community and the housing stock. The blue box in Figure 117 highlights such an area.

Figure 117: Solar PV suitability in an area east of Ipswich town centre with an area highlighted for further investigation

These streets have a high-level of homogeneity across the housing stock with good south-westerly or south-easterly orientations and low shading. One of the dwellings shown in Figure 118 has nine solar PV panels already installed with a capacity likely to be around 2.25kW_p.

The tenure of these dwellings is unknown, but a targeted scheme could be developed to encourage the uptake of solar PV, reduce installation costs through mass purchase, and alleviate some of the fuel poverty seen in this area of the region.

Figure 118: Aerial image taken from Google Earth of area around Woodville Road, Ipswich as shown in the blue box in Figure 117.

3.3. Planning Allocations

Using polygons of 354 current planning application sites provided by Suffolk council, this part of the report will look at what insights and comparisons can be drawn from these and other data within the report.

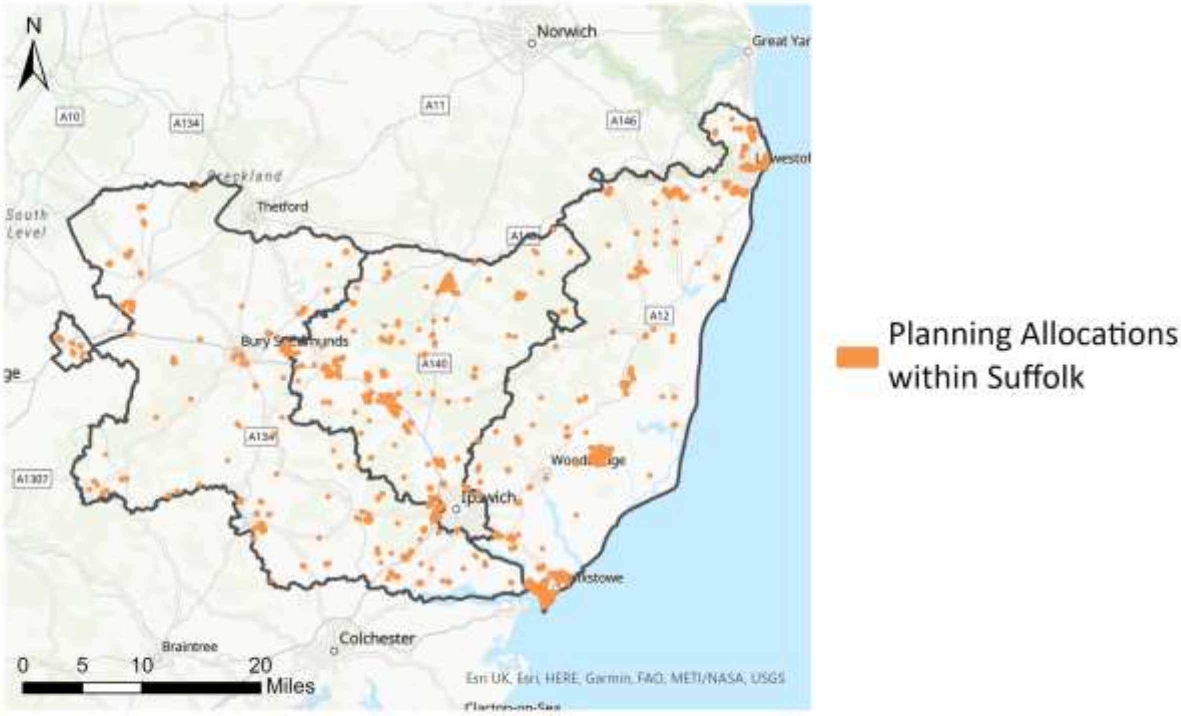

Figure 119: Planning Allocation areas provided within Suffolk

3.3.1. Network Capacity

By comparing available HV substation electrical capacity as reported by UKPN[36] with the proposed locations of allocations, an initial indication can be made of allocations may be most suitable for future low carbon developments. Spare grid capacity can mean the easier installation of new renewable generation within the area, with less additional network reinforcement and subsequent cost required on the local electrical network.

It should be noted that these suggestions serve as high level examples and have been made using overall headroom figures provided by UKPN rather than generation only. A more detailed on-the-ground study is recommended before proceeding with a specific project to take into account how these might relate with existing contractual arrangements and the ability of claiming Feed-in-Tariff (FiT)[37] or Renewables Obligation (RO)[38].

Of the 354 sites, more than 90% sit purely within one HV substation region. Of these, the available capacity of the HV substation of the local area is shown below in Figure 120.

[36] Values taken from field '*HEADROOM_M*' of UKPN dataset '*UKPN_Primary_Postcode_Area*': https://ukpowernetworks.opendatasoft.com/explore/dataset/ukpn_primary_postcode_area/table/
[37] https://www.ofgem.gov.uk/environmental-and-social-schemes/feed-tariffs-fit
[38] https://www.ofgem.gov.uk/environmental-and-social-schemes/feed-tariffs-fit/applicants/roo-fit-large-installations

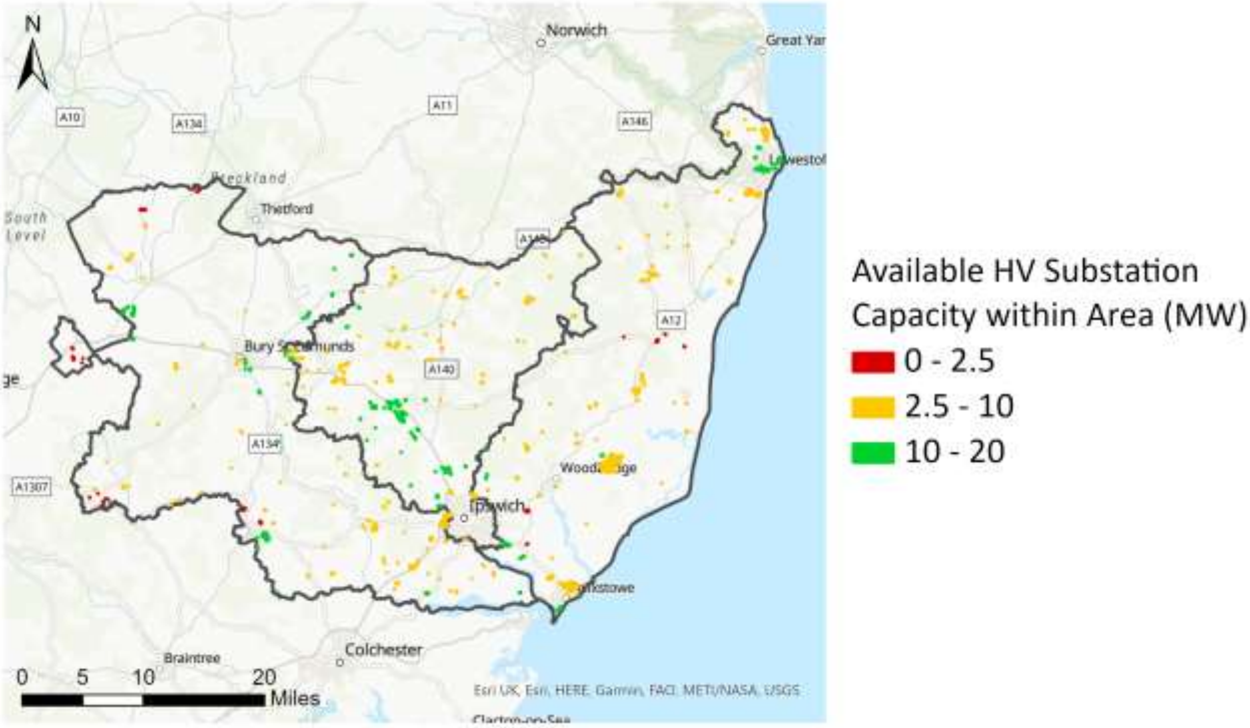

Figure 120: Available capacity of HV substation for each allocation site within Suffolk

Of these sites, available capacity is highest in urban areas with a large concentration in the area between Stowmarket and Ipswich. These can be seen in further detail below in Figure 121.

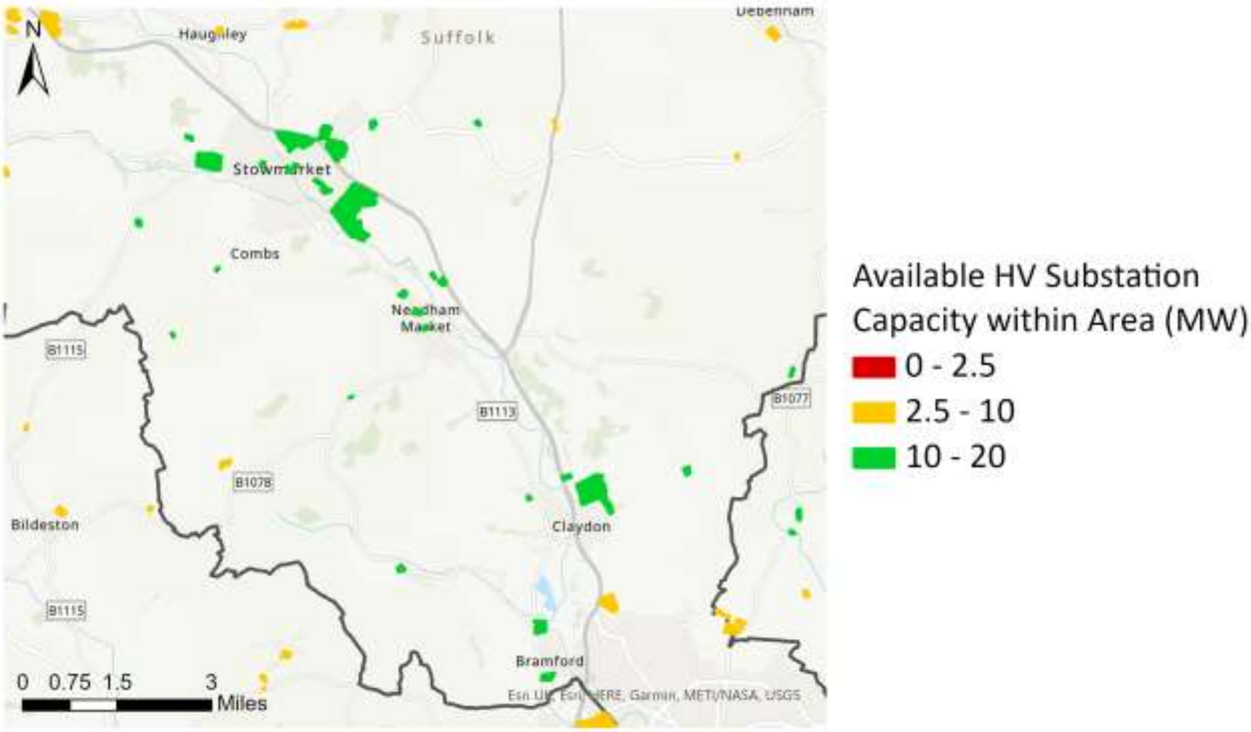

Figure 121: Allocation sites with available network capacity south-east of Bury St Edmunds.

3.3.2. Existing Renewable Generation

Using the Renewable Energy Planning Database (REPD)[39] which contains local generation of over 150 kW, it can be seen which new allocation sites may be able to benefit from nearby low carbon generation and subsequently reducing load on local electricity networks – both import from the new sites, and export from the generation.

The sites shown with the Renewable Generation sections of the report are shown below to highlight the variety of generation technologies present and operating within Suffolk.

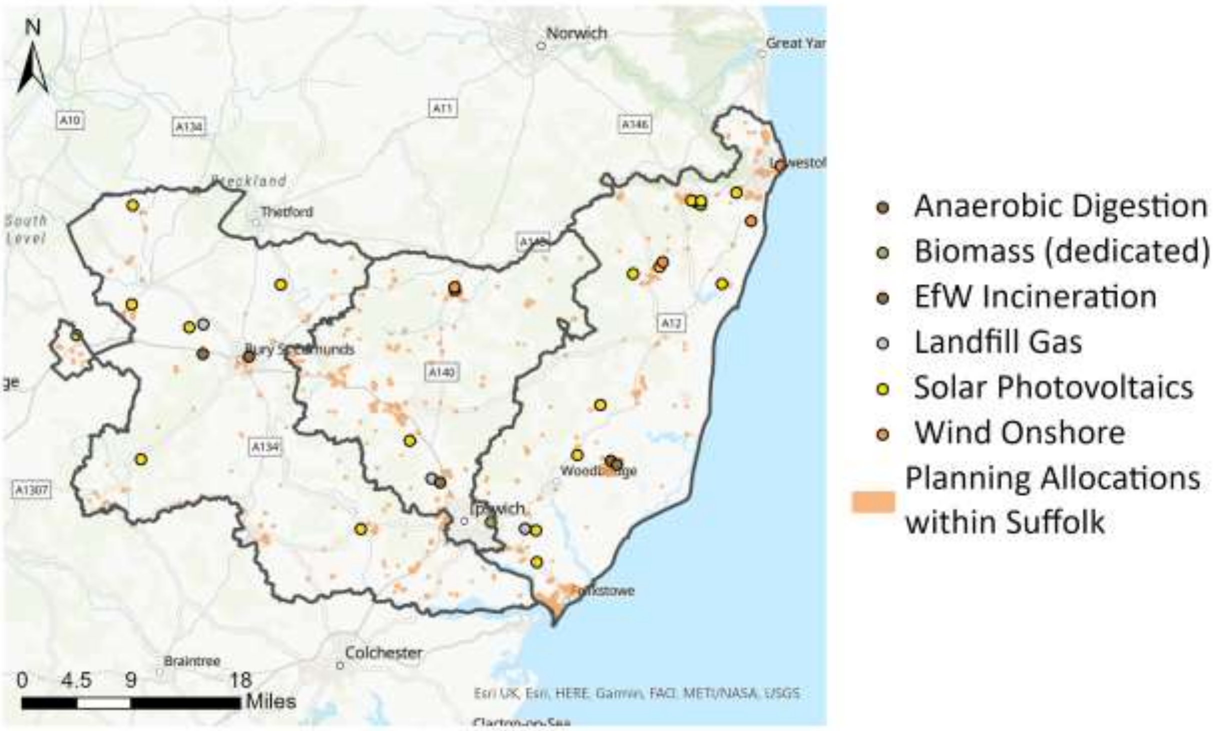

Figure 122: Existing renewable generation above 150 kW and planned allocation sites within Suffolk.

Two sites where these intersect are shown below in Figure 123 and Figure 124. For these sites, it may be beneficial for energy generated to be consumed by the new developments happening around or near the generation.

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[39] https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract

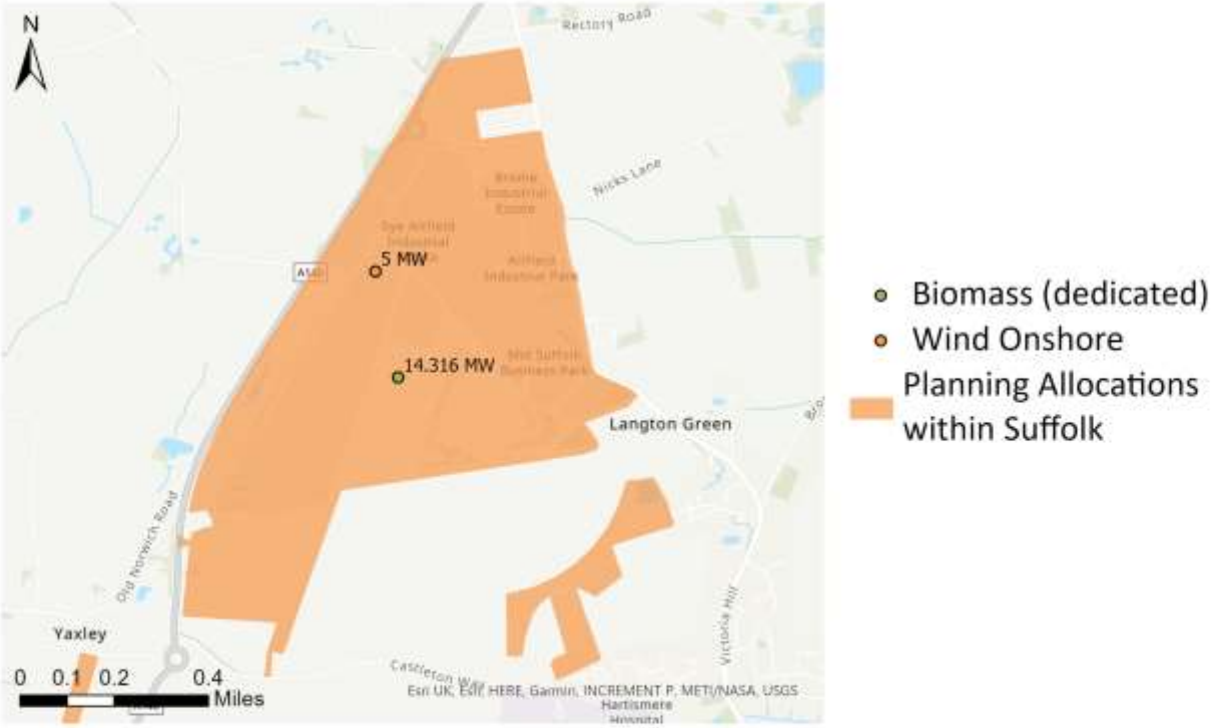

Figure 123: Development site around existing generation north of Eye.

Figure 124: Development site near existing 1.65 MW PV farm south of Beccles.

3.3.3. A11 Tech Corridor

Figure 125 shows the A11 Tech Corridor across Suffolk. The vision for the Tech Corridor is[40]:

"To be internationally recognised as a top-tier destination for technology firms looking to establish, grow and cluster, for highly skilled workers looking for a rewarding career with a strong purpose and a rich quality of life, and for businesses and investors seeking the next high-value, sustainable opportunity".

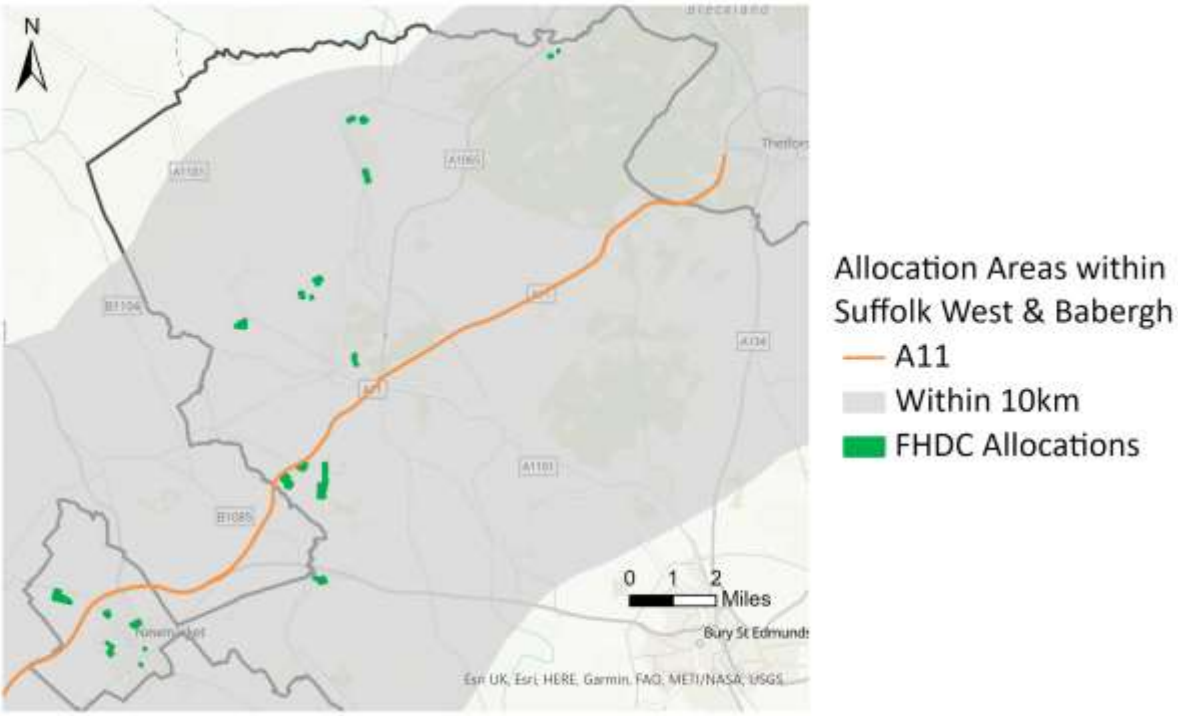

Figure 125: Project area showing Suffolk West & Babergh and the A11 Tech Corridor with a 10km buffer boundary

Across Suffolk, the A11 Tech Corridor ranges from Thetford to Newmarket with a 10km buffer. This 10km boundary covers the majority of the former Suffolk region of Forest Heath, meaning all Forest Heath District Council residential sites are within the buffer and would benefit from the Tech Corridor.

[40] https://www.techcorridor.co.uk/articles/tech-corridor-programmes/

4. Data Metrics

Using comparisons between different data sets and considering the completeness of individual data sets it is possible to get an indication of the quality, accuracy, and completeness of this local energy system representation. The following table shows a selection of data metrics which provide these indications for different aspects of this representation.

Based on several local area energy system representations, a RAG rating has been developed for comparison of each data metric against other project areas and the national average. This provides specific indicators for which categories of national data may require additional local knowledge under a full detailed Local Area Energy Plan.

Data metrics are an average across the three sub-regions to give an overall metric for Suffolk.

4.1. Map Data Quality and Accuracy

Data Metric	Description	Value
Basic Land and Property Unit (BLPU) completeness (%)	Percentage of buildings that have a BLPU status code. This code shows the current status of a building including whether it is live or inactive. Subsequently this infers whether it would have an energy demand. For example, a value of 40% signifies that for this many properties in the area it is known whether they are live or no longer active. This will not be known for the remaining 60%, and therefore energy demands, and energy networks may lose accuracy.	78.37%
Classification code completeness (%)	Percentage of buildings with a classification code that indicates their use. If a high number of buildings are unclassified this indicates poor quality, or badly maintained map data. Since the local area representation is built on the map poor quality raises concerns around the quality of that representation. In addition, low levels of completeness mean that building use is likely to be mis-classified leading to poor representation of buildings, energy demands and energy networks.	100%
Active buildings (%)	Percentage of records with a BLPU code that is not inactive or unoccupied buildings. If high numbers of buildings are classified as active this increases confidence on estimates of local energy demand.	73.17%
Commercial classification code (%)	Percentage of buildings with a commercial classification code. Due to large variability in non-domestic building construction methods and uses estimating energy demand for these buildings is inherently more uncertain than for domestic buildings. If most buildings in the project area have a domestic classification, then energy demand estimates are expected to be better than if most buildings are non-domestic.	10.16%
Land classification code (%)	Percentage of buildings with a "land" classification code. In theory this should be zero. If a high number of buildings are classified as land this indicates poor quality, or badly maintained data. Since the local area representation is built on the map poor quality data raises concerns around the quality of that representation.	7.98%
"Other" classification code (%)	Percentage of buildings with a classification code of "other". If a high number of buildings are classified as other this indicates poor quality, or badly maintained data. Since the local area representation is built on the map poor quality data raises concerns around the quality of that representation.	1.45%
Parent shell classification code (%)	Percentage of buildings with a "parent shell" classification code. In these cases, cross references are not available within the OS data meaning that it is not possible to associate the map data with other data sources such as the Valuation Office Agency. This means that there is less confidence in the quality of data associated with these buildings resulting in less confidence that local building stock is correctly represented and that estimates of energy use and network capacity are accurate.	5.22%
Residential classification code (%)	Percentage of buildings with a residential classification code. Due to large variability in non-domestic building construction methods and uses estimating energy demand for these buildings is inherently more uncertain than for domestic buildings. If most buildings in the project area have a domestic classification, then energy demand estimates are expected to be better than if most buildings are non-domestic.	74.42%

Unclassified code (%)	Percentage of buildings with a classification code of "Unclassified". If many buildings are unclassified this indicates poor quality, or badly maintained data. Since the local area representation is built on the map poor quality data raises concerns around the quality of that representation. In addition, if use cannot be identified with certainty this will lead to poor understanding of the local building stock and poor-quality energy demand estimates.	0.06%
Dual use classification code (%)	Percentage of buildings with a dual use classification code. It is more difficult to correctly estimate the energy use of dual use buildings as the floor area used for different purposes may not be known. If many buildings are dual use, then understanding of local building stock will be less good and energy demand estimates will be of lower quality.	0.30%
Non-domestic addresses with Valuation Office Agency mappings (%)	Percentage of buildings with a commercial classification code that can be linked with Valuation Office Agency data. The Valuation Office Agency data provides information on buildings that pay business rates. It categorises how a building is used and the floor area within a building that is used for different purposes. When most non-domestic buildings can be mapped to an entry in the Valuation Office Agency data this allows a better understanding of the local stock and better-quality estimates of energy use.	48.25%
Building points correctly assigned to building Toids (%)	Percentage of Building Points[41] correctly assigned Building Toids. Where building points exist but are not contained within Building Toids[42] this can indicate poor quality, or badly maintained map data. Since the local area representation is built on the map data poor quality data raises concerns around the quality of that representation. Furthermore, it is likely that buildings will be mis-classified or omitted from the analysis in these cases resulting in reduced understanding of the local building stock and associated energy demand and network capacity analyses. In addition, if a Building Point is assigned to a non-building Toid then the information associated with that Building Point cannot be used as the size of the building is not known. This means that understanding of local building stock and energy demand estimates will be of lower quality.	78.45%
Buildings with height data (%)	Percentage of buildings with height data. Height data is used to understand the number of storeys in a building and so the total building floor area. If height data is missing from a building, then the number of storeys will be estimated using LIDAR data and the quality of the energy use may be less accurate.	81.91%

4.1.1. Map Data Summary

The rural nature of Suffolk poses challenges around how agricultural land and ancillary buildings are assigned. This is because Ordnance Survey mapping is primarily based around postal addresses, however larger more rural sites may only contain one address point, and a number of secondary buildings. Therefore care will be required to ensure e.g. the largest industrial buildings are classified correctly, and not given the classification of their address point which may be a small nearby office. This can be done by a spot check of the largest building polygons within the area within a more detailed study such as a Local Area Energy Plan[43].

4.2. Building Data Completeness and Quality

Data Metric	Description	Value
Proportion of domestic buildings with Energy Performance Certificate (%)	Energy Performance Certificates provide information on a variety of factors that are important when estimating the energy consumption of a house such as whether there is wall insulation. If Energy Performance Certificates are available for a large proportion of domestic buildings, then this provides a better understanding of local building stock and improves energy demand estimates.	51.94%
Proportion of domestic buildings where	Domestic building type can be identified by analysing the map geometry for each Building Toid. Where this matches the building type given by the Energy	86.07%

[41] Within the OS data all buildings that have an address should be represented by a building point as well as some geometry that shows the building's footprint (the associated Building Toid).
[42] Within the OS data all buildings should be represented by some geometry that shows their footprint. This is the Building Toid.
[43] https://es.catapult.org.uk/tools-and-labs/our-place-based-net-zero-toolkit/local-area-energy-planning/

building type from analysis of map data matches building type from Energy Performance Certificates (%)	Performance Certificate there is high confidence that the building has been correctly categorised. This indicates that there is a good understanding of local building stock and that energy use estimates will be of better quality.	
Percentage difference between domestic building ages and London Datastore data	London Datastore data provides information on housing age aggregated to Lower Super Output Area level. If the percentage difference between the proportions of different domestic building ages and the London Datastore data is low, then this gives high confidence in the building age predictions used in the project and that energy use estimates will be of better quality.	18.28%
Percentage difference between local building types and Office of National Statistics census data	National census data provides information on housing type aggregated to Lower Super Output Area level. If the percentage difference between the proportions of different house types in the project area and the ONS data is low, then this gives high confidence that there is a good understanding of local building stock and that energy use estimates will be of better quality.	16.57%
Comparison of Non-domestic use category between Valuation Office Agency and Ordnance Survey	The use category of non-domestic buildings is provided in the Ordnance Survey data with a commercial classification code and in the Valuation Office Agency data. Where these use categories agree this gives confidence that the use of the building has been correctly identified and reduces uncertainty associated with estimates of energy use.	99.22%

4.2.1. Building Data Summary

The quality of building data is very high, which is likely due to the higher proportion of large single use properties. Studies in more urban areas have shown problems in national building data around shared use properties, e.g. flats above shops, where multiple building classifications may not fit within one defined 2D building footprint.

4.3. Other Data Comparisons

Data Metric	Description	Value
Social Data Scaling (%)	Social data is provided by the Office for National Statistics at Lower Super Output Area Level[44]. In cases where the project boundary cuts across a Lower Super Output Area the social data is calculated by proportioning the data based on the number of buildings contained in both the project area and the Lower Super Output Area compared to those in the whole Lower Super Output Area. For projects where this apportionment has been performed for a large number of Lower Super Output Areas it is likely that social metrics produced will be less accurate than in cases where little or no data points have been apportioned. This metric shows the percentage of buildings within the project area that belong to a proportioned LSOA.	0.00%
Annual gas demand comparison to BEIS data (%, LEAR/BEIS)	Total annual gas demand is published by BEIS at Medium Super Output Area level. This can be used to give an estimate of demand within the project area. Where this value compares closely with the demand estimate calculated for this work then there is good confidence in the value. Where there is a significant difference then confidence in the demand estimate is reduced. A number less than 100% means the demand modelled in LEAR is lower than BEIS reported demand. A number greater than 100% means the demand modelled in LEAR is higher than BEIS reported demand. It should be noted that the way buildings are categorised in the BEIS data, and the associated modelling used to calculate aggregate demand is different to the approach adopted here and is also likely to contain sources of error. This comparison gives an indication of confidence but should not be used to assess whether either number is a better estimate.	222.43%
Annual electricity demand comparison to	Total annual electricity demand is published by BEIS at Medium Super Output Area level. This can be used to give an estimate of demand within the project area. Where this value compares closely with the demand estimate calculated for this work then there is good confidence in the value. Where there is a significant	115.60%

[44] Lower Super Output Areas are used by the Office for National Statistics to report national census data. Each Lower Super Output Area has a population of less than 3,000 people or 1,200 households.

BEIS data (%, LEAR/BEIS)	difference then confidence in the demand estimate is reduced. A number less than 100% means the demand modelled in LEAR is lower than BEIS reported demand. A number greater than 100% means the demand modelled in LEAR is higher than BEIS reported demand. It should be noted that the way buildings are categorised in the BEIS data, and the associated modelling used to calculate aggregate demand is different to the approach adopted here and is also likely to contain sources of error. This comparison gives an indication of confidence but should not be used to assess whether either number is a better estimate.	

4.3.1. Other Summary

As can be seen above, while modelling electrical demand is very similar to other studies there are larger differences with modelled gas demands. A further study such as a Local Area Energy Plan would see an investigation into where exactly these differences in modelled demand lie, to determine whether it is the LEAR method or BEIS method of modelling that are causing differences. The rural nature of Suffolk and higher proportion of oil fuelled properties could drive further differences; while BEIS publishes sub-national statistics on electricity and gas, the same is not available for oil.

4.4. Overall Data Summary

The quality of classifications of buildings within the area is very high, likely due to the small number of shared buildings such as flats. For a more detailed study, land use would need to be checked to ensure more rural buildings are being classified correctly, and manual checking of the largest assigned buildings with other sources.

Appendix A: Accompanying Data

The accompanying Excel workbooks contains all the data that sits behind the graphs and maps in this document. The summary tab can be used to navigate to the data of interest.