ATKINS

Member of the SNC-Lavalin Group

Net Zero Leiston

Carbon Baselining

Revision 04

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Introduction

When considering a route map to achieve net zero carbon in the study boundary area (), the first step is to baseline the current and predicted future carbon emissions of the area as if no external intervention was taken i.e. the business-as-usual scenario (BAU). This allows for an accurate comparison and carbon reductions to be calculated. The BAU scenario shall include carbon emissions across the following three sectors that make up the in-scope emissions:

1. Buildings/Energy Consumption
2. Transportation
3. Agricultural

This technical note calculates the existing carbon emissions across the first 2 of these sectors (buildings and Transportation). The existing Carbon emissions associated with Agriculture are reported in a sperate technical note, authored by University of East Anglia[1].

The emissions will be calculated for the start year and estimated up to 2050. The start year is 2020, as this is the year the carbon budget[2] was calculated. Further detail on this will be published later this year).

Due to the large volume of data involved, much of this analysis was completed in GIS software. This will allow the results to be presented graphically over a web-based system at a later stage. This will be particularly useful in reviewing change over time.

The sections below outline the method used and the results from each sector, with a final section outlining the total baseline carbon emissions by summing the three sectors under the BAU scenario, with input from University of East Anglia

[1] University of East Anglia, Net-Zero Leiston: Agriculture Baseline, 2020

[2] As a result of the targets set out in the United Nations Paris Agreement, the Intergovernmental Panel on Climate Change (IPPC) has calculated a global carbon budget. It is predicted adhering to this budget should stop the world from exceeding the global temperature increase limit. The Tyndall Centre for Climate Change Research has developed a methodology to apportion this global budget to the UK. However, this UK budget needs to be further broken down for districts and individual local authorities. Atkins has developed a tool which allows for the calculation of such budgets using the methodology from the Tyndall Centre to apportion IPCC global carbon budgets to local authorities for the period 2018-2100.

1.0 Building Carbon Analysis

This section calculates the carbon emissions from energy use in all buildings within the Leiston study area.

To calculate the carbon emissions, we first establish an energy demand for each defined building within the study area, and then business-as-usual fuel type(s) for each building. Where possible, this data will come from one of our collected datasets, as noted below. As a fall-back position, and to ensure that datasets are not carrying large errors, benchmark energy use will be derived for each building type. These will be based on the nature of the building and the floor area. For future analysis in developing the route map, further information such as current insulation levels, building age and construction type will be needed. These data have also to be collected at this point.

This analysis will assume that building energy consumption will remain broadly constant without intervention in the future.

There are **3,173 buildings** in the study area ,that have been identified as having an energy demand. **2,828** (89%) are domestic, with the remaining 11% non-domestic. See Figure 1 for a map of building locations across the study area.

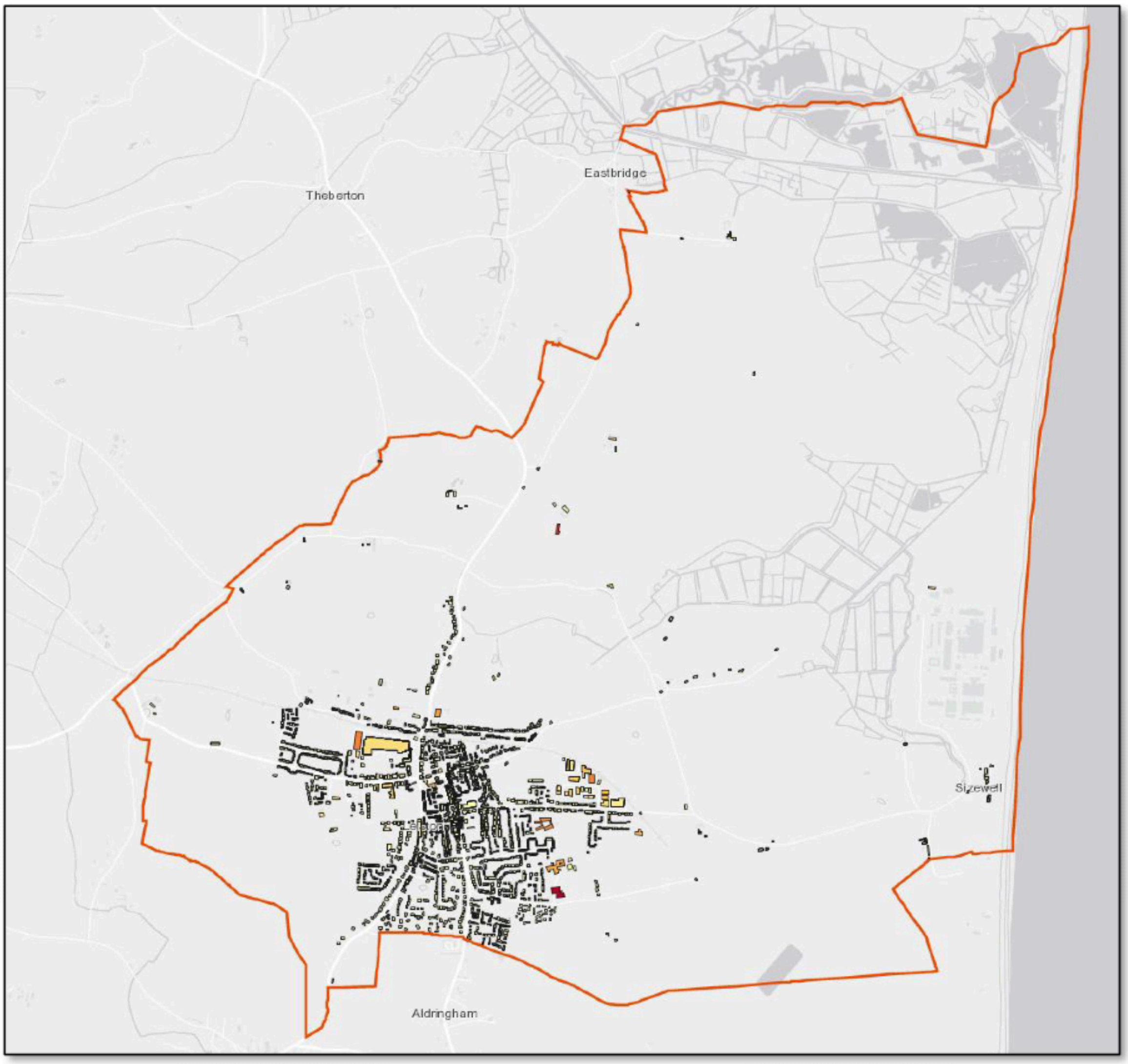


Figure 1 – Buildings in Study Area

1.1. Data sets used

There is limited accurate information available at a building level across England. All data sources used in the dataset are publicly available.

BEIS were contacted for more granular information than is available online i.e. building level rather than data zone. No response has been received to date. While these datasets would be informative, they are not critical. In the past, BEIS provided a National Heat Map which would have been a useful start for this exercise. This was de-commissioned in 2018 and, as yet, has not been replaced[3].

The following data sources were used in the dataset[4]:

1	AddressBasePlus is an Ordnance Survey paid product listing addresses, including residential, non-residential, and non-traditional buildings such as tanks. The data is delivered in Point format, with one point potentially representing multiple buildings, for example a school with several teaching blocks. ▪ AddressBase Plus, Ordnance Survey, Accessed May 2020
2	Ordnance Survey Open Map Local is an open data product which includes polygon data on buildings, somewhat simplified. ▪ Open Map Local, Ordnance Survey, Accessed May 2020
3	Off-gas postcodes were produced by the Centre for Sustainable Energy based on data collected in 2017. Postcodes are only included where every property is outside the main gas network; where even one property is connected the whole postcode is excluded from the list. ▪ Off Gas Postcodes, Centre for Sustainable Energy, Accessed May 2020
4	Energy Performance Certificate (EPC) and Display Energy Certificate (DEC) data are released by the Ministry of Housing, Communities, & Local Government. The dataset only includes properties which have had an EPC issued post-2008, and therefore does not include every property. ▪ Energy Performance Certificate & Display Energy Certificates, Ministry of Housing, Communities & Local Government, Accessed May 2020.

Further data sets have been requested in relation to:

- Building Age
- Conservation Areas
- Section 106 Agreements (Land Use)
- Leiston Neighbourhood Plan
- Tree Preservation Map
- East Suffolk Council Ownership

[3] https://www.cse.org.uk/projects/view/1183

[4] This report is prepared based on Open data and proprietary data, issued by Ordnance Survey, Centre for Sustainable Energy, and Ministry of Housing, Communities & Local Government. The following attribution statements apply: Contains public sector information licensed under the Open Government Licence v3.0. Ordnance Survey data is used under © Crown copyright and database rights [2020] OS [609497] © Local Government Information House Limited copyright and database rights [2020] [609497] Contains Royal Mail data © Royal Mail copyright and Database right [2020]

1.2. Generation Sources

From the data sources reviewed, no local generation sources are identified as being within the study area boundary[5].

While there are local substations receiving electricity from offshore windfarms, these have been excluded from this study as it is not possible to disaggregate the electricity from these that would be used within the bounds of the study area compared to that shared to the remainder of the National Grid[6].

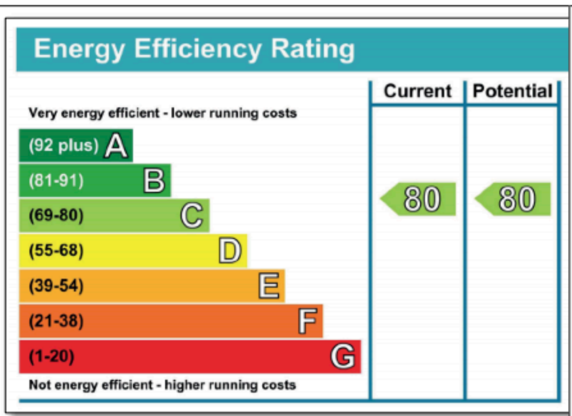
The same logic pertains to Sizewell's generation itself. Its low carbon power is intrinsic to the calculated grid emissions factor that is used for the grid average, and thus for all the buildings in the study area. Only energy that can be disaggregated from the grid supply (whether directly or indirectly) will be considered.

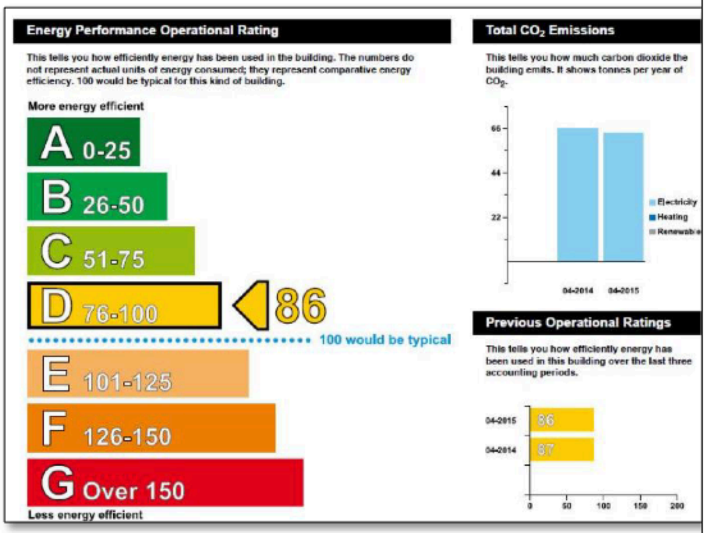
There is a wastewater treatment works in the study area. This is a potential heat source and will be explored in further detail in future analysis. For this stage, the energy consumption associated with the wastewater treatment works has been accounted for, see Benchmarks section below.

1.3. GIS methodology

After all data sets were "clipped" to the local authority boundary for Leiston Ward, EPC data was first processed to retain only the most recent EPC for each property. Following this, AddressBasePlus (ABP) data were joined with EPC and DEC data by using the full PAO text[7] as the common factor. This required some manual processing to ensure address formats were identical. Around 50% of addresses were present in the EPC data, offering a good coverage of Leiston. This EPC data supplied factors including floor area, fuel type and energy consumption.

What is an EPC and how does it differ from a DEC?





[5] Embedded generation is electricity generation which is connected to the Distribution network rather than to the high voltage National Grid. Embedded generation is typically smaller generation such as Combined Heat and Power (CHP) or renewable generation: small hydro, wind or solar power
[6] Note the transmission network moves electricity from a power plant or power station to various substations whereas the distribution network carries electricity from the substation to the consumer's end. i.e, to the residential and commercial customers
[7] This is the Primary Addressable Object Name as text – e.g. building name or street number.

An **Energy Performance Certificate (EPC)** is a certificate that shows how energy-efficient a domestic property is. The document includes estimated energy costs, as well as a summary of the home's energy performance-related features.	**Display Energy Certificates (DEC)** show the energy performance of non-domestic buildings based on actual energy consumption

In order to classify the remaining addresses and calculate a baseline, OpenMapLocal polygons were imported and spatially joined to ABP data using a one-to-many operation. This allowed a count of addresses to be assigned to each building polygon i.e. in the case of a block of flats. ABP data also includes a four-level building classification, allowing residential and non-domestic building types to be assigned, for example whether a residence was terraced, detached, or semi-detached. To determine the number of storeys of each building, a manual visual check of Google Streetview was conducted. Floor area per property was then calculated using the polygon geometry multiplied by the number of storeys, then divided by the number of ABP points present within each building.

Off-Gas Postcodes were then joined to the resultant dataset to indicate whether gas was not a primary energy type for the property; this data was used in conjunction with EPC data.

1.4. Data Limitations

The data come with a series of recognised limitations. Most of these are inherent for any such analysis which cannot rely on a pre-populated data set, and are not unique to our project:

- EPC data was the main source for domestic properties, this is based on a modelled energy demand for the building rather than actual building demand. This allows difference in say insulations levels to be accounted for, but not actual consumption. This is the best quality data available, so this is what was used. This demand is for regulated energy only, so a benchmark allowance for non-regulated energy (i.e. domestic appliances, plug loads etc) has been added.
- DEC data was used for non-domestic buildings where available. This was the case for a small selection of buildings in the area for which there is real data for each building. The buildings with DEC data are:
    - The Surgery, Main Street
    - Leiston Sports Centre
    - Leiston Primary School[8]
    - Leiston High School
- It is widely recognised that there are little available datasets for non-domestic building energy consumption, outside of main public buildings. In the absence of the afore-mentioned National Heat Map, we have used benchmarks to assign a heat and power demand where building attribute is provided.
- The visual check of buildings using Google Streetview is constrained by using only an outside view of houses, from the road, therefore buildings which have concealed storeys, for example attic extensions visible to the rear, will have their floor area underrepresented.
- Postcodes off-gas is a 2017 dataset and therefore some properties may have subsequently been connected to the main gas network. Due to the whole-postcode nature of the dataset, there is likely to be other properties which are not connected to the gas network which are not included within this dataset, as others in their postcode may have been gas connected and therefore excluded the whole postcode from inclusion. This effect is mitigated where an EPC exists and allows a “check” on this data node.

[8] It is noted on the DEC that Leiston Primary School has existing renewable electricity generation, serving 46.6% of electrical demand.

- EPC data does not reflect any changes in a property during tenure and is generally conducted only upon sale or rental of a property. Actual energy ratings may therefore have changed since the EPC was issued, i.e. if an owner installed photo-voltaic panels.
- OpenMapLocal presents a simplified building shape; building areas that rely on this dataset will be somewhat approximate.

1.5. Benchmarks

Benchmarks were used for buildings where data was unavailable to provide a heating demand and a power demand.

For domestic buildings, this was an average annual demand based on house type, for non-domestic this was based on a kWh/m^2/annum usage per building type.

Domestic Buildings

For domestic buildings the following benchmarks were used:

Property Type	Average Annual Heat Demand (kWh)[9]	Average Annual Electricity Demand (kWh)[10]
All Dwellings	10,800	2,900
Houses	11,440	2,900
Detached	14,960	2,900
Semi-Detached	11,360	2,900
End Terraced	10,240	2,900
Mid Terraced	9,600	2,900
Bungalow	11,040	2,900
Flats	6,640	2,900
Converted Flat	8,880	2,900
Purpose Built Flat	6,080	2,900

Clearly the dataset is utilised to identify the most appropriate dwelling type, but if data is lacking, it will default to the more generic “house” or “all dwellings”.

Non-Domestic Buildings

For non-domestic buildings, CIBSE TM46 data was used. See heat and power benchmarks below. The heat benchmark comes from the fossil fuel benchmark with a boiler efficiency of 80% applied.

TM46 Type	Heat Benchmark (kWh/m^2)	Power Benchmark[11] (kWh/m^2)

[9] Gas Consumption by Dwelling Type, National Energy Efficiency Data Framework, 2019. Converted to Heat demand by applying 80% efficiency.
[10] Typical Domestic Energy Consumption Values (TDCV), Ofgem, 2020
[11] Electricity used for heat taken from TM46 percentage of electricity benchmark pro-rated to degree days - assumption made that the degree days is applied to 50% of the heat proportion. E.g. 15% electricity benchmark to degree days results in 30% of the electricity in total being assumed heat usage.

General Office	96	95
High Street Agency	56	84
General Retail	49.5	115.5
Large non-food shop	136	70
Small Food Store	93	217
Large Food Store	84	400
Restaurant	296	90
Bar, pub or licensed club	280	130
Hotel	264	105
Cultural Activities	160	70
Entertainment halls	336	150
Swimming pool centre	904	245
Fitness and Health Centre	352	160
Dry Sports and Leisure facility	264	95
Covered Car Park	0	20
Public Buildings with Light Usage	84	20
Schools and Seasonal Public Buildings	120	40
University Campus	192	80
Clinic	160	70
Hospital (clinical and research)	336	90
Long term residential	336	65
General Accommodation	240	60
Emergency Services	312	70
Laboratory or Operating Theatre	128	160
Public Waiting or Circulation	96	30
Terminal	160	75
Workshop	144	35
Storage Facility	128	35
Cold Storage	64	145

The TM46 categories were assigned to the ABP categories provided by the dataset to determine the appropriate benchmark to be assigned to the property. Buildings assigned the workshop category were individually considered, due to the varying nature of uses of this building type. Where appropriate, the benchmark was altered to a more suitable estimation.

Specific manual changes of benchmark energy usage were applied to the following buildings:

- **Applefields Caravan and Camping Park** – this has an office for check in to the park and has twenty electrical hook-ups. Assuming the site is busy for 16 weeks of the year, using a benchmark for a single occupancy domestic building electrical only and multiplying this by 20 pitches and the number of weeks, gives 35,600 kWh/annum. The Office is 150m^2 so using the benchmarks above, this gives a total electrical demand for the office of 28,650 kWh/annum, so 64,250 kWh/annum total.

- **Wastewater Treatment Works on Valley Road** – this will have an electricity demand only. From google maps, there appears to be no digester. Using a benchmark of 45 kWh/Population Equivalent,[12] and assuming an average local area population of 5,000 people, gives and annual demand of 225,000 kWh.
- **Data Centre at Eastlands Industrial Estate** – data centres have a high electrical demand, benchmark of 400 kWh/m^2 used.
- **Leiston Recycling Centre** – has a portacabin onsite that will have an electrical demand, therefore General Office benchmark assumed.

[12] https://www.huber.co.uk/solutions/energy-efficiency/general/wastewater-treatment-plants.html

1.6. Assigning a Heat and Power Demand

EPC data was used where available as the primary source of truth, i.e. it is known that the building has been surveyed by a registered energy assessor. While this is no guarantee of accuracy, it is the best available data set for such an exercise.

In the EPC data set, the key indicator is the "primary energy consumption" based on the SAP 2012 method of assigning energy to the fuel type[13]. This is a comparative value and is not an actual measure of energy use in that building's boundary, nor its nature. The following method was used to split the primary energy use into a more useful heat and power demand:

1. Benchmark electricity demand converted to electricity primary energy using factors in Table 1;
2. Electricity primary energy subtracted from building primary energy demand to fuel primary energy demand; and
3. Fuel primary energy demand converted to fuel demand using primary energy factor, then converted to a heat demand using assumed efficiency, Table 1.

Table 1 - Primary Energy Factors and Assumed Efficiency

Primary Fuel Type	Primary Energy Factor[14]	Assumed Efficiency
Mains Gas	1.22	85%
Electricity	3.07	100%
Dual Fuel appliance (mineral + Wood)	1.02	75%
Wood Logs	1.04	80%
Bulk LPG	1.09	85%
Heating Oil	1.1	85%

Where EPC data was available for a building, this was used in favour of a benchmark value. While it could be argued that EPC data is also a benchmark of sorts, as it is based on a modelled building rather than actual data, in theory it should take into account varying insulation levels across buildings.

Where there was no EPC data available for domestic buildings (1,328 properties), the benchmarks identified in the section above were applied to the corresponding property type. Where domestic property type information was not available from any data set, the benchmark for "All Dwellings" was used.

Where there was no demand information for non-domestic buildings (349 properties), the non-domestic benchmarks were used to assign a heating and power demand. A benchmark could only be applied where a type and floor area were available. Where a building type and floor area were not available, analysis could not be undertaken. This was the case for 34 properties.

Fuel type was determined through EPC information provided and the gas grid data set applied. Where no information was provided about fuel type on the EPC, connection to gas grid was looked for first. If connected

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[13] Primary Energy is energy that has not undergone any conversion or transportation process, as defined by SAP2012. This takes into account the energy used to produce this fuel – so for example, all fuels involved in the production of electricity will be accounted for based on the Government projections of the electricity grid mix. For this analysis, we are concerned with the fuel that is used in the property, not the chain of energy to get the fuel to the property as this is accounted for at the generation source. For this analysis, the Primary Energy Consumption must be divided by the associated Primary Energy Factor to give the real fuel used at the property. Derivation and Use of Primary Energy Factors in SAP, 2019: https://www.bregroup.com/wp-content/uploads/2019/10/Briefing-note-on-derivation-of-PE-factors-V1.3-01-10-2019.pdf
[14] SAP 2012, Table 12: https://www.bre.co.uk/filelibrary/SAP/2012/SAP-2012_9-92.pdf

to the gas grid, the heating fuel is assumed to be gas. Otherwise, heating fuel assumed to be electricity. Out of all the buildings with EPC and DEC data, 3.6% of the buildings had a fuel type of Oil, Wood Logs, Dual Fuel or LPG. With this being such a small portion and with no way of assessing whether a property uses these fuel types, it was assumed that all properties not on the gas network were electricity. Figure 2 identifies the fuel types across Leiston.

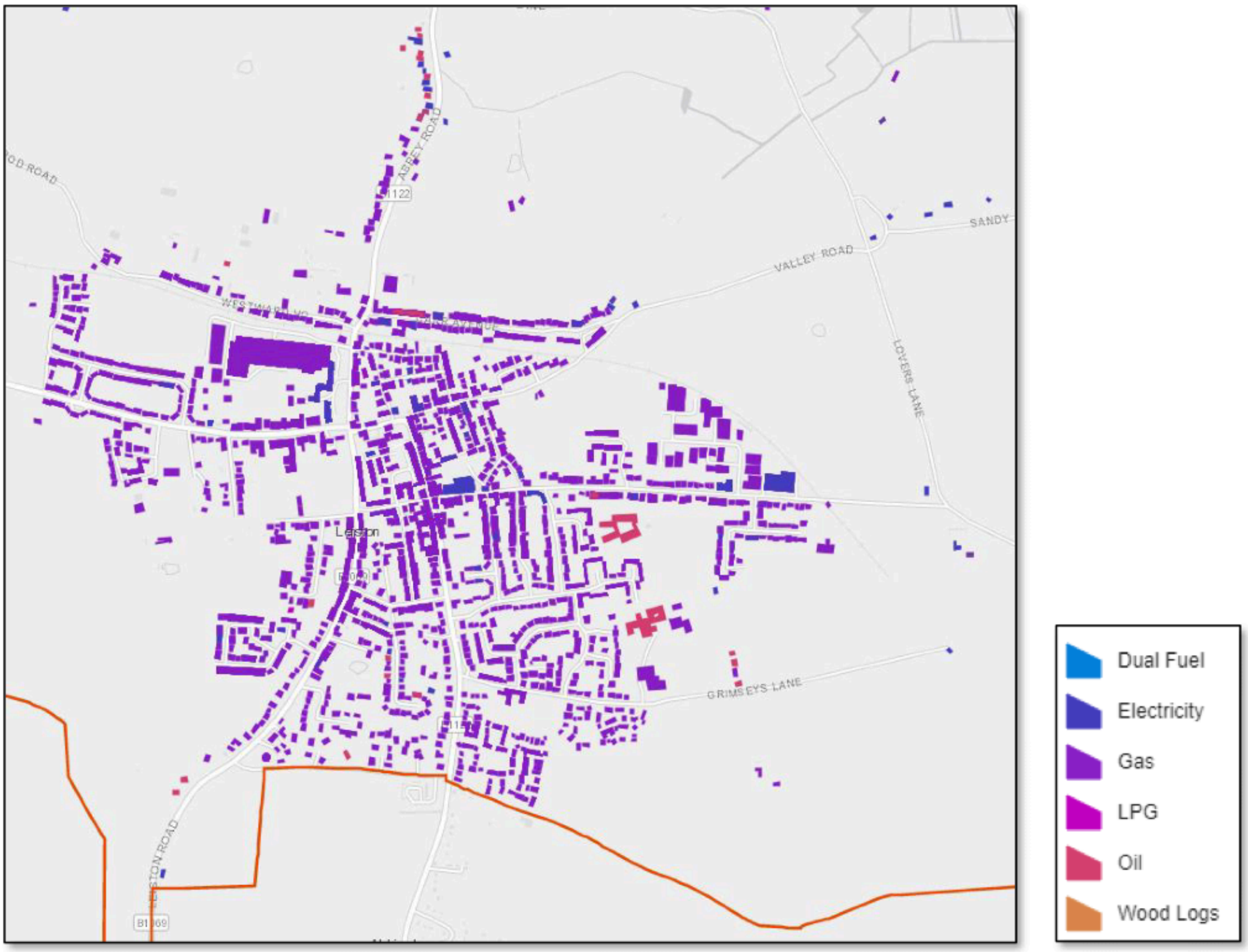

Figure 2 - Fuel Type Leiston

The majority of the demand in the area comes from the number of domestic dwellings in Leiston. However, the largest energy load is the Leiston Sports Centre, the only building to have an annual energy demand of more than 1,000 MWhs. See Figure 3 for the heat demands of buildings across the study area, the sports centre is the building in red towards the bottom right.

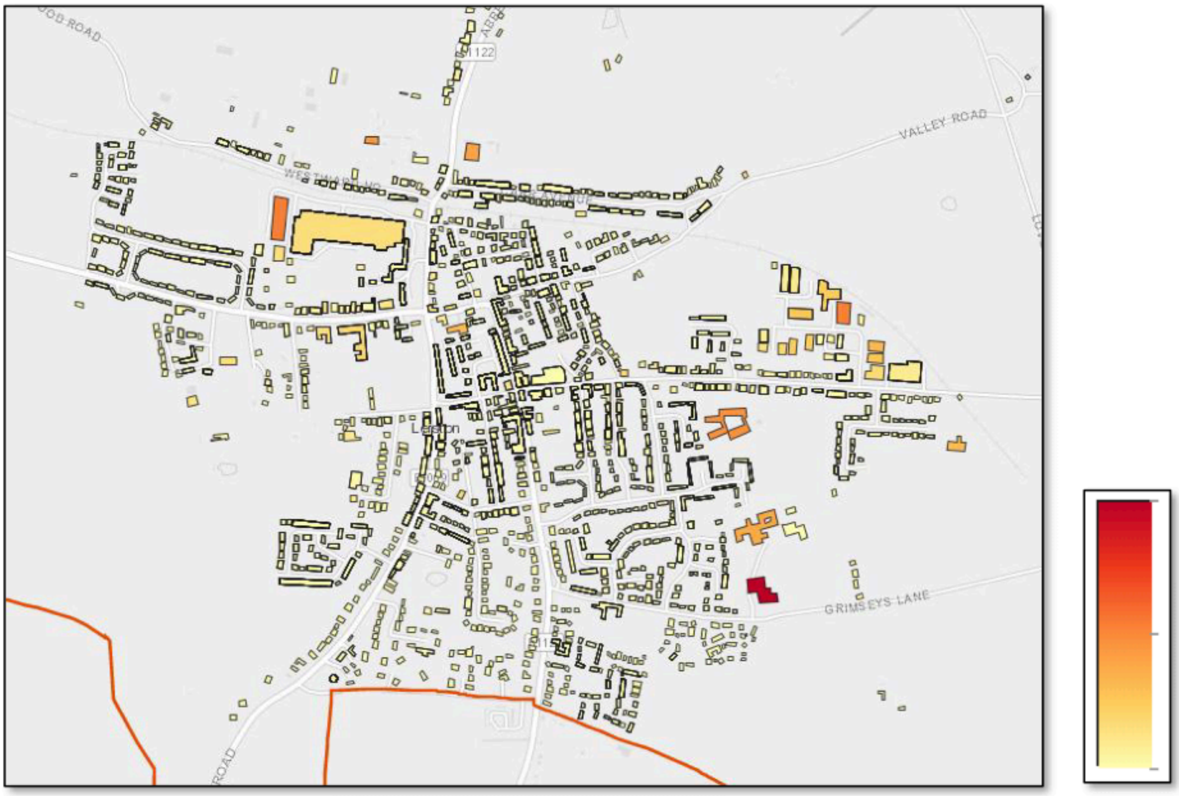

Figure 3 - Heat Demand Across Leiston Town Centre - (Red shows highest heat demand, yellow is lowest)

1.7. Carbon Factors

Three sources of carbon factors were used for this assessment, see Table 2. For fossil fuel, it is assumed that the factor does not change year on year, however, the carbon factors for electricity take into account the predicted decarbonisation of the electricity grid, a list of factors used can be found in Appendix A: Electricity Carbon Factors. The carbon factors were multiplied by the corresponding fuel and power demand for each building. The heating demand must be converted to a fuel demand, using efficiencies previously presented in Table 1.

Grid average electricity carbon emission factors were used to establish the baseline in a carbon foot printing exercise and based on current usage not changing. When measure changes are taken into account, long run marginal factors will be used as this will take into account the potential change in future energy mix as a result of any demand changes.

Table 2 - Carbon Factors

Fuel	Factor (kgCO2/kWh)	Carbon Factor Source
Gas	0.184	BEIS Green House Gas reporting carbon conversion factors 2019[15]
Oil	0.267	BEIS Green House Gas reporting carbon conversion factors 2019
LPG	0.214	BEIS Green House Gas reporting carbon conversion factors 2019
Wood Logs	0.019	BEIS Green House Gas reporting carbon conversion factors 2019
Dual Fuel (Mineral and Wood)	0.226	SAP2012 Carbon Emissions Factor[16]
Electricity	Domestic (2020) - 0.141 Commercial/Public Sector (2020) - 0.138	Green Book Greenhouse Gas Emissions- Grid-Average Domestic and Commercial/ Public Sector[17]

[15] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019

[16] https://www.bre.co.uk/filelibrary/SAP/2012/SAP-2012_9-92.pdf

[17] Carbon Factors show predicted decrease in carbon emissions from the electricity grid. https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

1.8. Buildings Results

The BAU building carbon emissions are shown in Table 3 below. Current year emissions are shown under 2020, with the annual emissions up to 2050 displayed as well. Without any intervention, carbon emissions from buildings are expected to reduce by 20% by 2050. The decrease in carbon emissions overtime is due to the projected decarbonisation of the electricity grid[13].

Table 3 – Estimated buildings carbon emissions (t CO_2) for 2020 and evolution to 2050

Type of building	2020 (baseline year)	2025	2030	2035	2040	2045	2050
Domestic	7,837	7,468	7,232	6,792	6,792	6,723	6,653
Non-Domestic	3,770	3,433	3,216	2,814	2,814	2,751	2,687
Total	**11,608**	**10,901**	**10,448**	**9,607**	**9,607**	**9,473**	**9,340**

The results above assume that all properties are occupied. In theory this will not be the case, however measures will need to be applied to all properties as it is likely that different properties will be vacant at different times over the analysis period. This analysis also assumes that property energy demands remain constant over this time period.

To sense check the domestic carbon emissions above, the CO_2 emissions from domestic electricity, gas and other fuels for Suffolk Coastal for 2017 were pro-rated for the population of the study area. This value (8,700tCO_2) was found to be approx. 11% more than the calculation completed above. see Table 4 (equivalent figure of 7,837tCO_2 for 2020), which is a reasonable correlation. We also note a period of 3 years between these figures (2017 and 2020), which will also account for some of the difference.

Table 4 - Local Authority Carbon Comparison

Area	Population	Domestic gas, electricity and other fuels CO_2 Emissions[18] (t CO_2)
Suffolk Coastal	129,01619	204.5
Leiston Study Area	5,508	8,700

[18] BEIS UK Local Authority and Regional Carbon Dioxide Emissions National Statistics 2017
[19] Mid-Year Estimate

2. Transportation Carbon Analysis

The transport carbon baseline for Leiston was calculated in line with guidance from the Department for Transport's (DfT) Transport Appraisal Guidance (TAG), using the following key inputs:

- Traffic volume, speed and composition (in terms of Cars, LGVs, HGVs and buses) data from the Leiston area VISUM model[20] for the years 2015 and 2034 and for each of 7 modelled hours (06.00 to 09.00 and 15.00 to 19.00);
- Fleet composition assumptions from the DfT's TAG databook;
- Fuel consumption assumptions by vehicle type from the DfT's TAG databook (accounting for improvements and fleet composition change through time);
- Carbon intensity factors (kg CO_2e/ litre of fuel) from the DfT's TAG databook and kg CO_2e/ per kWh of electricity from the BEIS dataset (using domestic grid average intensity for the baseline rather than marginal intensity which is recommended in the TAG databook to appraise changes in energy use); and
- Traffic demand growth forecasts from the VISUM model and from the DfT's National Traffic Forecasts 2018 for the East of England.

2.1. Methodology

The calculations involved the following steps:

1. For the modelled years of 2015 and 2034 and for each time period, calculation of fuel consumption /electricity use for traffic on each modelled road link within the Leiston area. Calculations included all traffic apart from any traffic to and from Sizewell C[21], and used the TAG fuel consumption formulae which link fuel consumption to vehicle type, fuel type, speed, year and distance of travel. See Figure 1 for an image of the modelled road links.
2. Summation across all modelled road links of estimated fuel consumption/electricity use by vehicle type (car, LGV, HGV and bus), time period and fuel type for the modelled years of 2015 and 2034.
3. Application of an uplift of 15% (based on road coverage) to allow for traffic on minor roads that are not captured in the model.
4. Interpolation and extrapolation to produce estimates of fuel and electricity use for each vehicle type in each time period in each year between 2020 to 2050. This process drew on:
    a. DfT National Traffic Forecasts for the East of England (by vehicle type):
        i. To distribute the VISUM modelled demand growth to the years between 2015 and 2034 (modelled years); and
        ii. To estimate additional traffic growth beyond 2034 (assumed to be equivalent to the East of England average).
    b. DfT TAG estimates of improvements in fuel consumption through time by vehicle type and fuel type (accounting for fleet composition change)
5. Conversion of fuel/ electricity consumption estimates in litres and kWh for modelled hours to represent:
    a. Full weeks - using expansion factors based on DfT statistics on the relative levels of travel by time of day
    b. Full years - on the assumption of 253 working days per year and the remainder weekend or bank holidays.
6. Conversion of fuel and electricity consumption estimates to estimated emissions impacts by year using the DfT and BEIS carbon intensity factors by year.

[20] Transport model provided by Sizewell C. This was used as the base for the modelling scenarios.
[21] Note that traffic to and from Sizewell B and A are included.

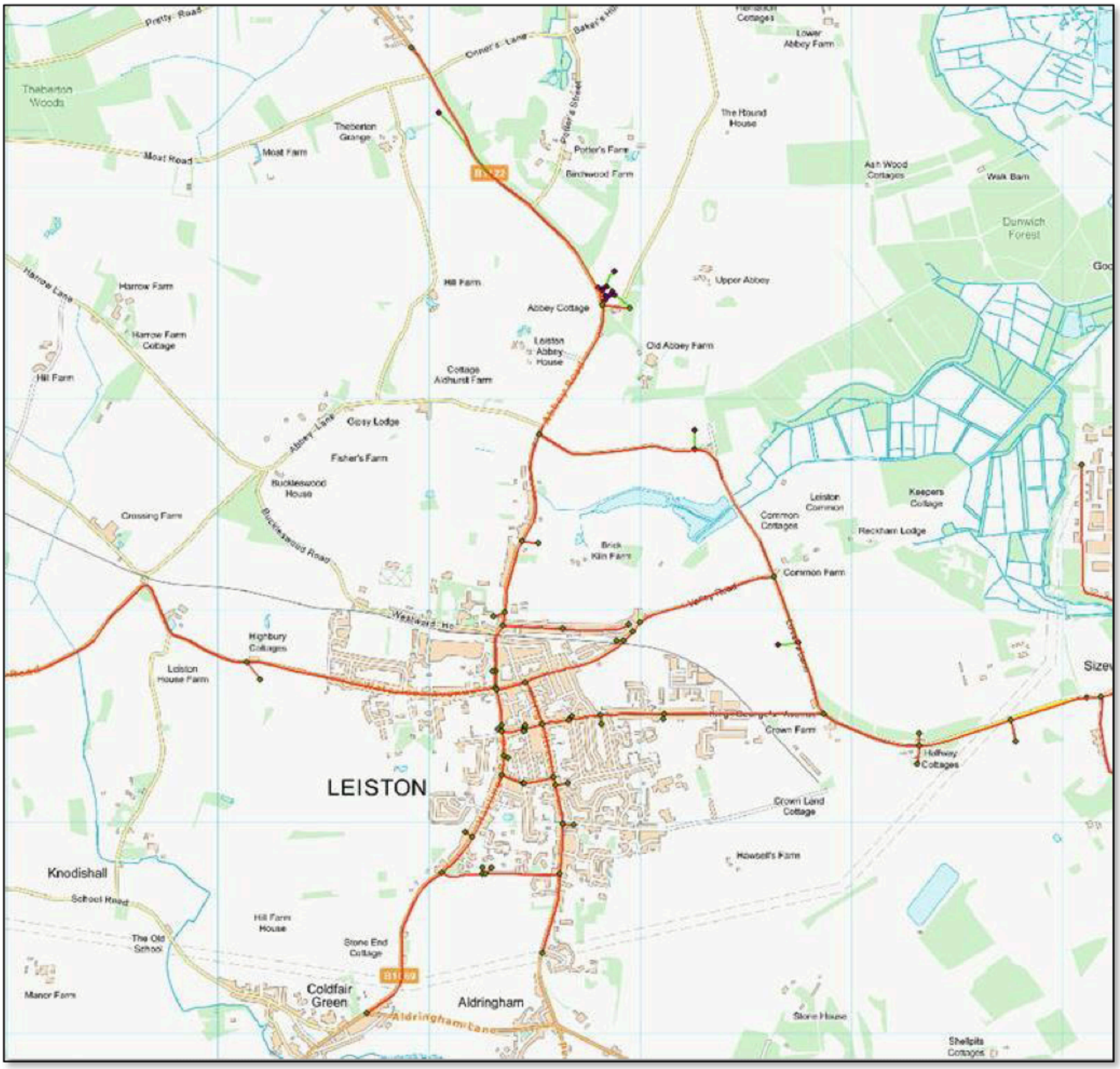

Figure 1 – Transportation Model – Modelled Road Links

2.2. Transportation Results

The summary results are presented below by 5-year intervals for the BAU scenario without Sizewell. Emissions associated with electric vehicle use are presented separately to those from petrol and diesel vehicle use as they are not usually considered part of transport sector emissions.

Table 1 - Estimated transport carbon emissions (t CO_2e) for 2020 baseline and evolution to 2050

Energy source	2020 (baseline year)	2025	2030	2035	2040	2045	2050
Petrol/Diesel	3,820	3,860	3,750	3,620	3,370	3,160	2,960
Electricity	10	20	60	50	70	70	70
Total	3,830	3,880	3,810	3,670	3,440	3,230	3,030

A sense check was undertaken, comparing the 2017 estimate against the BEIS local authority road vehicle emissions for the Suffolk Coastal district for 2017. The calculated emissions figure for Leiston was just over 1.5% of the Suffolk Coastal total. This compares to the population accounting for approximately 4.2% of the total.

This difference largely reflects the fact that there are no A roads passing through the Leiston study area. Traffic on A roads was attributed 60% of emissions in the BEIS statistics as the high traffic flows and high good vehicles proportions (for instance to and from Felixstowe) contribute disproportionately to emissions totals.

3. Total Carbon Analysis Results

Combining the results of sections 2.0, 3.0 and the supporting note from University of East Anglia (buildings, transportation and agriculture) gives the total current carbon emissions for the study area as:

- **15,738 t CO_2/annum**

This is the gross level of emissions in the Leiston parish boundary. The area benefits from existing green space which naturally removes carbon from the environment. The existing carbon sequestration from the boundary area is estimated at:

- **-3,725 t CO_2/annum**

Detailed methodology for calculating this will be published later this year.

This provides the net total current carbon emissions for the area of:

- **12,013 t CO2/annum**

Comparing these net values to the CO_2 budget of the study area, 95 kt CO_2 up to the year 2100, if business as usual were to carry on, the carbon budget of the study area would be emitted (i.e. used up) in just under eight years. **Essentially, this defines the scale of the carbon challenge required to make Leiston Net Zero and sets the baseline for defining the route map.**

Table 1 below shows the annual carbon emissions up to 2050. Almost 70% of the carbon emissions can be attributed to building energy consumption.

Looking at this over the period from 2020 – 2050, the overall carbon emissions are reducing. This is due to the baseline predicted increase in electric vehicle usage combined with the projected decarbonisation of the electricity grid.

Table 1 - Total Estimated Emissions (t CO_2) for the Study Area

Sector	2020 (Baseline year)	2025	2030	2035	2040	2045	2050
Buildings	11,608	10,901	10,448	9,607	9,607	9,473	9,340
Transport	3,830	3,880	3,810	3,670	3,440	3,230	3,030
Agricultural[1]	300	300	300	300	300	300	300
Total	15,738	15,081	14,558	13,577	13,347	13,003	12,670

Note: An assessment into the changes between now and 2050 emissions forecast as a result of changes in land use area or agricultural equipment efficiency has been undertaken.
The assessment identified that agricultural land use area in Leiston has not undergone any particular change over the last 15-year period (further detail will be published in a separate Land Use, Land Use Change and Forestry (LULUCF) chapter). It is therefore, assumed that land use area will not undergo significant changes between now and 2050.

Furthermore, the DfT's TAG forecast statistics do not forecast any changes in fuel efficiency of diesel HGV's between 2020 - 2050, which are of a similar engine size to agricultural vehicles. Equally, the DfT's TAG forecast statistics do not forecast any changes in carbon emissions from diesel fuel burnt between 2020 - 2050.

It is therefore assumed that there will similarly be no changes in the efficiency of diesel agricultural vehicles nor changes in carbon emissions from diesel fuel burnt for agricultural equipment.

It is therefore assumed that the baseline agricultural emissions calculated for 2020 will be constant 300 t CO_2 for each year from 2020 – 2050[1].

Appendix A: Electricity Carbon Factors

Carbon Emission Factors

Year	Grid average (kgCO2e/kWh)			
	Consumption-based			Generation-based
	Domestic	Commercial/ Public sector	Industrial	
2020	0.141	0.138	0.135	0.128
2021	0.115	0.113	0.111	0.105
2022	0.107	0.105	0.103	0.098
2023	0.112	0.110	0.108	0.102
2024	0.104	0.102	0.100	0.095
2025	0.105	0.103	0.101	0.096
2026	0.099	0.097	0.095	0.090
2027	0.105	0.103	0.101	0.096
2028	0.100	0.098	0.096	0.091
2029	0.092	0.090	0.088	0.084
2030	0.083	0.081	0.080	0.076
2031	0.073	0.072	0.070	0.067
2032	0.061	0.060	0.059	0.056
2033	0.057	0.056	0.055	0.052
2034	0.049	0.048	0.048	0.045
2035	0.041	0.040	0.039	0.037
2036	0.041	0.040	0.039	0.037
2037	0.041	0.040	0.039	0.037
2038	0.041	0.040	0.039	0.037
2039	0.041	0.040	0.039	0.037
2040	0.041	0.040	0.039	0.037
2041	0.040	0.039	0.038	0.036
2042	0.038	0.038	0.037	0.035
2043	0.037	0.036	0.036	0.034
2044	0.036	0.035	0.034	0.032
2045	0.034	0.034	0.033	0.031
2046	0.033	0.032	0.032	0.030
2047	0.032	0.031	0.030	0.029
2048	0.030	0.030	0.029	0.028
2049	0.029	0.028	0.028	0.026
2050	0.028	0.027	0.027	0.025

Net-Zero Leiston: Agriculture

This document discusses a number of issues regarding agriculture and the Net-Zero Leiston (NZL) project. It begins with some background information on agricultural activities and then provides responses to a number of key questions.

Agricultural Background

The most recent data from the Agriculture in the United Kingdom publication indicate that in 2018 agriculture was responsible for 10.1% of total UK greenhouse gas (GHG) emissions (Defra, 2020). However, this share varied appreciably between GHGs, with agriculture being the source of 49.3% of Methane, 69.8% of Nitrous Oxide and only 1.6% of Carbon Dioxide (CO_2) emissions. Most agricultural Methane emissions arise from digestive processes in ruminating animals and those of Nitrous Oxides from nitrogen fertiliser or manure applications to soils. The main sources of Carbon Dioxide are combustion, vehicle emissions and releases from soil during cultivations. This document focuses on CO_2, though it is important to keep in mind that they are only a small proportion of agricultural GHG emissions.

An insight into the composition of agricultural activities in the NZL project area can be obtained from the Crop Map of England (CROME) dataset (Rural Payments Agency, 2020). Figure 1 and Table 1 below summarise the most recent data from 2019 for the project area.

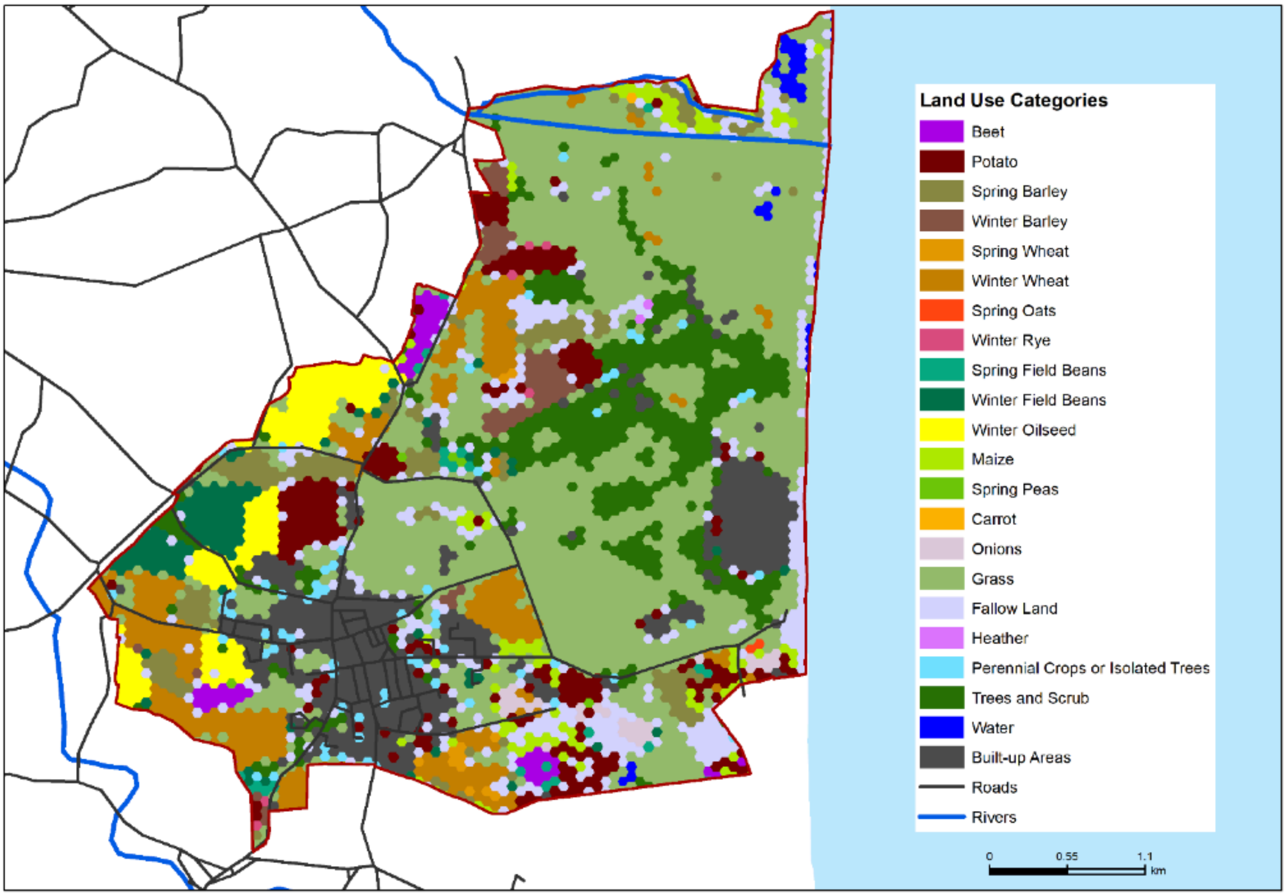

Figure 1: Crop and other land use information from CROME 2019 for the NZL project area.

Table 1. CROME 2019 crop and other land cover totals for the NZL project area.

Category	Hectares	Category	Hectares
Winter Wheat	139.0	Carrot	0.4
Spring Wheat	5.0	Onions	12.9
Winter Barley	27.6	Potato	96.7
Spring Barley	69.2	Maize	39.9
Winter Rye	2.5	Fallow Land	147.9
Spring Oats	0.8	Grass	697.1
Winter Oilseed	71.5	Heather	0.8
Winter Field Beans	44.6	Trees, Shrubs, Hedgerows	182.4
Spring Field Beans	8.8	Perennial Crops, Isolated Trees	26.2
Spring Peas	2.1	Built-Up or Sparsely Vegetated Land	193.7
Beet	21.0	Water	11.8

Most of the agricultural activity is associated with arable farming, primarily cereals, other combinable crops, potatoes, and other vegetables. A check using aerial imagery indicates that there are some areas of grass pasture, but no obvious evidence of large-scale poultry or pig sheds. This means that initiatives to reduce CO_2 emissions need to focus primarily on arable farming.

Assessing Current Agricultural CO_2 Emissions in the NZL Project Area

Carbon dioxide emissions estimates by local authority are published on an annual basis. Table 2 summarises data for the East Suffolk district for a number of years through to 2018. Several important points can be made from this table.

- Overall and per capita CO_2 emissions have declined over time.
- The decline in emissions has been particularly pronounced in the Industrial, Commercial and Domestic sectors.
- The contribution from Transport has been relatively stable and so has become proportionally more important over time.
- Emissions associated with Land Use, Land-Use Change and Forestry (LULUCF) can be positive or negative. On average, land uses such as Forestry and Grassland tend to sequester carbon, so reducing emissions, while Croplands are associated with an increase, though this depends on factors such as soil types and cultivation methods.
- Combining the Agriculture (E) and Cropland (O) categories in Table 2 represents 44.8 kt CO2 in 2018, some 4.2% of the East Suffolk total. If, say, a third of the grassland is attributed to agricultural activity then the net contribution would be closer to 3%.

East Suffolk is obviously much larger than the NZL project area, but the data in Table 2 provide useful context for estimating the importance of agriculture in this smaller area. The local authority summaries draw upon gridded datasets (1 km^2 resolution) which are available from the National Atmospheric Emissions Inventory (NAEI) website (https://naei.beis.gov.uk/data/map-uk-das) and details for Carbon Dioxide have been downloaded and a map of total emissions for 2018 is shown in Figure 3. The map highlights that grid cells with higher levels of CO_2 emissions are associated with larger urban centres or main roads. Few grid cells around Leiston have higher emissions on a district scale but using GIS software it is possible to extract and summarise the available data layers for 20 1 km^2 cells intersecting the boundary of the NZL project area. These details are shown in Table 3.

Table 2: Territorial CO_2 emissions estimates for East Suffolk 2005-2018 (kt CO_2)

Sector	2005	2010	2015	2017	2018	2018%
A. Industry and Commercial Electricity	384.8	331.8	229.2	163.6	149.1	14.1%
B. Industry and Commercial Gas	92.5	63.6	67.9	66.7	75.6	7.1%
C. Large Industrial Installations	0.1	0.0	0.0	0.0	0.0	0.0%
D. Industrial and Commercial Other Fuels	114.4	139.3	134.0	118.2	105.1	9.9%
E. Agriculture	27.5	22.6	21.9	22.5	22.4	2.1%
Industry and Commercial Total	**619.3**	**557.3**	**453.0**	**370.9**	**352.2**	33.3%
F. Domestic Electricity	289.8	262.8	171.8	122.3	110.4	10.4%
G. Domestic Gas	258.4	250.4	205.3	209.8	211.8	20.0%
H. Domestic 'Other Fuels'	62.4	66.3	49.2	48.5	48.5	4.6%
Domestic Total	**610.5**	**579.5**	**426.3**	**380.7**	**370.7**	35.0%
I. Road Transport (A roads)	250.8	217.6	226.6	239.5	236.0	22.3%
J. Road Transport (Motorways)	0.0	0.0	0.0	0.0	0.0	0.0%
K. Road Transport (Minor roads)	158.9	159.3	156.0	174.3	172.3	16.3%
L. Diesel Railways	7.2	7.2	7.5	7.1	5.9	0.6%
M. Transport Other	9.0	10.2	10.8	11.6	11.8	1.1%
Transport Total	**425.8**	**394.3**	**400.8**	**432.5**	**426.0**	40.3%
N. LULUCF Net Emissions: Forest	-106.1	-106.9	-102.2	-102.0	-101.3	-9.6%
O. LULUCF Net Emissions: Cropland	24.8	24.3	22.6	23.2	22.4	2.1%
P. LULUCF Net Emissions: Grassland	-21.0	-24.8	-29.1	-30.7	-31.3	-3.0%
Q. LULUCF Net Emissions: Wetlands	0.0	0.0	0.0	0.0	0.0	0.0%
R. LULUCF Net Emissions: Settlements	21.2	20.3	19.4	19.8	19.7	1.9%
S. LULUCF Net Emissions: Harvested Wood	0.0	0.0	0.0	0.0	0.0	0.0%
LULUCF Net Emissions	**-81.2**	**-87.1**	**-89.3**	-89.7	**-90.5**	-8.6%
Grand Total	**1,574.5**	**1,444.0**	**1,190.8**	**1,094.4**	**1,058.4**	100.0%
Population ('000s, mid-year estimate)	235.7	239.9	243.3	246.9	248.2	
Per Capita Emissions (t)	6.68	6.02	4.89	4.43	4.26	
Area (km^2)	1,294.8	1,294.8	1,294.8	1,294.8	1,294.8	
Emissions per km^2 (kt)	1.22	1.12	0.92	0.85	0.82	

Source: https://data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/emissions-of-carbon-dioxide-for-local-authority-areas

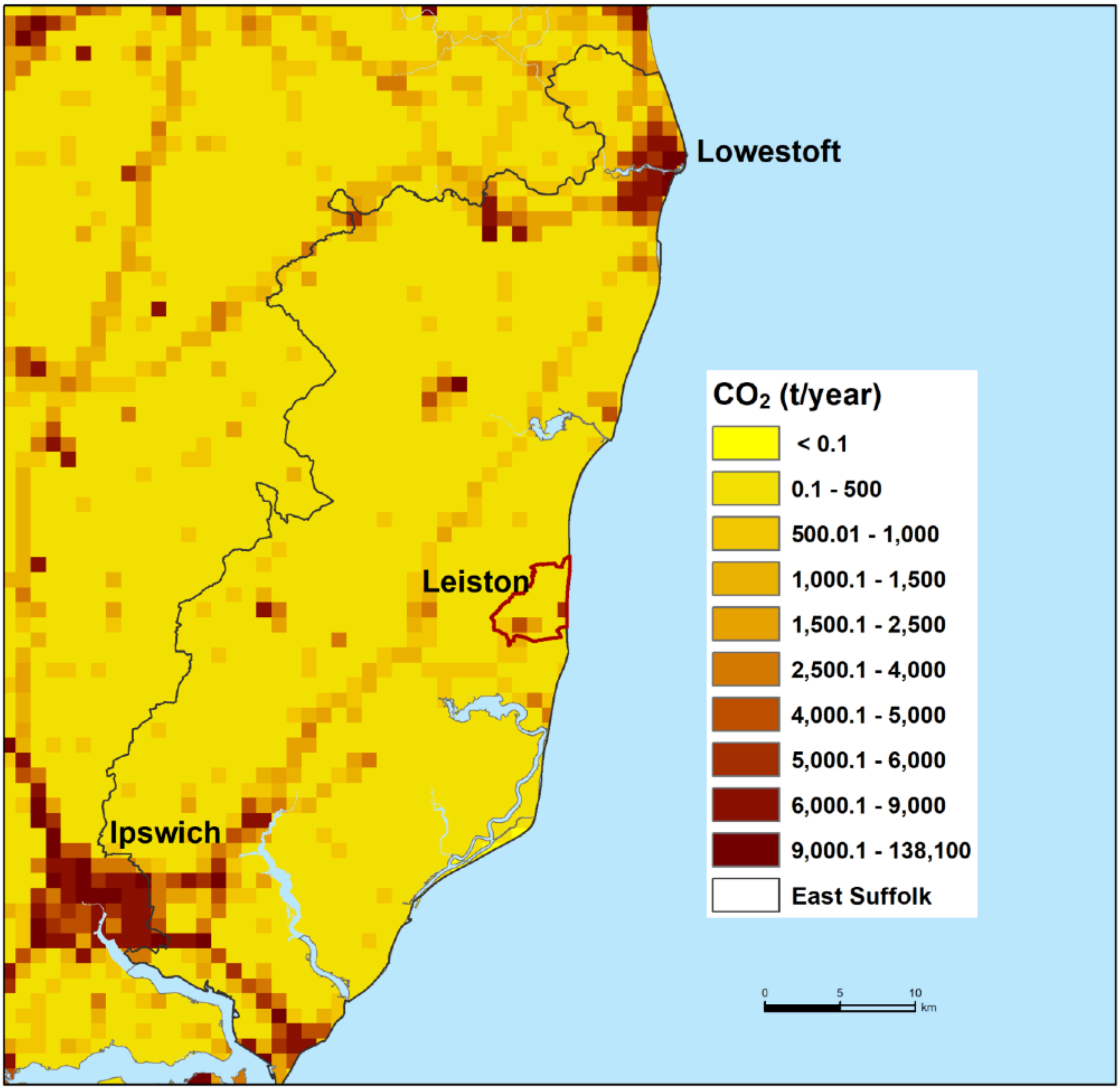

Figure 2: Estimated total CO_2 emissions in tonnes (area and point sources) in 2018 from NAEI gridded data.

The NAEI data units are tonnes of Carbon Dioxide as Carbon and have been converted to tonnes of CO_2 for presentation in Figure 2 and Table 3. They are also presented for CORINAIR sectors which, unfortunately, are not directly comparable with the categories used in the local authority estimates. It is also important to note that the grid cell format introduces an element of approximation in calculating totals for smaller geographical areas and, for instance, summing the values in Figure 2 within the East Suffolk boundary produces a total which is 15% less than that in the local authority statistics. At least some of this discrepancy is likely to be due to boundary effects around Ipswich.

Table 3 shows the results of the calculations for the NZL project area, with an estimate of 15,273 t CO_2 from all sources and 12,652 t CO_2 if point sources are excluded. Agricultural activities are split across two categories where, unfortunately, they are combined with other sources. However, based on the district proportions and totals in Table 2 it seems unlikely that agriculture could account for more than 300 t CO_2 of this total (2.5% of area sources or 2% of total emissions) and a figure close to 250 t CO_2 might be more realistic. In any respect, it is clear that the current net contribution of agriculture is very small compared to domestic or transport sources.

Table 3: Estimates of CO2 emissions for the NZL project area using NAEI gridded data.

CORINAIR Sector	CO_2 (t)	% of Total
Combustion in Commercial, Residential and Agriculture	6,344.4	41.5%
Combustion in Industry	1,938.9	12.7%
Road Transport	2,310.0	15.1%
Agriculture, Forestry and Land-Use Change	48.7	0.3%
Nature	27.1	0.2%
Total Area Sources (Sum of all Sectors)	12,652.4	82.8%
Total Emissions (Including Point Sources)	15,272.7	100.0%

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