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UTTOXETER NET ZERO CARBON FEASIBILITY STUDY

CARBON BASELINE, INTERVENTIONS AND RECOMMENDATIONS

JULY 2022

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THE GLOBE FOUNDATION

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JULY 2022

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1 ABBREVIATIONS

AD	Anaerobic Digestors
ASHP	Air Source Heat Pump
BAU	Business As Usual
CBM	Compressed Biomethane
CCC	Climate Change Committee
CCRA	Climate Change Risk Assessment
COP	United Nations' Conference of the Parties
CSE	Centre for Sustainable Energy
BEIS	Department for Business, Energy and Industrial Strategy
DEFRA	Department for Environment, Food and Rural Affairs
DHN	District Heat Network
DHW	Domestic Hot Water
DNO	Distribution Network Operator
EA	Environment Agency
EPC	Energy Performance Certificate
EU	European Union
EV	Electric Vehicle
EVCP	Electric Vehicle Charging Points
FIT	Feed-In-Tariff
GHG	Greenhouse Gas
GSHP	Ground Source Heat Pump
GVA	Gross Value Added
GWP	Global Warming Potential
HBS	Heat and Buildings Strategy
HGV	Heavy Goods Vehicle
IHA	International Hydropower Association
IPCC	Intergovernmental Panel on Climate Change
LGV	Light Goods Vehicle
LPG	Liquified Petroleum Gas
LTP	Local Transport Plan
LULUCF	Land Use, Land Use Change, and Forestry
NAP	National Adaptation Programme
NDC	Nationally Determined Contributions

NFU	**National Farmer's Union**
NPPF	**National Planning Policy Framework**
NPPG	**National Planning Practical Guidance**
NSIP	**Nationally Significant Infrastructure Project**
NZHF	**Net Zero Hydrogen Fund**
OFGEM	**Office of Gas and Electricity Markets**
PBCC	**Place Based Carbon Calculator**
PM	**Particulate Matter**
PV	**Photovoltaics**
RCP	**Regional Concentration Pathways**
RTPI	**Royal Town Planning Institute**
TCPA	**Town and Country Planning Association**
ULEV	**Ultra Low Emissions Vehicles**
VCA	**Vehicle Certification Agency**
WA	**Wardell Armstrong**
WCC	**Woodland Carbon Code**
WMO	**World Meteorological Organization**
WPC	**Western Power Distribution**
WWHR	**Waste Water Heat Recovery**
ZCB	**Zero Carbon Buildings**

2 DEFINITIONS

Selected definitions[1]	
Net Zero	Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period. Where multiple greenhouse gases are involved, the quantification of net zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon).
Carbon Neutral	Carbon neutrality means not adding new greenhouse gas (GHG) emissions to the atmosphere. Where emissions continue, they must be offset by absorbing an equivalent amount from the atmosphere, for example through carbon capture and reforestation that is supported by carbon credit schemes[2].
Renewables	Technologies that contribute to climate change mitigation by reducing emissions or enhancing greenhouse gas sequestration.
Global warming	In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.
Climate change	Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or

[1] All definitions taken from: IPCC, 2018: Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press

[2] BSI Group (2022) *PAS 2060 Carbon Neutrality.* Available from: https://www.bsigroup.com/en-GB/pas-2060-carbon-neutrality/ [Accessed 19 July 2022].

	external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.' The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes.
Adaptation	In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.
Resilience	The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation.

3 INTRODUCTION

3.1 Background

3.1.1 Wardell Armstrong (WA) was commissioned by The Globe Foundation to develop a feasibility study to establish a carbon baseline for the town of Uttoxeter and the surrounding area falling within the ST14 postcode and evaluate the likely viability of achieving a target to be carbon neutral by 2030 within that boundary.

3.1.2 The overall aim of the work was to evaluate what the current expected carbon footprint would be in 2030 with no further intervention, and then consider what level of intervention would be required to bridge the gap between those business-as-usual emissions at 2030 and the target of carbon neutrality. The study then evaluated what potential interventions might be possible and what scale of impact those interventions could plausibly have, in order to broadly inform future work to develop a local strategy to achieve the outcome.

3.1.3 Staffordshire County Council has committed to tackling climate change and improving energy efficiency, having declared a Climate Emergency in 2019. A summary of local climate change policies is presented in this report.

3.1.4 The Sustainable Uttoxeter project has developed ten Priority Themes. These are:

- Food & Agriculture
- Education & Awareness
- Health & Wellbeing
- Resource Management & Waste
- Transport
- Energy & Water
- Housing & Planning
- Biodiversity
- Community
- Industry & Tourism

3.2 Scope of Works

3.2.1 The evaluation considered energy use and the associate carbon emissions across the residential, agricultural, commercial, industrial, public and transport sectors within this geographic area, with a detailed review of current and emerging policies to assess how the target of becoming net zero by 2030 might be achieved.

3.2.2 The feasibility study quantifies the current energy and greenhouse gas (GHG) emissions and is presented in two parts; a baseline exercise to establish the current carbon footprint and the 'business as usual' (BAU) projected emissions, and a review of what interventions could be undertaken and projections for how these would impact the BAU trajectory.

3.2.3 The challenge of using the ST14 postcode area is that this is not commonly used for the purposes of statistical reporting. Typically, statistical reports are based on local government areas instead of postcode boundaries. For this reason, the first part of the study presents the methodology for establishing the carbon footprint. The forward projection is risk assessed because the projection is based on assumptions, such as the current circumstances remaining in effect up until the target date. This will then indicate the level of confidence in the projection, providing a guide as to how likely the projection will match reality.

3.3 Location and Environment

3.3.1 The ST14 postcode boundary includes the market town of Uttoxeter in addition to multiple villages. The ST14 boundary largely lies within the East Staffordshire District, with a small area in the Derbyshire Dales.

3.3.2 It covers an area of around 110 km^2 and is home to approximately 20,789 residents, according to data collected by the Centre for Sustainable Energy (CSE)3. The main town within the scope boundary is Uttoxeter, with smaller villages such as Denstone, Bramshall, Rocester, Stramshall and Marchington falling within the scope.

3.3.3 There are several significant organisations and attractions in the general area. Alton Towers is North West of Uttoxeter, but located just outside the scope boundary. HMP Dovegate is a prison to the East of Uttoxeter which falls within the scope boundary. The company JCB is headquartered North West of Uttoxeter, with the head office and several manufacturing facilities located within the study boundary. Uttoxeter has a racecourse to the East of the city. There is a quarry to the North operated by Aggregate Industries.

3.3.4 In addition to these larger facilities and organisations, there are numerous smaller business premises, education sites, churches, farms and other buildings. These are distributed throughout the area. Much of the scope area is rural in nature.

[3] Centre for Sustainable Energy & University of Exeter (2022) *Impact Tool Community Carbon Calculator*. Available from: https://impact-tool.org.uk/using-impact [Accessed 15 March 2022]

3.3.5 The landscape is largely dominated by agricultural land and improved grassland. There are no major rivers within the boundary. Smaller rivers include river Dove and river Tean.

3.3.6 Figure 1 shows the location of the study area in red within the context of the UK and region, while Figure 2 shows the location within the context of the West Midlands. Figure 3 defines the ST14 postcode area boundary which is the scope area for the study.

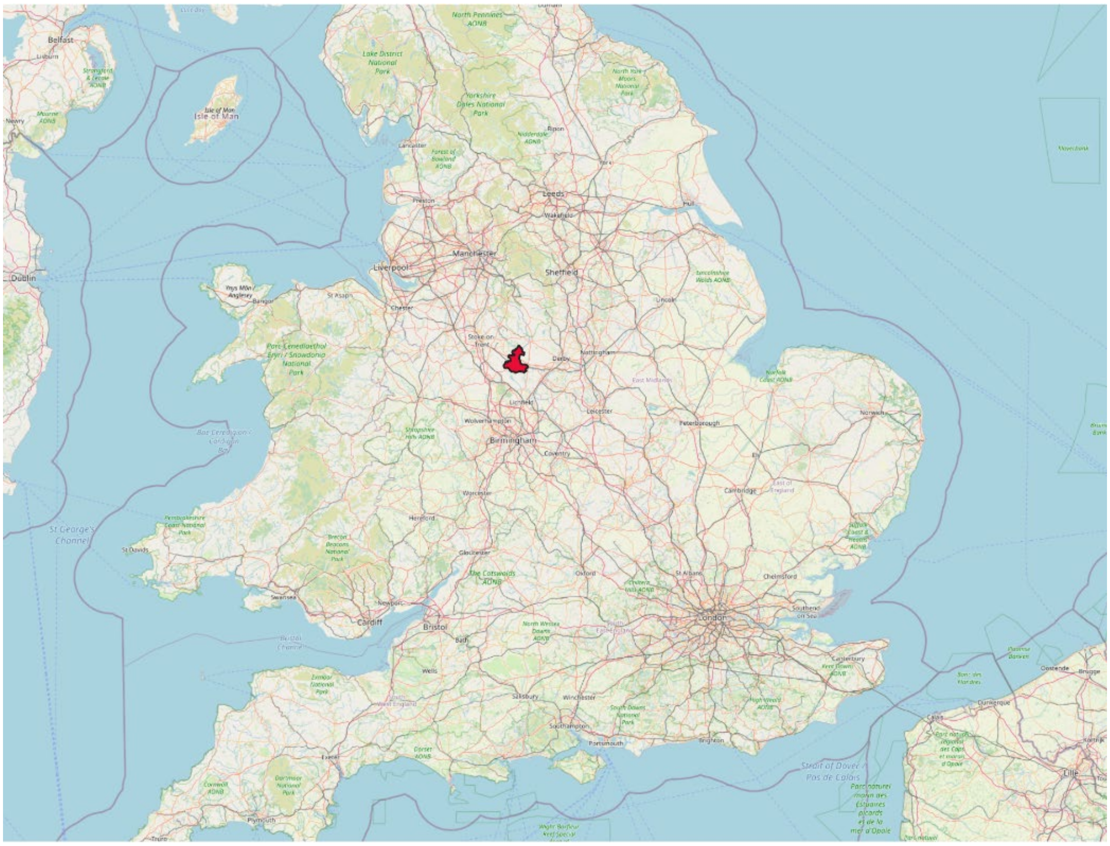

Figure 1 - Location of the ST14 area, located within the UK.

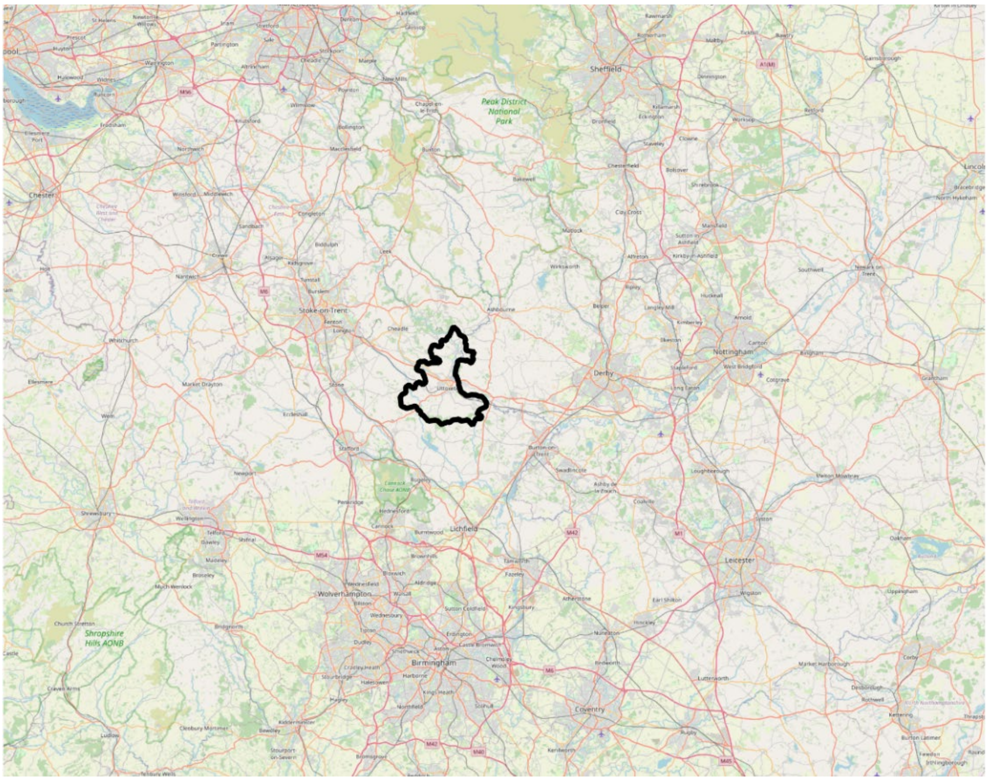

Figure 2 - Location of the ST14 area, located around Uttoxeter in the West Midlands

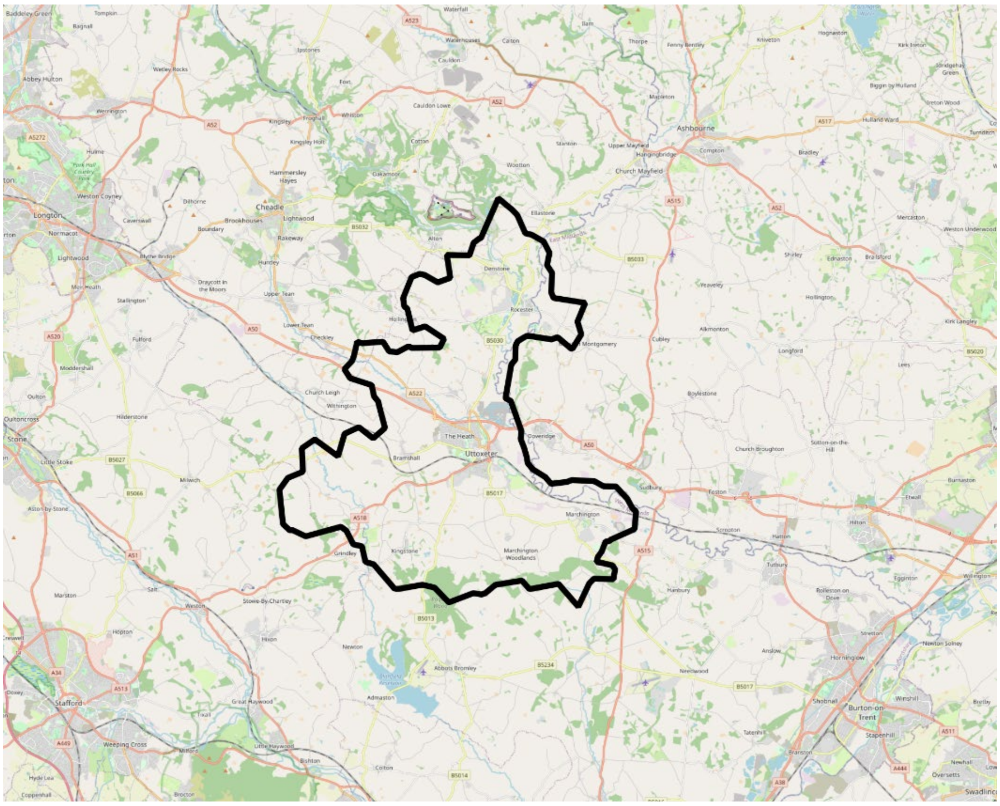

Figure 3 - Boundary of the ST14 study area

3.3.7 Two A roads cut through the study area, these are the A50 and the A518. There is a bus station which is owned by Staffordshire County Council and a railway station within Uttoxeter. The railway station is owned by National Rail and managed by East Midlands Railway.

3.4 Air Quality

3.4.1 The relationship between air quality and climate change is highly complex but is an important consideration due to the direct risk to human health[4]. For example, when atmospheric pressure increases, pollutants are concentrated to the ground, resulting in increased respiratory health issues. Climate variations across regions will affect air quality differently. Increased precipitation aids the clearing of pollutants from air, whilst warmer, drier conditions stalls air that is saturated in pollutants, e.g. smog. Higher temperatures associated with climate change can also lead to an increase in ozone, a harmful air pollutant[5]. The matter of air quality is not within the scope of this report, but it is noted that a move towards electric or hydrogen powered vehicles is likely to improve air quality in the urban areas.

3.5 Nitrogen Dioxide

3.5.1 Nitrogenous gases play an important role in global climate change and are a source of acid rain. Nitrogen Dioxide (NO2) is not classed as a greenhouse gas in itself, but it is a pollutant of concern as it contributes to the creation of ozone which is a particularly potent greenhouse gas. Therefore, NO2 emissions from transport and industry do impact on global warming. NO2 is harmful to humans, even in small quantities, and high concentrations can also reduce plant growth.

3.5.2 Data was not available for this study to assess the contribution of NO2 to the total emissions for the ST14 area, however a future strategy may look to identify processes that produce it in significant quantities and look to work with the process owner to find ways to reduce these emissions while decarbonising towards the 2030 target.

3.6 Ozone

3.6.1 Ozone (O3) has a very high initial GWP of about 1000. Over 20 years its GWP is reduced to 62-69 which is still high. The high GWP has a detrimental effect on the climate when O3 is formed in the wrong places through chemical interactions with other gases such as NO2. Ozone has a cooling effect in the stratosphere and protects from solar

[4] Air Quality Expert Group (2007) 'Air Quality and Climate Change: A UK Perspective.' Crown copyright, London.
[5] https://www.cdc.gov/climateandhealth/pubs/air-quality-final_508.pdf

radiation. Human activity is leading to a breakdown of stratospheric ozone and an increase in O3 levels closer to ground-level which has a global warming effect. Inhalation of ground-level O3 can cause severe respiratory problems.

3.6.2 Data was not available for this study to assess the contribution of Ozone to the total emissions for the ST14 area, however a future strategy may look to identify processes that produce ozone in significant quantities and look to work with the process owner to find ways to reduce these emissions while decarbonising towards the 2030 target.

3.7 Particulate Matter & Other Air Pollutants

3.7.1 Particulate matter (PM) are very small microscopic solid or liquid particles which are suspended in air (commonly soot (carbon), dust, or dirt), and affect air quality. PM are not gases and have no global warming potential, therefore, PM do not contribute to climate change. However, changes in climate will affect how PM is suspended in the air at any given moment in time. Particulates are not considered within the scope of this study.

3.7.2 There are other air pollutants that have an effect on climate change and human health which can be monitored by the national air quality objectives for the UK. These air pollutants include:

- Nitrous Oxide (N_2O), better known as laughing gas, is an especially potent greenhouse gas with a GWP of 300. It traps far more infrared radiation than both carbon dioxide (CO_2) and methane (CH_4). Prolonged exposure to N_2O can have health impacts, such as hypoxia.
- Sulphur Dioxide (SO_2) is not a greenhouse gas but when coupled with elemental carbon, it forms aerosols which could have a warming effect. SO_2 pollution is the main cause of acid rain which is harmful to ecosystems. In high concentrations, SO_2 affects the respiratory system, particularly lung function, and can also irritate the eyes.

3.8 Methane

3.8.1 Methane (CH_4) is also a powerful greenhouse gas which causes climate change, with a GWP of 28-36 over 100 years or 86 over 20 years. CH_4 is emitted by human activities such as leakage from natural gas systems, landfill sites, and the raising of livestock, as well as by natural sources such as wetlands.

3.8.2 Most human-caused methane emissions stem from three sectors – energy, agriculture and waste. At COP26 105 countries, including the UK, pledged to cut methane emissions by 30 %. The Global Methane Pledge commits signatories to reduce their overall emissions by 30 % by 2030, compared with 2020 levels. This initiative aims to tackle methane leaking from oil and gas wells pipelines and other fossil fuel infrastructure. Other sources come from animal farming and waste in landfill sites.

3.8.3 Domestic gas in the UK is mostly composed of CH_4 as it is the major constituent of the natural gas used for cooking and heating. In industry, CH_4 is used to refine petrochemicals and to produce products such as plastics, fertilisers, anti-freeze and fabrics.

3.8.4 This gas does not have a national air quality objective as it is subject to separate monitoring and control requirements for activities causing fugitive CH_4 emissions which could impact on both local air quality and national emissions reduction targets.

3.8.5 Agriculture, Forestry and Other Lange Use activities accounted for 44 % of methane emissions globally during 2007-2016[6]. Small shifts in diet choices, particularly away from beef, can make an impact globally. Both in terms of freeing up agricultural land and also reducing methane emissions. Two of the five priorities Staffordshire County Council have identified in their Climate Change Strategic Development Framework include waste and behaviour change and therefore it may be there is policy alignment to support objectives to reduce methane emissions by 2030.

[6] IPCC, 2019: Summary for Policymakers. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.- O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

4 METHODOLOGY AND APPROACH

4.1.1 The feasibility study is set out as a baseline exercise to establish a reference emissions total and an evaluation of the potential for achieving the carbon neutral target for 2030.

4.1.2 The approach to producing the baseline was to use existing data wherever possible to provide full coverage of the scope area. Primary data was obtained from some businesses to provide case studies. The ST14 postcode area includes a number of parishes for which carbon data is available from the CSE.

4.1.3 Postcodes were matched to parishes and where parishes overlapped the scope boundary an apportionment was made based on the percentage of the total area included in the scope boundary.

4.1.4 The total baseline figure was then compared with other footprints of UK areas as a sense-check.

4.1.5 The study is intended to provide a baseline footprint which is a snapshot of what has already happened. The baseline year for this study is 2018. In order to inform the development of delivery plans to achieve the carbon target it is necessary to forecast forward what the business as usual (BAU) emissions are expected to be without intervention. This is important to reflect existing planned changes and grid decarbonisation expectations. This forecasting was undertaken in dialogue with the client to capture any significant public domain plans that may impact on the carbon emissions.

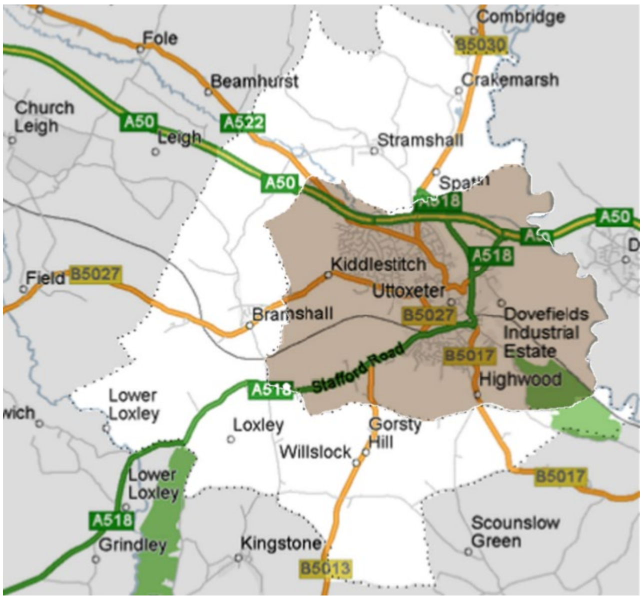

Figure 4 - Uttoxeter (shaded) and Uttoxeter Rural (white) parish areas

4.1.6 The assessment of climate change impacts will be carried out in accordance with the general principles contained within the following guidance:

- WBCSD and WRI, 2015. Greenhouse Gas Protocol – Community Scale Greenhouse Gas Emission Inventories;
- BEIS and DEFRA, 2019. Environmental Reporting Guidelines: Including streamlined energy and carbon reporting guidance;
    - IPCC, 2021: Sixth Assessment Report (AR6);
- The Met Office UK Climate Projections Models;
- 'Methodologies for the Assessment of Project GHG Emissions and Emission Variations: European Investment Bank, 2020'
- The Task Force on Climate-related Financial Disclosures Framework (2017).

4.2 Data Sources

4.2.1 The Impact Tool: Community Carbon Calculator was created by the CSE and Exeter University[7]. It shows levels of carbon emissions at various localised levels. The report provides two methodologies for counting emissions: the consumption-based carbon footprint and the territorial-based carbon footprint.

4.2.2 The consumption-based carbon footprint shows emissions produced from what people use within Uttoxeter. Such as gas, electricity, petrol, appliances, food and drink, clothes and financial services.

4.2.3 The territorial-based carbon footprint shows the emissions produced within the boundary of Uttoxeter. This includes emissions from the presence of roads or other transport systems, or local agriculture and manufacturing.

4.2.4 The tool uses modelled data, based on over 30 datasets. The datasets used within the tool and further detail on the methodology applied, can be found in the Impact Methodology Paper[8].

4.2.5 For the purpose of this study, the territorial approach is considered.

4.2.6 There are 670 postcode units in the ST14 district. Postcode areas were matched to parishes using 2011 Census data[9]. The parishes and the proportion of the total

[7] Centre for Sustainable Energy & University of Exeter (2022) *Impact Tool Community Carbon Calculator*. Available from: https://impact-tool.org.uk/using-impact [Accessed 15 March 2022].
[8] Centre for Sustainable Energy & University of Exeter (2022) *Impact Tool Method Paper.* Available from: https://impact-tool.org.uk/static/doc/Impact-methodology-paper-v1.7.pdf [Accessed 15 March 2022].
[9] Office for National Statistics (202) *Open Geography Portal.* Available from: https://geoportal.statistics.gov.uk/ [Accessed 01 April 2022].

emissions for each parish that were considered to be within the scope area are listed in Table 1.

Table 1- Parish emissions apportioned to the scope area

Parish	Apportionment
Uttoxeter	100.0%
Uttoxeter Rural	98.6%
Marchington	100.0%
Rocester	100.0%
Denstone	100.0%
Kingstone (East Staffordshire)	93.5%
Croxden	89.5%
Checkley	3.7%
Leigh (East Staffordshire)	7.4%
Abbots Bromley	3.5%
Marston Montgomery	18.8%
Stowe-by-Chartley	5.6%
Doveridge	1.8%

4.3 Exclusions and Caveats

4.3.1 The study is based on data collated by the Centre for Sustainable Energy (CSE) and was not gathered directly by WA, who take no responsibility for the accuracy of this data.

4.3.2 The emissions data used was for 2018. Emissions have been projected forward based on available information and the grid carbon factors for electricity. The impact of COVID since the data was collected, and the current and near-future impact of the war in Ukraine, may both have a profound impact on projections. Carbon factors may change due to the possible reintroduction of coal as part of national energy security measures, and overall emissions may reduce considerably due to a significant and prolonged economic downturn caused by a global recession, in part triggered by these twin economic shocks. Our projection is therefore valid only as an illustration of general trends and scale through implementing certain measures but is not intended as a prediction and no investment decision should be based solely on this study.

4.3.3 Very limited data was available for major commercial interests within the ST14 boundary. As such it has not been possible to validate or break down some elements of the data set to consider how these organisations might impact on emissions in any detail. Future work, ideally in partnership with these interests, may reveal significant scope to reduce carbon emissions.

4.3.4 The CSE data indicates that agriculture emissions are a key emissions segment. This report has not investigated these emissions in detail due to the complexities of the farming sector, the variation in emissions between farms of different types and the importance of working with farmers within an overall land management strategy that will support the farming economy while also delivering a range of natural services and other outcomes such as reduced pollution of waterways. Further work, ideally in partnership with the National Farmers Union (NFU), would engage with farms within the ST14 boundary to identify a roadmap tailored to the local area for delivering a range of benefits, one of which would be carbon reduction. The NFU have a national aspiration for farms to become net zero by 2040[10]

4.3.5 The CSE data indicates that transport emissions are also a key emissions segment. This report has intentionally avoided a detailed evaluation of road transport emissions due to the inevitable shift towards electrification of private vehicle transport, certain other light duty vehicles and public transport. The timescale of this is influenced strongly by factors that are beyond local control or influence, such as the cost of fuel, tax policies, availability and cost of electric vehicles and the shifting working patterns towards home working with reduced commuting travel. As such it is not possible to provide a representative indication of how transport emissions will change within the ST14 area to 2030, beyond a recognition that these are unlikely to substantially shift within this period due to the high capital cost of new vehicles and the current financial pressures on residents and businesses resulting from the current economic situation, which make substantial investments less likely.

4.3.6 Midlands Connect have designed a transport strategy which has a focus on decarbonising transport. Broadly, transport emissions will be dealt with a national level.

4.4 Emissions from Buildings

4.4.1 Buildings generated nearly 40 % of annual global CO_2 emissions in 2019, with building operations responsible for 28 % annually[11]. Since 2008, houses in the UK which are to be sold, rented, or are newly constructed, are required to get an Energy Performance Certificate (EPC) which are valid for up to 10 years.

4.4.2 An EPC measures the current energy efficiency of a property on a scale of A (most efficient) to G (least efficient). The energy performance is rated in terms of the energy

[10] National Farmers Union (2019) *Achieving Net Zero: Farming's 2040 Goal.* Available from: https://www.nfuonline.com/archive?treeid=137544 [Accessed 03 May 2022].

[11] United Nations Environment Programme, Global Alliance for Buildings and Construction, (2020). '2020 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector.' Nairobi.

use per square metre of floor area, with energy efficiency based on fuel costs, and environmental impact based on CO_2 emissions.

4.4.3 An EPC provides a range of energy indicators, such as whether the property would benefit in terms of upgrades to heating, insulation, lighting, glazing, etc. The EPC also provides the likely potential performance arising from the application of those improvement measures and associated notional costs for installation. Sometimes EPC ratings are given based on a number of assumptions according to the age of the property and building standards in place at the time it was built, so the energy efficiency should be taken with a bit of caution but is a useful guide.

4.4.4 The energy efficiency of the English housing stock has increased over the last decade, with the proportion of dwellings in the lowest energy efficiency bands F and G having fallen from 14 % in 2008 to 4 % 2018[12].

4.4.5 EPC data is used for the assessment of residential buildings in the scope area. The data coverage is noted as not being comprehensive, in that the number of EPCs is fewer than the total number of residential properties, and therefore the available data is extrapolated and assumed to be representative for all properties for which data is not available in order to achieve full coverage.

4.5 Characterisation of the housing stock in the ST14 scope area

4.5.1 According to the Electoral Register, the total number domestic properties within ST14 is 9,916.

4.5.2 EPC data was considered for certificates which were added to the EPC register between 2008 and December 2021.

4.5.3 The number of dwellings in each energy efficiency band is shown in **Table 2**.

4.5.4 According to data provided by East Staffordshire Council, the total number of EPCs for unique dwellings within the region is 5,844.

Table 2 - Properties in the ST14 area by EPC band

EPC Band	Number of properties
A	10
B	933
C	1,520
D	2,136
E	858

[12] Ministry of Housing, Communities & Local Government. National Statistics (2020) 'English Housing Survey: Energy efficiency, 2018-19'. Crown copyright, London.

Table 2 - Properties in the ST14 area by EPC band	
EPC Band	**Number of properties**
F	282
G	105
Total	5,844

4.6 Climate Risks to Businesses

4.6.1 Climate change is expected to have a number of impacts on end users and organisations and are expected to drive the need for adaptation. This can be expected to present opportunities and also risks, for example the emergence of new products and services which can create new lines of business, but also disruption of supply chains, changes to the cost model for operating some businesses and greater likelihood of significant fluctuations in labour and commodity availability, arising from global events and responses to a changing climate.

4.6.2 In the latest UK Business Sector Briefing for Climate Change Risk[13], the top climate risks to UK businesses needing additional action in the next five years were identified as being:

i) the risk of flooding and extreme weather events;
ii) the risks from disruption of supply chains and distribution networks; and
iii) the risk of climate change outside the UK that affects UK businesses through investment, supply chains, distribution networks, and other business relationships.

4.6.3 An impact assessment for these climate risks on the studied area is beyond the scope of the report, however it is noted that these events may introduce a wider error into any forecast of emissions, even to 2030. It is assumed that, while these issues will emerge there will also be countering activities to mitigate some or all of the impacts at least in the short term. As such, this is not considered as a key factor in forecasting emissions forward to 2030. However, any strategy that is implemented should consider whether and how to best reflect this issue.

4.7 Estimating Baseline Emissions - Scopes

4.7.1 There are several greenhouse gases including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Different greenhouse gases have different levels of impact on the climate. It is standard practice to report GHG emissions in terms of CO_2 equivalent (CO_2e). This is a universal metric used to measure and compare the emissions from

[13] Surminski, S. (2021) Business and industry. In: The Third UK Climate Change Risk Assessment Technical Report [Betts, R.A., Haward, A.B. and Pearson, K.V. (eds.)]. Prepared for the Climate Change Committee, London.

various GHG on the basis of their global-warming potential (GWP). GWP is a measure of the amount of infrared radiation captured by a gas in comparison to an equivalent mass of CO_2 over a fixed lifetime. The amounts of other GHG are converted to the equivalent amount of CO_2 with the same GWP to give CO_2e. Throughout this report, the term 'emissions' is used to refer to CO_2e unless explicitly stated otherwise.

4.7.2 The baseline for ST14 will be established by estimating the existing levels of greenhouse gas (GHG) emissions. There are two types of study – Consumption and Territorial. For Consumption studies emissions are divided into 3 Scopes according the GHG Protocol as illustrated in Figure 5. These reflect the emissions under the direct control of the organisation consuming the energy, or undertaking the activity, that produces the emissions (Scope 1 and 2) and the emissions of the supply chain for that organisation which may fall outside its direct operational control (Scope 3).

4.7.3 Direct GHG emissions (also termed as 'Scope 1 emissions') include emissions that occur from sources that are owned or controlled by the organisation, for example, emissions from boilers, furnaces, vehicles, and emissions from production in facilities or equipment.

4.7.4 Indirect GHG emissions (also termed as 'Scope 2 emissions') accounts for GHG emissions from the generation of purchased or acquired electricity, steam, heat or cooling consumed by the organisation. In this instance it will generally refer to purchased electricity, which is defined as electricity that is purchased or otherwise brought into the organisational boundary of the reporting company.

4.7.5 Indirect GHG emissions occurring within the Supply Chain (also termed as 'Scope 3 emissions') are a consequence of the activities of an organisation but are not owned or controlled by that organisation. This includes upstream and downstream emissions such as those associated with the production of fuels, the transport movements of goods and services, workers, supply chain and visitors to the city.

4.7.6 Similarly, the GHG Protocol provide a GHG accounting standard for community or city level. These three scopes can be seen in Table 3.

Table 3 - Definition of GHG accounting scopes

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking places within the city boundary

4.7.7 This study is based on a Territorial approach. In a Territorial study all emissions that arise within the geographical boundary of the study are included, irrespective of which scope they might fall in.

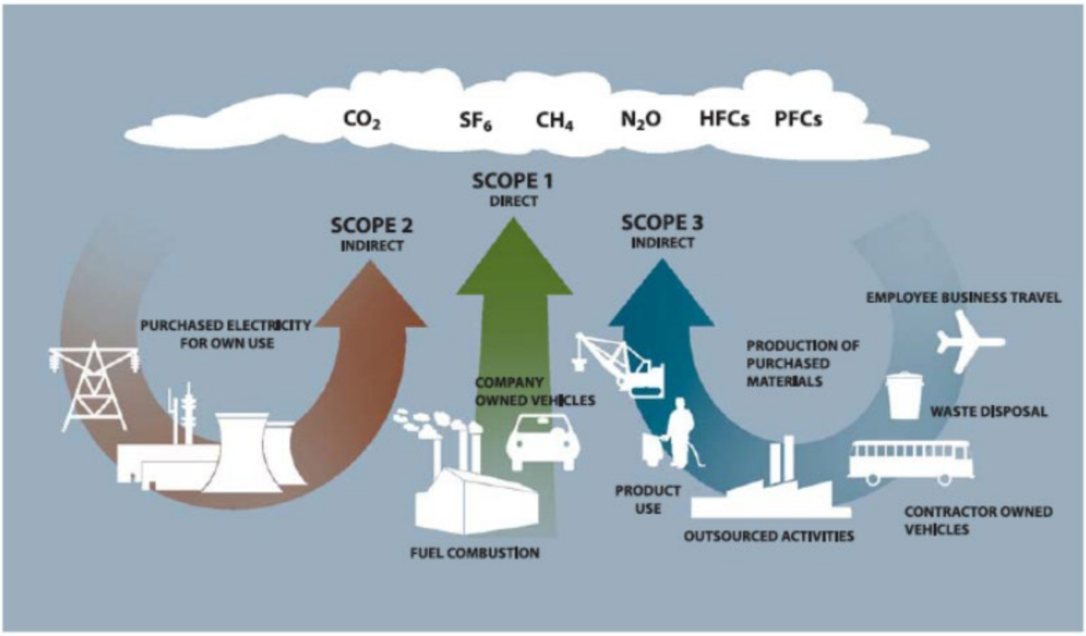

Figure 5 - Sources of GHG Emissions and Emissions Categories (Source: GHG Protocol)

4.7.8 Where emissions data are not directly available, they are calculated from activity data and emission factors. Activity data can be given in units of energy consumed, volume of fuel consumed, distance travelled, mass of material, etc. Emission factors are generally given in mass of CO_2e per corresponding unit. Emissions are calculated using the following formula:

$$\textbf{GHG Emissions} = \textbf{Activity Data} \times \textbf{Emission Factor}$$

4.7.9 Activity data have been obtained from UK government public databases. Transport data (i.e., vehicle distances) are published by the Department for Transport.

4.7.10 Emission conversion factors are also published annually by BEIS and DEFRA. It is standard industry practice to use the conversion factors for the year which corresponds to the year the data was reported for (e.g., 2019 data will use 2019 conversion factors, etc.). In the case of commercial transport vehicles where the emission factors depend on the mass of load transported, those for average loads have been used.

4.8 Data Limitations

4.8.1 Wardell Armstrong accepts no responsibility for inaccuracies in third-party data. The calculations within the assessment are based on the information supplied by the City Council at the time of assessment, as well as publicly available datasets.

4.8.2 According to the IPCC's 2018 Special Report on Global Warming of 1.5°C[14], there is high confidence that climate-related risks for natural and human systems depend on the magnitude and rate of warming, geographic location, levels of development and vulnerability, and on the choices and implementation of adaptation and mitigation options. The report states:

"Pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (high confidence). These systems transitions are unprecedented in terms of scale, but not necessarily in terms of speed, and imply deep emissions reductions in all sectors, a wide portfolio of mitigation options and a significant upscaling of investments in those options (medium confidence)."

4.8.3 Measures can be implemented to reduce any impacts and increase climate resilience according to global and regional climate projections. However, the uncertainties associated with probabilistic climate projections cannot be fully mitigated against. Intelligent design, preparation, and responsible construction can help to minimise future risks. A whole systems approach should be adopted, with all new planning proposals to consider climate adaptation and mitigation throughout.

[14] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

4.9 Assessing the Interventions

4.9.1 Consideration was given to the scope of interventions which would be appropriate to decarbonising ST14. These key approaches were agreed with The Globe Foundation in advance of this study.

4.9.2 These interventions fall into three categories:

- Heat Pumps
- Domestic Solar PV
- Hydro Schemes

4.9.3 In addition, it was recognised that heat pumps work best in well insulated buildings. Therefore, an intervention focussed on improving energy efficiency within homes was also assessed.

4.9.4 The impacts from these interventions were positioned within likely mitigation pathways. In all scenarios residual emissions occur in 2030. To achieve a net zero target, a level of GHG removal would be required. The final intervention assesses the natural capital of ST14 and its ability to sequester carbon to balance residual emissions.

4.9.5 The method for assessing each was based on available data and typical arrangements for similar settings. A more forensic study would be required to refine the assumptions and increase the confidence level for the forecasts through investing resources to capture large data sets for properties in the study area, user behaviours and other details, in order to feed into a consumption model. This level of detail was outside the scope of the study; however the study provides a representative indication of the likely impact that each of the interventions could make.

4.10 Heat Pump Impact Assessment Methodology

4.10.1 The study sought to identify how applicable heat pump technology would likely be to buildings within the study area and assess the likely carbon emissions that could be avoided by switching to heat pumps. In order to do this several assumptions were made. The study area is a mixture of urban and rural and some properties are known to be off the gas grid and use oil or LPG.

4.10.2 Data was available for the primary heating system for each property using the EPC data. Properties were assessed for suitability for fitting heat pumps. It was recognised that properties with existing wet heating systems would be easier and cheaper to fit with heat pumps. Electric heating systems would require a new wet system to be fitted would therefore be more costly.

4.10.3 It was assumed that all buildings using a wet heating system would convert to a heat pump solution. More assessment would be required to consider sites where this may be constrained due to heritage designations, lack of internal or external space for equipment, or for other reasons.

4.11 Solar PV Impact Assessment Methodology

4.11.1 Roof-mounted solar is a relatively straightforward approach for delivering renewable energy. It requires a roof that is not North facing due to the light availability at the latitude of the study area and ideally the solar array would not be shaded by trees, buildings or terrain throughout the day.

4.11.2 For the purposes of estimating the impact of deploying solar PV two 100-house samples were taken and visually assessed from an aerial viewpoint. Houses were assessed for whether they had South facing pitched roofs or if they were East of West facing. Any houses with existing solar PV were also counted.

4.11.3 Flat roofs were included in the South facing percentage due to the ability to mount the PV on frames angled in the preferred direction. In practice it may be that some flat rooftops would be unsuitable for PV due to limitations arising from shading of nearby structures or other restrictions, however it is likely that most flat roof areas could accommodate some PV, albeit performing less well than theoretically possible. In those cases, they would likely perform closer to East-West solutions.

4.11.4 The total capacity for PV across the study area was calculated by taking the number of buildings of each type, applying a reduction to account for the number of viable buildings likely, then multiplying this by the likely capacity of PV that could be applied to a typical building of that type. The electrical infrastructure within the building, roof structure and planning considerations are all relevant in the deployment of PV and would need to be confirmed case by case prior to deployment.

4.11.5 Two areas were assessed using satellite imagery to validate the figures against the ST14 area. The buildings were identified and categorised within these areas and the roof areas were assessed for orientation to determine their potential capacity. The red line boundary of the two sample areas are shown in Figure 6 and Figure 7.

Figure 6 - First area evaluated for prospective roof mounted PV deployment

Figure 7 - Second area evaluated for prospective roof mounted PV deployment

4.12 Hydro Impact Assessment Methodology

4.12.1 The river Dove was considered for a hydro scheme. The methodology used to assess prospective opportunities considered proximity to potential offtakers, existing river features such as weirs and locations where there is a consolidation of waterways to maximise potential flow.

4.12.2 A location identified was on the river Dove. The dropped pin can be seen in the Northeast of the map in Figure 8.

Figure 8 - Location of potential site for the hydro scheme

4.12.3 The available head was approximately <0.5m at the sawtooth weir. Average annual flow rates for the Dove were 8m^3S^{-1} according to the data provided by DEFRA[15].

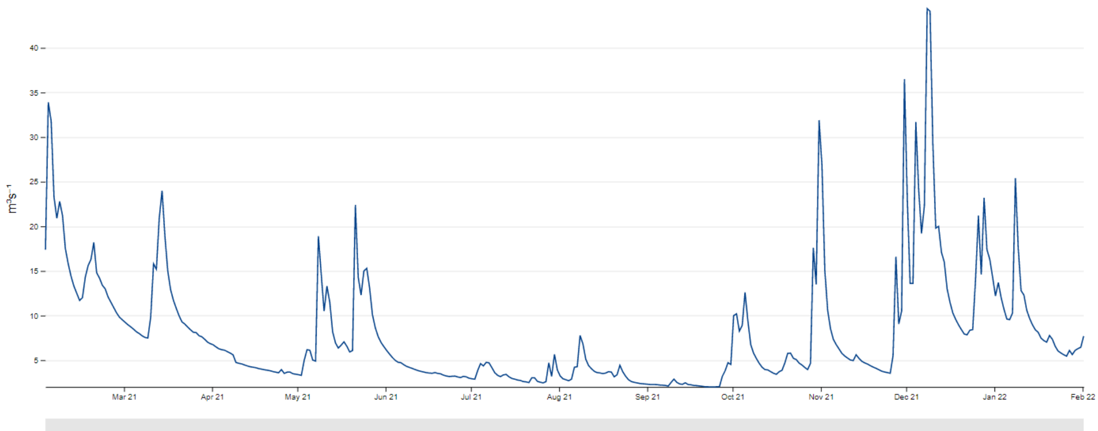

Figure 9- Flow rates at river Dove Rocester monitoring site

4.12.4 The initial assessment of the concept of river hydro on the Dove near Uttoxeter appears to indicate very high variability in the flow rates and a typical flow rate from April to October that is very low. The river is also understood to be prone to flooding and limited potential offtakers were identified close to the river who would receive the energy generated. The amount of water available to be used in the river hydro

[15] DEFRA (2022) *Rocester Dove.* Available from: http://environment.data.gov.uk/hydrology/station/d173a23d-0450-4ca0-8aae-0524490e9d75 [Accessed 16 Marsh 2022].

scheme would be limited by the Environment Agency. The outcome would likely result in minimal electricity generation during summer months. This would impact the economic viability of a river hydro scheme.

4.12.5 The next steps might be to consider identifying an enthusiast, or suitable community group, to undertake a feasibility study over a period of 12-24 months at a specific site to explore whether the river would support a low cost hydro project producing a small amount of power for a single adjacent facility. Some community groups such as Salisbury Community Energy based in Wiltshire have experience of evaluating such projects and could be contacted by a local group to provide insight and potentially provide some general support to any local initiative.

4.12.6 The limiting factors for deployment of hydroelectric power are expected to be location and the quality of the financial case, rather than the availability of materials or solution providers to service the demand.

4.12.7 River hydro projects have been deployed at various scales across the UK and elsewhere in the world. A detailed review of such projects is beyond the scope of this report, however it is helpful to consider some small scale river hydro projects that operate with either low head or low flow rates. It is noted that hydro projects operating with low flow and low head are extremely rare due to the poor performance of the project and tend to not be commercial investment projects. **Table 4** shows some river hydro case studies[16].

Table 4 - Example river hydro projects (UK and Ireland)

Case study	Details
Carncarin Hydro	• Archimedes Screw • Turbine Rating: 20kW • Gross head: 5.7 meters • Maximum flow: 538 litres / second
Ballievey Hydro	• Archimedes Screw • Turbine Rating: 34 kW • Gross head: 1.45 meters • Maximum flow: 3,100 litres / second
Whitehill Hydro	• Archimedes Screw • Turbine Rating: 54 kW

[16] Hydro NI (2022) *Case Studies*. Available from: http://www.hydroni.co.uk/Case%20Studies.html [Accessed 04 February 2022].

	• Gross head: 2.8 meters • Maximum flow: 2,800 litres / second
MaryBrook Hydro	• Crossflow Turbine • Turbine Rating: 60kW • Gross head: 5.6 meters • Maximum flow: 1540 litres / second

4.12.8 A river hydro project will be most likely to succeed where it is located close to a continuous electrical load, on a watercourse that has either high flow, high head, or ideally both. The River Dove does not appear to have a significant head or flow rate and a review of the course of the River indicates that there is currently limited scope for continuous power offtake. Dovegate Prison may represent a potential offtaker, however the river Dove around Dovegate appears to remain very flat which would lack substantial head needed for a feasible hydro scheme.

4.12.9 It may be technically viable to install a micro power project at the weir close to the quarry, near Uttoxeter. A detailed assessment of the river and any potential generation project would be required in order to determine the likely potential of such a project with accuracy, however it is considered that any technology approach in this setting would be likely to yield less than perhaps 10 kWe average output. Assuming an offtaker were available close to the project able to accept 100% of the generated electricity and this displaced grid electricity then the carbon saving to 2050 is expected to be in the order of 500 tCO_2e, allowing for expected grid decarbonisation. It is noted that the bridge may be of historical significance and a construction project close to it may not be acceptable. It is also noted that the area is a flood risk, and the river dynamics would need to be understood within a detailed feasibility study specifically assessing the engineering and planning aspects of such a project. Detailed engagement with the Environment Agency is recommended in order to assess the potential scope for such a project.

4.12.10 The farm close to this location may be able to accept a continuous supply of 10 kW, especially if refrigeration equipment is in use. The farm could use the electricity coupled with battery storage in order to maximise the usage, however this would increase the overall project cost and complexity. The commercial viability of the project will depend enormously on the capital cost of the project and implementing it in such a way that it requires very little ongoing maintenance and is at minimal risk of damage from river flooding events, especially as climate change is expected to drive an increase of such events going forward.

4.12.11 Table 5 shows the average flow rates needed for a range of heads. [17]

Table 5 - River hydro indicative power outputs versus river head

	Maximum Power Output (kW)				
	5	10	25	50	100
Head (m)	Flow required (m^3/sec)				
2	0.340	0.680	1.699	3.398	6.796
5	0.136	0.272	0.680	1.359	2.718
10	0.068	0.136	0.340	0.680	1.359
50	0.014	0.027	0.070	0.136	0.272
100	0.006	0.014	0.034	0.068	0.136

4.12.12 Hydro is quite difficult to make generalisations about costs. However, Table 6 can be used as a guide.[18]

[17] Renewables First (2022) Head and flow detailed review. Available from: https://www.renewablesfirst.co.uk/hydropower/hydropower-learning-centre/head-and-flow-detailed-review/ [Accessed 04 February 2022].
[18] Renewables First (2022) *How much does a hydropower system cost to build?* Available from: https://www.renewablesfirst.co.uk/hydropower/hydropower-learning-centre/how-much-do-hydropower-systems-cost-to-build/ [Accessed 09 February 2022].

Table 6 - Hydro scheme indicative capital cost

Maximum Power Output	Estimated Project Cost	£ / kW installed
25 kW	£169k	£6.8k
50 kW	£300k	£6.0k
100 kW	£529k	£5.3k
250 kW	£963k	£3.8k
500 kW	£1.6M	£3.2k

4.13 Local initiative

4.13.1 Zero Carbon Rugeley is a project lead by Engie Services integrating an affordable low carbon energy system for the future. Focusing on 3 key principles; economic, social, and environmental sustainability. The project features a smart local energy system (SLES) that includes 2300 homes, implementing the latest renewable energy technologies and smart control systems. This creates a scalable solution in support of the UKs transition to a zero-carbon future making it affordable for residents, mobility, retrofits and generation.[19].

4.13.2 This project involves a range of "*community gatekeepers*" including Cannock Chase District Council, Rugely Town Council, Rugeley Community Centre and Keele University.

4.13.3 The project aims to involve renewable energy generation and storage at scale on the former Rugeley Power Plant site to balance local energy demand.

4.13.4 This capability would allow the town to benefit from a smart local energy system. This will allow Rugeley to transition to a low carbon town[20].

[19] Rugeleypower.com. 2021. *Zero Carbon Rugeley project – Rugeley Power Ltd*. [online] Available at: <http://www.rugeleypower.com/zero-carbon-rugeley-project> [Accessed 7 July 2022].
[20] UKRI (2022) *Zero Carbon Rugley: A major new development as a catalyst for a town wide smart local energy system.* Available from: https://gtr.ukri.org/projects?ref=105844 [Accessed 20 July 2022].

SECTION ONE

Establishing a baseline

5 ASSETS AND INFRASTRUCTURE IN THE SCOPE AREA

5.1 Existing Grid Network

5.1.1 Western Power Distribution (WPD) are the Distribution Network Operator (DNO) responsible for maintaining the electricity network infrastructure for ST14. The area currently has four substations. As indicated in Figure 10[21], the substation at Rocester, Uttoxeter and Church Street are all marked green for being suitable for energy generation. Marchington is categorised as red to indicate is not suitable to be connected with energy generation.

Figure 10 - Location of Substations in ST14 and Network Capacity Status

[21] Western Power Distribution. *Network Capacity Map.* Available from: https://www.westernpower.co.uk/our-network/network-capacity-map-application [Accessed 17 March 2022].

5.2 Battery Storage

5.2.1 National Grid ESO[22] indicates that energy storage could help manage constraints on the electricity transmission network between 2022 to 2030. As the electricity system decarbonises, constraints costs are expected to rise significantly between now and 2030. This is because renewable generation connects faster than new transmission capacity can be built. After 2030, planned increases in transmission network capacity are expected to significantly reduce the level of constraints.

5.2.2 According to Wadia *et al*. (2011)[23], batteries have great promise for facilitating the grid integration of renewable energy and powering electric vehicles. High costs of implementation currently remain a critical barrier to the widespread scale-up of battery energy storage. Enabling facilities for local battery storage to capture renewable energy generation will help the city to be more resilient to future climate.

5.2.3 The national planning legislation for NSIPs was relaxed in 2020, allowing for battery storage projects above 50 MW in England (and 350 MW in Wales) to proceed without approval through the national planning regime. Development proposals that include battery storage would need to be discussed on a case by case basis with the Distribution Network Operator (DNO) to ensure viability of connection to the national grid, or the creation of local micro grid networks.

5.3 Hydropower

5.3.1 To create hydroelectric power, generators are driven by turbines that convert the potential energy of falling or fast-flowing water into mechanical energy which is then converted into electricity. A suitable body of water is required that has suitable flow rates to produce a significant amount of energy.

5.3.2 The proportion of electricity generated by hydropower over the past 30 years has remained at around 2 % of total power generation in UK. According to a recent report by the International Hydropower Association (IHA)[24], the UK has a total hydropower installed capacity of over 4,700 MW. This includes over 2,800 MW of pumped storage.

[22] https://www.nationalgrideso.com/news/how-could-energy-storage-help-manage-constraints [Accessed August 2021]

[23] Wadia, Cyrus & Albertus, Paul & Srinivasan, Venkat. (2011). 'Resource constraints on the battery energy storage potential for grid and transportation applications.' Journal of Power Sources. 196. 1593-1598. 10.1016/j.jpowsour.2010.08.056.

[24] International Hydropower Association (2021). '2021 Hydropower Status Report Sector trends and insights.' IHA, London.

The majority of installed capacity is currently located in the wet and mountainous regions of Wales and northwest Scotland.

5.3.3 Hydropower supports the development of the UK's variable renewable sector by providing peaking, balancing and other grid services. The IHA describes how small-scale hydropower projects, including community-led projects, are being developed across the UK. Innovations in small hydropower turbines have allowed for some hydropower to be applied at sites with very low heads and low flows. This is the case in the neighbouring areas of Stafford and Staffordshire Moorlands. Staffordshire Moorlands has two FiT registered domestic hydropower facilities with a combined installed capacity of 14.75 MW, while Stafford has one with installed capacity of only 2.76 MW[25].

5.3.4 We have not had data for any hydropower projects in the ST14 area and we are unaware of existing projects.

5.3.5 A comprehensive evaluation of the opportunity would require design input from a qualified river hydro engineer, however based on the available information it appears unlikely that a viable and low-risk scheme could be implemented that would have a measurable and significant impact on the carbon emission footprint of the scope area. As such it is not considered further in this feasibility study, albeit that this exclusion does not mean that a small scale hydro project is not theoretically possible. The investment risk would seem to be high at the likely scale of such a venture.

5.4 District Heating Networks

5.4.1 As defined by the UK Government, a District Heating Network (DHN) supplies heat from a central source to consumers, via a network of underground pipes carrying hot water. Heat networks can cover a large area or even an entire city, or be fairly local supplying a small cluster of buildings. This avoids the need for individual boilers or electric heaters in every building. Heat networks form an important part of the UK Government's plan to reduce carbon and cut heating bills for both domestic and commercial customers. Currently, just over 2% of buildings heat in the UK is served by DHNs. The CCC estimates that around 18% of UK heat will need to come from heat networks by 2050 if the UK is to meet its carbon targets cost effectively[26].

[25] OFGEM (2021). 'Feed-in Tariff Installation Report (01 April 2010 - 31 March 2021) - Part 1.' OFGEM, London.
[26] Department for Business, Energy & Industrial Strategy (2018) 'What is a heat network?'

5.4.2 We have not had data for any district heating projects currently in use within the ST14 boundary and our understanding is that there is no significant district heating in operation. District heating functions where there is a substantial heating (or cooling) load that is collocated in an area, for example in a town, industrial or retail park, a setting such as a science or University campus, or equivalent. Historically such heating systems have been fuelled by natural gas, but it may be possible to look at alternative heat sources into the future on a case by case basis.

5.5 Photovoltaics

5.5.1 Solar PV technology collects and converts solar radiation directly into electricity. The use of PV arrays can displace the requirements for grid electric and can be used for lighting, ventilation systems, EV charging and other electrical appliances. There are numerous solar PV panels available in a range of sizes and efficiencies.

5.5.2 Solar PV technology is commercially proven and large multi-megawatt generating plants (Solar Farms) have been operating since the 1990s. Capital costs associated with PV are relatively high but are continually falling. The technology is well-known and reliable as a source of renewable energy generation.

5.5.3 As the UK moves towards net zero emissions it must ensure that the infrastructure needed for decarbonisation of the national grid is in place, to enable effective adaptation and mitigation for climate change. Large-scale infrastructure projects, including renewable energy generation projects above 50 MW, are classed as Nationally Significant Infrastructure Projects (NSIP). Decisions regarding applications for NSIP are not determined by the Local Planning Authority, as these are required to be examined by the Planning Inspectorate.

5.5.4 Large plants are based either on fixed solar panels inclined at a latitude related angle, or tracker systems that move either horizontally, vertically or both ways in order to maximise the sunlight received. Fixed systems are more widely available, easier to maintain, have a limited environmental impact and can easily be removed from the site. Commercial/non-domestic and domestic roof mounted PV can be deployed parallel to the roof surface on pitched roofs, or at an angle on flat roofs, to improve the solar energy captured. Ground-mounted PV arrays, and innovations such as solar canopies, can also be deployed at suitable locations.

5.5.5 The Feed-in Tariffs (FIT) scheme was a government programme which was introduced in 2010 and closed to new applicants in 2019. It was designed to promote the uptake of renewable and low-carbon electricity generation technologies. The scheme is overseen by the Office of Gas and Electricity Markets (OFGEM), the independent national regulatory authority for energy in the UK.

5.6 Solar Thermal

5.6.1 Solar thermal devices use solar radiation to generate hot water but generally compete with solar PV for roof space. The Renewable Energy Hub UK[27] states that an average UK household requires between 3000 kWh-5000 kWh worth of water heating annually. Solar thermal systems are not able to produce all of a property's hot water demand but may provide between 40 % and 60 %. Solar PV installations can be fitted with a diverter system so that zero carbon hot water can be provided to the premises as well as electricity. There was limited data available to present a clear picture of solar thermal deployment in ST14.

5.7 Energy from Waste

5.7.1 According to the UK Government[28], energy from residual waste is a partially renewable energy source, sometimes referred to as a low carbon energy source. However, changes in waste composition could drive EfW impacts above those of a traditional landfill, leading to increases in emissions from which will adversely impact on climate change. A standard approach for comparing the climate change impacts of different energy generation technologies is to refer to carbon intensity - the amount of carbon by weight emitted per unit of energy consumed (CO_2/energy). Lower impact (greener) electricity sources have lower carbon intensity.

5.7.2 Results from a recent technical report by Zero Waste Scotland[29] show that the carbon intensity of EfW plants is twice as high as the national grid average. This is why there is debate about referring to EfW as a low carbon technology in the UK. In the Sixth Carbon Budget for UK emissions[30], the CCC stress that rising emissions from EfW need to be carefully managed and carbon capture and storage utilised to limit any adverse impacts on climate change.

[27] The Renewable Energy Hub UK "Is Solar Thermal Worth The Investment?". Available at: https://www.renewableenergyhub.co.uk/main/solar-thermal-information/is-solar-thermal-worth-the-investment/ [Accessed 30/03/2021].
[28] HM Government. Department for Environment, Food, and Rural Affairs (DEFRA) (2014) 'Energy from waste: A guide to the debate.' Crown Copyright, London.
[29] Zero Waste Scotland (2020) 'The climate change impacts of burning municipal waste in Scotland'. Scotland.
[30] Committee on Climate Change (CCC) (2020) 'The Sixth Carbon Budget: Waste' CCC, London.

5.8 Significant Users

5.8.1 There are several very significant energy users within the scope boundary. These include HMP Dovegate and JCB for example.

5.8.2 Whilst JCB have published their emission reduction targets in their global environmental sustainability strategy, they have not released the amount of emissions they are responsible for. They are developing a roadmap including Scope 3 targets which they aim to publish in 2023. They have targets to reduce emissions across Scopes 1 & 2 by 50% by 2030. They aim to reduce their single use packaging by 75% by 2030. They also aim for zero deforestation risk in their supply chain by 2030.

5.9 Housing Stock

5.9.1 The data suggests 59% of residential properties in ST14 have a current EPC. The split in EPC grades from properties in the study area with an EPC can be seen in Figure 11. 21% of properties have a rating of E or lower.

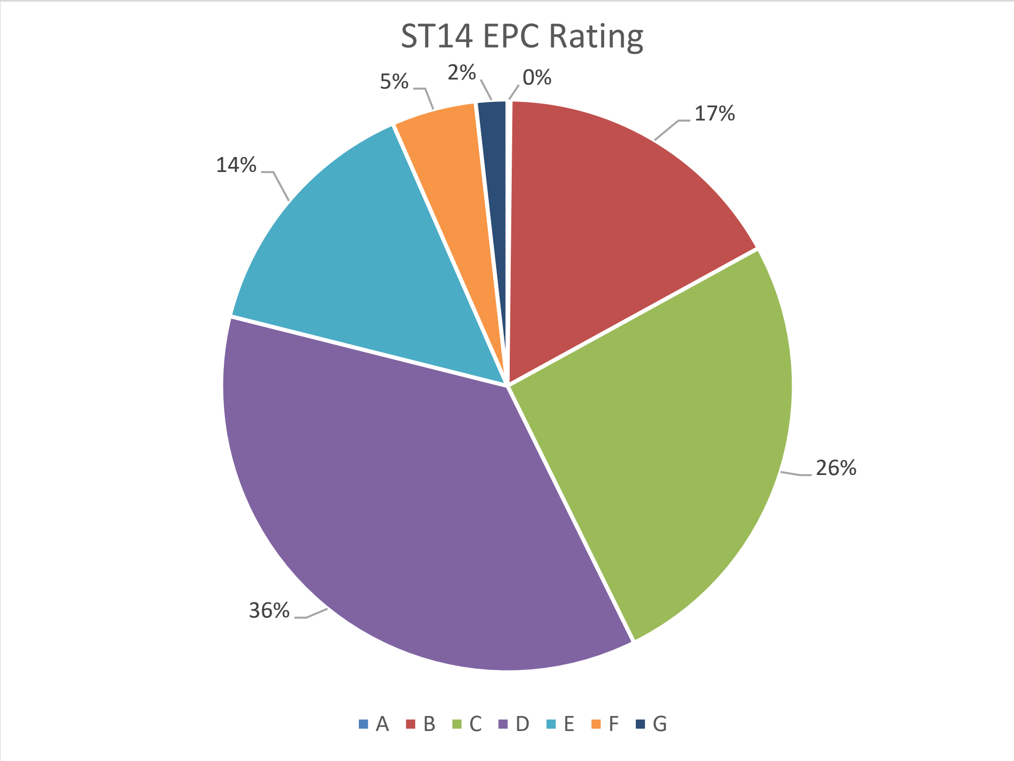

Figure 11: ST14 EPC Ratings

5.10 Domestic Solar PV

5.10.1 There was limited data available to present a clear picture of solar PV deployment in ST14. A visual assessment was made to estimate the level of PV deployment over the study area. Section 4.11 Solar PV Impact Methodology presents the two sample areas from which estimates of solar PV deployment were produced.

5.10.2 The results from the two samples were averaged. This offered the following percentages:

- 40% of roofs were East or West facing
- 5% of roofs have visible existing roof mounted solar
- 55% of roofs were South facing without visible PV

6 INTERNATIONAL, NATIONAL AND LOCAL POLICY CONTEXT

6.1 The International Panel on Climate Change

6.1.1 The Intergovernmental Panel on Climate Change (IPCC) was formed in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme. It is now the globally recognised United Nations body for assessing the science related to climate change. The IPCC aims to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward realistic adaptation and mitigation options. The IPCC does not conduct its own research but allows for open and transparent review by experts and governments around the world.

6.1.2 The IPCC Fifth Assessment Report (AR5, 2014)[31] indicated that global greenhouse gas (GHG) emissions will need to drop by half by 2030 and reach net-zero around mid-century to avoid the worst climate impacts. The Sixth Assessment Report (AR6), which is the latest IPCC report published in August 2021[32], highlights how human-induced climate change is already affecting many weather and climate extremes in every region across the world. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical storms has strengthened since AR5.

6.1.3 AR6 states that:

"global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades."

6.2 The Paris Agreement

6.2.1 The United Nations Climate Change Conference of Parties (COP) has 197 member countries which have been meeting annually since 1995. The 21st meeting (COP21) was held in Paris in 2015. This made global history with the first legally binding international treaty on climate change, commonly referred to as The Paris Agreement.

[31] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

[32] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M.Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

The treaty sets out a global framework which aims to strengthen the global response to the threat of dangerous climate change, by limiting global warming to well below 2 degrees Celsius (°C) above pre-industrial levels, and pursuing efforts to limit the temperature increase this century to 1.5 °C.

6.2.2 The Paris Agreement has now been adopted by 191 countries, including the UK. All member countries are required to prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. NDCs should represent a progression from the previous NDC and reflect the country's highest possible ambition. This includes a requirement to report regularly on emissions and on mitigation implementation efforts. The collective progress towards achieving the purpose of the Paris Agreement will be assessed every five years in a global stocktake of progress. The latest updated NDCs for the UK were published in December 2020, committing the UK to reduce economy-wide GHG emissions by at least 68% by 2030, compared to 1990 levels[33].

6.2.3 According to a recent article published by the World Resources Institute (WRI)[34], the European Union (EU) and 19 other countries and have since adopted net-zero carbon targets, and more than 100 others are considering doing so within the coming years. A rapidly growing number of national governments, local governments and business leaders are now making commitments to reach net-zero emissions in an effort to recognise the urgency of reducing global GHG emissions and tackle climate change.

6.3 The Glasgow Climate Pact 2021

6.3.1 In November 2021 the UK hosted COP26. This agreement aims to turn the 2020s into the decade of climate action. Key decisions included:

- Strengthen efforts to build resilience to climate change.
- Curb greenhouse gas emissions.
- Provide the necessary finance for both previous points.

6.3.2 Nations agreed to work to close the gap between existing emissions reductions plans and what is required to reduce emissions. The aim is to keep the rise in the global temperature to 1.5 degrees.

[33] UK Government (2020) 'United Kingdom of Great Britain and Northern Ireland's Nationally Determined Contribution' Crown copyright, London.
[34] World Resources Institute (2020). 'Designing and Communicating Net-Zero Targets.' https://www.wri.org/research/designing-and-communicating-net-zero-targets [Accessed June 2021].

6.3.3 Nations are called upon to phase down unabated coal power and inefficient subsidies for fossil fuels.

6.4 Climate Change Act 2008 (2050 Target Amendment) Order 2019

6.4.1 The Climate Change Act 2008 establishes the framework for the UK to set and deliver greenhouse gas (GHG) emission reduction targets; mainly through the establishment of the Committee on Climate Change (CCC) which ensures targets are evidence based and independently assessed. The Act commits the UK government to reduce GHG emissions to a minimum of 80 % below 1990 baseline levels by 2050. In 2019, this target was amended to be more ambitious and now the commitment is to reduce GHG emissions to a minimum of 100 % below 1990 baseline levels by 2050 – Net Zero.

6.4.2 The Climate Change Act requires the UK government to set legally-binding 'carbon budgets' which act as key milestones towards achieving net zero by 2050. A carbon budget is a cap on the amount of emissions emitted in the UK over a five-year period, and must be set at least 12 years in advance to allow policy-makers, businesses and individuals enough time to prepare. The UK is currently in the third carbon budget period (2018 to 2022). In April 2021, the UK Government set into law the sixth carbon budget (2033 to 2037) to reduce emissions by 78 % by 2035 (compared to 1990 levels).

6.4.3 The Government is also required to regularly report on emission target progress, assess the risks and opportunities to the UK associated with climate change, and develop preparation and adaptive plans for these. The UK Climate Change Risk Assessment (CCRA) is required to be produced every five years under the Climate Change Act 2008, in order to look at the risks and opportunities arising for the UK from climate change. The latest report was issued in 2017[35]. The UK Government's next progress update, known as CCRA3, is expected to be published in 2022.

6.4.4 The CCC published an independent advice report in June 2021[36] which will inform the CCRA3. This advice report identifies eight risk areas that require the most urgent attention in the next two years. These involve multiple hazards and broadly cover the following areas:

1. Risks to biodiversity in land and water habitats;
2. Risks to soil health through increased flooding and drought;

[35] HM Government (2017). 'UK Climate Change Risk Assessment 2017.' Crown copyright, London.
[36] Climate Change Committee (June 2021). 'Independent Assessment of UK Climate Risk: Advice to Government for the UK's Third Climate Change Risk Assessment (CCRA3).' Climate Change Committee, London.

3. Risks to natural carbon stores leading to increased emissions;
4. Risks to farming (i.e., crops, livestock, commercial forestry);
5. Risks to global distribution networks for vital services (including public procurement and supply chains for food and goods);
6. Risks to people and the economy from climate-related failure of the power system, affecting infrastructure and energy security;
7. Risks to human health, wellbeing and productivity from increased heat exposure in homes and other buildings; and,
8. Multiple risks to the UK from climate change impacts overseas, highlighting need for national resilience as well as business resilience.

6.4.5 In addition to the above reporting, the CCC publishes an annual progress report to parliament that assesses progress in reducing UK emissions over the past year against the set carbon budget. The Joint Recommendations 2021 Report to Parliament[37] offers more than 200 policy recommendations covering every part of Government.

6.4.6 One of the priority recommendations is that the UK Government should aim to be zero carbon in the long term and eliminate emissions from buildings within the next 30 years. Another priority recommendation is for a stable long-term policy framework to be provided to support sustained energy efficiency and heat pump growth at sufficient scale, i.e. 600,000 heat pumps per year in existing homes by 2028.

6.4.7 The CCC also recommends that the Government continues to support widespread deployment of EV charging infrastructure as a priority, to ensure the network can support high EV uptake levels. The Government should aim for there to be around 150,000 public charge points operating by 2025 which should be widely available across all regions of the UK.

6.5 National Adaptation Programme (NAP, 2018)

6.5.1 The second National Adaptation Programme (NAP, 2018)[38] sets out the government's response and actions to the second Climate Change Risk Assessment (CCRA) from 2017. The next CCRA is expected to be published in 2022. The NAP shows the current

[37] Climate Change Committee (June 2021). 'Joint Recommendations 2021 Report to Parliament.' Climate Change Committee, London.
[38] HM Government, Department for Food & Rural Affairs, (2018) 'The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting: Making the country resilient to a changing climate.' Crown copyright, Her Majesty's Stationary Office, London.

actions that the UK government is taking to address the risks and opportunities posed by a changing climate. It forms part of the five-yearly cycle of requirements laid down in the Climate Change Act (2008) to build climate resilience.

6.6 25 Year Environment Plan (2018)

6.6.1 The 25-Year Environment Plan, published in 2018[39], sets out the UK Government's ambitions for enhancing the natural environment over the coming decades. The strategy includes ten goals across six policy areas. Mitigating and adapting to climate change is goal seven. However, the CCC advise that to meet the challenges of climate change, all of the goals in the Plan will need to be met.

6.7 The Ten Point Plan for a Green Industrial Revolution (2020)

6.7.1 The Ten Point Plan[40] is the current overarching paper that was published in November 2020 and lays the foundations for a Green Industrial Revolution. The ten points are:

- Point 1 - Advancing Offshore Wind
- Point 2 - Driving the Growth of Low Carbon Hydrogen
- Point 3 - Delivering New and Advanced Nuclear Power
- Point 4 - Accelerating the Shift to Zero Emission Vehicles
- Point 5 - Green Public Transport, Cycling and Walking
- Point 6 - Jet Zero and Green Ships
- Point 7 - Greener Buildings
- Point 8 - Investing in Carbon Capture, Usage and Storage
- Point 9 - Protecting Our Natural Environment
- Point 10 - Green Finance and Innovation

6.8 National Planning Policy Framework (NPPF, 2021)

6.8.1 The policies within the NPPF relevant to climate change can be found in Chapter 14 'Meeting the challenge of climate change, flooding and coastal change'. Those paragraphs most specific to this assessment are detailed below:

Paragraph 152: *"The planning system should support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change. It should help to: shape places in ways that contribute to radical reductions in*

[39] HM Government (2018). 'A Green Future: Our 25 Year Plan to Improve the Environment.' Crown copyright, London.
[40] HM Government (2020) 'The Ten Point Plan for a Green Industrial Revolution: Building back better, supporting green jobs, and accelerating our path to net zero.' Crown copyright, London.

greenhouse gas emissions, minimise vulnerability and improve resilience; encourage the reuse of existing resources, including the conversion of existing buildings; and support renewable and low carbon energy and associated infrastructure."

Paragraph 153: *"Plans should take a proactive approach to mitigating and adapting to climate change, taking into account the long-term implications for flood risk, coastal change, water supply, biodiversity and landscapes, and the risk of overheating from rising temperatures. Policies should support appropriate measures to ensure the future resilience of communities and infrastructure to climate change impacts, such as providing space for physical protection measures, or making provision for the possible future relocation of vulnerable development and infrastructure."*

Paragraph 154: *"New development should be planned for in ways that: a) avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and b) can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards."*

Paragraph 155: *"To help increase the use and supply of renewable and low carbon energy and heat, plans should: a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts); b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers."*

Paragraph 157: *"In determining planning applications, local planning authorities should expect new development to: a) comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and b) take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption."*

Paragraph 161: *"All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by: a) applying the sequential test and then, if necessary, the exception test as set out below; b) safeguarding land from development that is required, or likely to be required, for current or future flood management; c) using opportunities provided by new development to reduce the causes and impacts of flooding (where appropriate through the use of natural flood management techniques); and d) where climate change is expected to increase flood risk so that some existing development may not be sustainable in the long-term, seeking opportunities to relocate development, including housing, to more sustainable locations."*

6.9 National Planning Practice Guidance (NPPG, updated 2019)

6.9.1 The National Planning Practice Guidance (NPPG) adds further context to the National Planning Policy Framework (NPPF) and it is intended that the two documents should be read together. The Climate Change Guidance was updated in 2019 and advises how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change.

6.10 Building Regulations (Part L and Part F)

6.10.1 Part L of The Building Regulations sets fabric energy efficiency standards, energy efficiency requirements and CO_2 emissions limits for dwellings and non-residential buildings. Approved document 'L1A and L2A 2013 edition incorporation 2021 amendments' provide details on the assessment criteria and methodologies used to test whether buildings are compliant. Aside from any local planning policy requirements it must be demonstrated that a building is compliant with the building regulations to be approved by building control. These regulations are the government's key mechanism for reducing CO_2 emissions in buildings.

6.11 Future Homes Standard and Future Buildings Standard

6.11.1 In October 2019 consultation began on the Future Homes Standard (FHS) which outlines proposed improvements to the 2013 Part L (conservation of fuel and power) and Part F (ventilation) of The Building Regulations applicable to new residential dwellings. The proposed changes include stricter energy efficiency and carbon emissions standards, as well as the introduction of measuring a dwelling's 'primary energy use'. The term 'primary energy use' refers to the direct use or supply at the source of energy that has not been subjected to any conversion or transformation process.

6.11.2 In January 2021, the Government published its response to the FHS consultation, at the same time as publishing a new consultation on 'Future Building Standards' (FBS). The FBS is a similar concept to the FHS, aimed at provoking decarbonisation in new non-residential and existing residential buildings. As part of the FBS, the Government is consulting on a preferred 27 % reduction in carbon emissions relative to Part L 2013 levels for non-residential buildings for the interim period, to facilitate the eventual realisation of zero-carbon buildings.

6.11.3 The FHS consultation response set out a clear timeline for the introduction of the FHS and the interim arrangements. It is intended (subject to the FBS consultation) that a new Part L 2021 (and Part F 2021) has now come into effect. The interim arrangements for both residential and non-residential developments have been formally instigated. This transitional period will only apply to individual units and not a development site in its entirety.

6.11.4 The consultation response also confirmed the Government's intention that Part L 2021 will apply the 31 % emission reduction interim uplift target over Part L 2013 for residential development in England, moving to a more stringent 75-80 % emissions reduction target by 2025. The requirement for new non-residential and existing buildings and dwellings will also move to an 75-80 % emissions reduction target by 2025.

6.11.5 The Planning and Energy Act 2008 will not be amended, meaning that Local Authorities will retain powers to set local energy efficiency standards for new homes, and this provides some certainty around reduction targets in the immediate term. Some Local Authorities are already encouraging consideration of zero carbon homes within their planning policies.

6.12 Electric Vehicle Infrastructure

6.12.1 In the Road to Zero strategy published in 2018[41], the UK Government announced that it wants every new home to have a smart charging point for electric vehicles (EV), where appropriate, to help future proof homes for the transition to low emissions

[41] HM Government, Department for Transport (2018) 'The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy.' Crown copyright, London.

transport. The government has now introduced Part S of the Building Regulations 2021 to provide EV provision within new dwellings and developments.

6.12.2 In November 2020, the UK Government announced that the phase-out date for the sale of new petrol and diesel cars and vans will be brought forward to 2030, with all new cars and vans to be fully zero emission at the tailpipe from 2035. To enable this transition and support the UK Government's target to achieve net zero GHG emissions by 2050, EVs need to be effectively integrated into and actively support the energy system[42].

6.12.3 The UK Government have confirmed that Building Regulations Part S for EV charging infrastructure will be effective from 2022 and requires:

Policy position: Residential Buildings

- Every new residential building with an associated car parking space to have a charge-point. This requirement applies to buildings undergoing a material change of use to create a dwelling.
- Every residential building undergoing major renovation with more than 10 car parking spaces will be required to have cable routes for electric vehicle charge-points in every car parking space.

Policy position: New Non-Residential Buildings

- Every new non-residential building and every non-residential building undergoing a major renovation with more than 10 car parking spaces will be required to have one charge-point, and cable routes for an electric vehicle charge-point for one in five spaces.

Policy position: Existing Non-Residential Buildings

- Existing non-residential buildings with more than 20 car parking spaces will be required to install at least one charge-point, applicable from 2025.

6.13 Net Zero Strategy: Build Back Greener (2021)

6.13.1 The Net Zero Strategy (NZS) document set out the UK Government's long-term plan for a transition to Net Zero emissions by 2050 that will take place over the next three decades, with plans for reducing emissions from each sector of the UK economy. The NZS stats that: *"By 2035 the UK will be powered entirely by clean electricity, subject to security of supply".*

[42] HM Government (2021) 'Electric Vehicle Smart Charging: Government Response to the 2019 Consultation on Electric Vehicle Smart Charging.' Crown copyright, London.

6.13.2 Many of the policies in the strategy will be phased in over the next decade or longer. The NZS includes key policies in the following areas:

- Power;
- Fuel supply and Hydrogen;
- Industry;
- Heat and Buildings;
- Transport;
- Natural resources, waste, and fluorinated gases;
- Greenhouse gas removals; and
- Supporting the transition with cross-cutting action.

6.14 Environment Act 2021

6.14.1 Some proposed targets are a cornerstone of the government's Environment Act 2021. These are currently undergoing public consultation[43]. These targets are:

- Halt the decline in species by 2030 and then bend the curve to increase species abundance by 10% by 2042. We will create or restore in excess of 500,000 hectares of a range of wildlife-rich habitat outside protected sites by 2042, compared to 2022 levels;
- Reduce residual waste (excluding major mineral wastes) kg per capita by 50% by 2042. It is proposed that this will be measured as a reduction from 2019 levels, which are estimated to be approximately 560 kg per capita;
- A maximum annual mean concentration of fine particulate matter (PM2.5) 10 µg/m3 across England by 2040 and a 35% reduction in population exposure to PM2.5 by 2040 (compared to a base year of 2018);
- Reduce nutrient pollution in water by reducing phosphorus loading from treated wastewater by 80% by 2037 and reducing nitrogen, phosphorous and sediment from agriculture to the water environment by 40% by 2037;
- Improve our marine environment with 70% of designated features in the MPA network to be in favourable condition by 2042, with the remainder in recovering condition, and additional reporting on changes in individual feature condition; and
- Increase tree canopy and woodland cover from 14.5% to 17.5% of total land area in England by 2050.

[43] UK Government (2022) *Delivering on the Environment Act: new targets announced and ambitious plans for nature recovery*. Available from: https://www.gov.uk/government/news/delivering-on-the-environment-act-new-targets-announced-and-ambitious-plans-for-nature-recovery [Accessed 06 May 2022].

6.15 Heat and Buildings Strategy (2021)

6.15.1 The Heat and Buildings Strategy (HBS) set out the immediate actions and long-term signals required to reduce emissions from buildings to near zero (between 0 and 2 Mt CO_2e) by 2050. There are about 30 million buildings in the UK. In total, these buildings are responsible for around 30% of our national emissions. The vast majority of these emissions result from heating: 79% of buildings emissions and about 23% of all UK emissions. Upgrading the UK building stock will require a comprehensive package of measures to be implemented in the next decade.

6.15.2 The primary focus of the HBS is on reducing emissions from heating as this is the predominant source of emissions from buildings. However, the HBS recognises the current and potential future demand of cooling. This will be considered further as the Government continue to develop the UK's approach to long-term choices for low-carbon heating.

6.16 UK Hydrogen Energy Strategy

6.16.1 In 2021, the UK Government released the UK Hydrogen Strategy which sets out the role hydrogen is expected to play in the UK's low carbon transition.

6.16.2 By 2030, the ambition is for 5GW of low carbon hydrogen production capacity to be for use across the economy. This ambition requires a rapid scaling up of production and use of hydrogen in this decade.

6.16.3 The UK's geography, geology, infrastructure and expertise make it particularly suited to rapidly developing a low carbon hydrogen economy.

6.16.4 The new hydrogen industry could support over 9,000 jobs and £900 million of Gross Value Added (GVA) by 2030.

6.16.5 The Net Zero Hydrogen Fund (NZHF) is expected to be launched in 2022 to provide funding to support new low carbon hydrogen production. The aim of this Fund is to support commercial deployment of projects during the 2020s.

6.17 HyDeploy

6.17.1 HyDeploy was an energy trial that demonstrated an injection of up to 20% hydrogen into Keele University's existing private gas network between 2019 and 2021[44].

[44] Keele University (2022) *Hydeploy.* Available from: https://www.keele.ac.uk/sustainable-futures/ourchallengethemes/providingcleanenergyreducingcarbonemissions/hydeploy/ [Accessed 11 May 2022].

Cutting carbon emissions from heat will be an essential part of the UK's low carbon transition.

6.18 Local Policies

6.18.1 East Staffordshire Borough Council declared a climate emergency in August 2020 with a pledge to make the Council's actions and operations climate neutral by 2040.

6.18.2 They have devised a Climate Change Action Plan and Carbon Management Strategy and Implementation Plan to support their ambitions.

6.18.3 Whilst the 2040 climate neutral pledge only covers the Council's actions and operations, the Climate Change Action Plan aims to support and promote actions that can be taken by local people and businesses.

6.18.4 East Staffordshire Borough Council have recently suspended its garden waste service due to higher employee absences as a result of Covid-19[45]. This could cause garden waste being sent to landfill which would be anaerobically digested and produce methane which is a potent GHG. Conversely, when the garden waste is recycled it is often supplied back to the community as compost. This offsets emissions that occur from the production of fertilisers.

6.19 East Staffordshire Borough Council: Local Plan 2012-2031

6.19.1 The Local Plan includes Strategic Policy 28: Renewable and Low Carbon Energy Generation

6.19.2 This policy promotes and encourages all technologies and types of renewable and low-carbon energy generation, appropriate to the location in the Borough.

6.19.3 The statement suggests the Council "*will encourage technologies that provide the greatest renewable energy generation and carbon savings*."

6.19.4 The policy states "*opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers will be encouraged*."

6.19.5 Detailed Policy 2: Designing in Sustainable Construction states the Council actively encourages the design and delivery of low carbon buildings.

[45] East Staffordshire Borough Council (2022) *East Staffordshire Borough Council to suspend garden waste collections.* Available from: http://www.eaststaffsbc.gov.uk/es-news/east-staffordshire-borough-council-suspend-garden-waste-collections-0 Available from: 06 May 2022].

6.20 Trent & Dove Social Housing

6.20.1 Trent & Dove are a local affordable and social housing provider. They have targets to reduce electricity, gas and water consumption in the buildings they construct and manage.

6.21 East Staffordshire Borough Council: Housing Strategy 2021 – 2025

6.21.1 The housing strategy has the potential to make an impact on the level of emissions the region is estimated to have in the future.

6.21.2 The Strategic Housing Market Assessment suggests there is a need for 613 dwellings per year between 2012 and 2031. The Housing Strategy suggests Uttoxeter would consist of 17.7% of that total. This equates to a housing supply of 109 houses per year.

6.21.3 A small portion of the ST14 boundary is covered by the Derbyshire Dales District Council. However, as this amount of land is so small the effects from their local policies on this study are negligible.

6.22 Climate Change Strategic Development Framework

6.22.1 Staffordshire County Council declared a climate emergency in 2019 and aims to achieve net zero by 2050. The Council has created a Climate Change Action Plan and is monitoring its carbon emissions annually. Buildings, waste and transport are the highest emitters. The Council recognises some residual emissions will remain. They aim to investigate options for carbon sequestration to balance residuals to achieve their net zero target.

6.22.2 The council has laid out five priority themes for achieving net zero:

1. Waste
2. Organisational carbon reduction (reducing the impact of their services)
3. Air quality (improving the health of individuals through improved air quality)
4. Natural environment
5. Behaviour change

6.22.3 The plans, performance and strategies of the Council will be revied to monitor progress and as new technologies and ideas are identified.

6.22.4 The Staffordshire Sustainability Board was set up in January 2022 to unite district and borough council's in achieving their net carbon zero target by 2050[46].

6.23 Other Relevant Guidance and Development Strategies

Planning and Compulsory Purchase Act (2004) - Section 19(1A)

6.23.1 Section 19(1A) of the Planning and Compulsory Purchase Act (2004) requires local planning authorities to include in their Local Plans *"policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change"*. This will be a consideration when the emerging Local Plan is examined by the Secretary of State prior to adoption of the local policies. This Baseline Report seeks to provide the supporting evidence for this.

6.24 Accounting for the Effects of Climate Change (Green Book)

6.24.1 Supplementary planning guidance on climate change was issued in 2014 with the aim to advise *"how to identify suitable mitigation and adaptation measures in the planning process to address the impacts of climate change."* This provides guidance to authorities for the implementation of climate change considerations into Local Plans but is helpful in outlining the topic areas for review and suggestions of general mitigation and adaptation methods.

6.24.2 The Accounting for the Effects of Climate Change Supplementary Green Book Guidance[47] was published by The Department for Environment, Food, and Rural Affairs (DEFRA) in November 2020. This is supplementary guidance to the Green Book guidance issued by Her Majesty's (HM) Treasury on how to appraise policies, programmes and projects. This supplementary guidance supports analysts and policymakers to ensure, where appropriate, that policies, programmes and projects are resilient to the effects of climate change, and that such effects are being taken into account when appraising options.

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[46] Staffordshire County Council (2022) *Council's join forces to tackle climate change*. Available from: https://www.gov.uk/government/news/delivering-on-the-environment-act-new-targets-announced-and-ambitious-plans-for-nature-recovery [Accessed 06 May 2022].

[47] HM Government, Department for Environment, Food, & Rural Affairs (2020). 'Accounting for the Effects of Climate change: Supplementary Green Book Guidance.'

6.25 A Guide for Local Authorities on Planning for Climate Change (2021)

6.25.1 The Town and Country Planning Association (TCPA) and Royal Town Planning Institute (RTPI) have published an updated guide for Local Authorities on planning for climate change. This document is designed as an introduction to some of the key issues and is intended to inform the preparation of strategic and local development plans. However, it does not contain detailed material on important elements such as green infrastructure, biodiversity, and food security. It can be used as a useful signpost to government agency guidance and practical advice from cross-sector organisations.

7 ASSESSING THE BASELINE: GREENHOUSE GAS EMISSIONS

7.1.1 This section evaluates the current carbon emission baseline within the ST14 postcode area. The carbon emissions are the total GHG emissions existing. Emissions have been compared against those of surrounding areas and elsewhere in the United Kingdom for reference and context.

7.2 Overview of Emissions

7.2.1 The CCC reports how lockdown measures due to the COVID-19 pandemic led to a record decrease in UK emissions in 2020, falling by 13% overall. The largest falls were in aviation (-60%), shipping (-24%), and surface transport (-18%). However, home energy use increased, with residential buildings the only sector to show an overall increase in emissions (+2%). Without underlying structural changes to UK operations, emissions are likely to rebound in most sectors in 2021 to pre-pandemic levels[48].

7.2.2 For this reason, a 2018 baseline is used as this is the most recent year available and it also completely eliminates any distortion arising from COVID.

7.2.3 Emissions for the ST14 area are assessed as being approximately 204,335 tCO_2e, which represents the total territorial emissions.

7.2.4 The breakdown of emissions by parish is presented in Figure 12. The distribution of emissions is heavily weighted towards the Uttoxeter urban centre and its immediate surroundings.

[48] Climate Change Committee (CCC) (2021) ‘Progress in reducing Emissions 2021 Report to Parliament’. CCC.

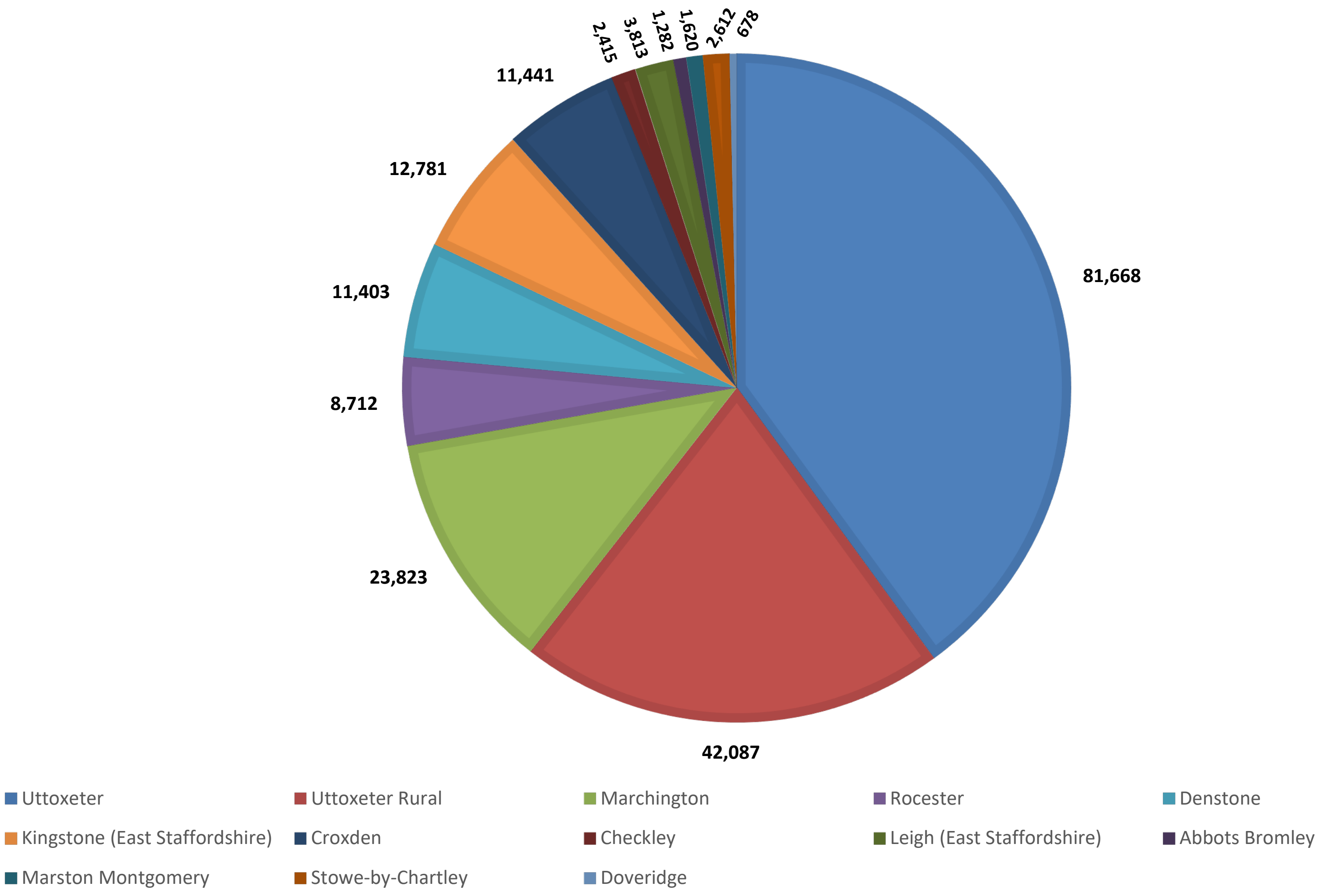

Figure 12 - Breakdown of Emissions (tCO2e) by parish

7.2.5 The net emissions for Land Use, Land Use Change, and Forestry (LULUCF) are negative year on year in ST14[49]. In 2019 these were minus 7.9 kt CO_2e. The LULUCF sector covers emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities. Carbon is absorbed (sequestered) by forestry and grassland, while carbon losses occur on existing cropland, grassland, and natural land that is converted to cropland or settlements. This sector has been a net carbon sink since 1998 and is projected to remain a net carbon sink beyond 2050. The UK has a range of options to increase carbon sequestration and reduce emissions in the LULUCF sector, which include planting more trees such as is happening in Stoke-on-Trent, and the restoration of peatlands[50].

Table 7 - Summary table of Greenhouse Gases in ST14 by emission source

Emission source	**Emissions (t CO_2e)**
Road Transport	56,938
Agriculture - Livestock and crop-related emissions	39,128
Housing – Mains gas	15,911
Aviation	12,630
Industrial and commercial - Electricity	12,436
Housing - Oil	11,586
Industrial and commercial - Mains gas	11,148
Waste management	9,315
Housing – Electricity	9,060
Industrial and commercial - Other Fuels	7,139
Agriculture - Fuel	6,135
Shipping	5,030
F-gases	4,200
Other Transport	2,657
Diesel fuelled railways	1,637
Housing - LPG	1,574
Housing - Coal	539
Housing - Biomass	157
Industrial and commercial - Large industrial consumers	2
Power generation	1
Land use, land-use change, and forestry	-2,886

7.2.6 Total emissions by sector, excluding LULUCF, is presented in Figure 13.

[49] Data Source: UK local authority and regional carbon dioxide emissions national statistics: 2005-2019, BEIS/DEFRA.
[50] Committee on Climate Change (2013). *Factsheet: Land Use, Land Use Change and Forestry.* Available from: https://www.theccc.org.uk/wp-content/uploads/2013/03/LULUCF.pdf [Accessed 30 March 2022].

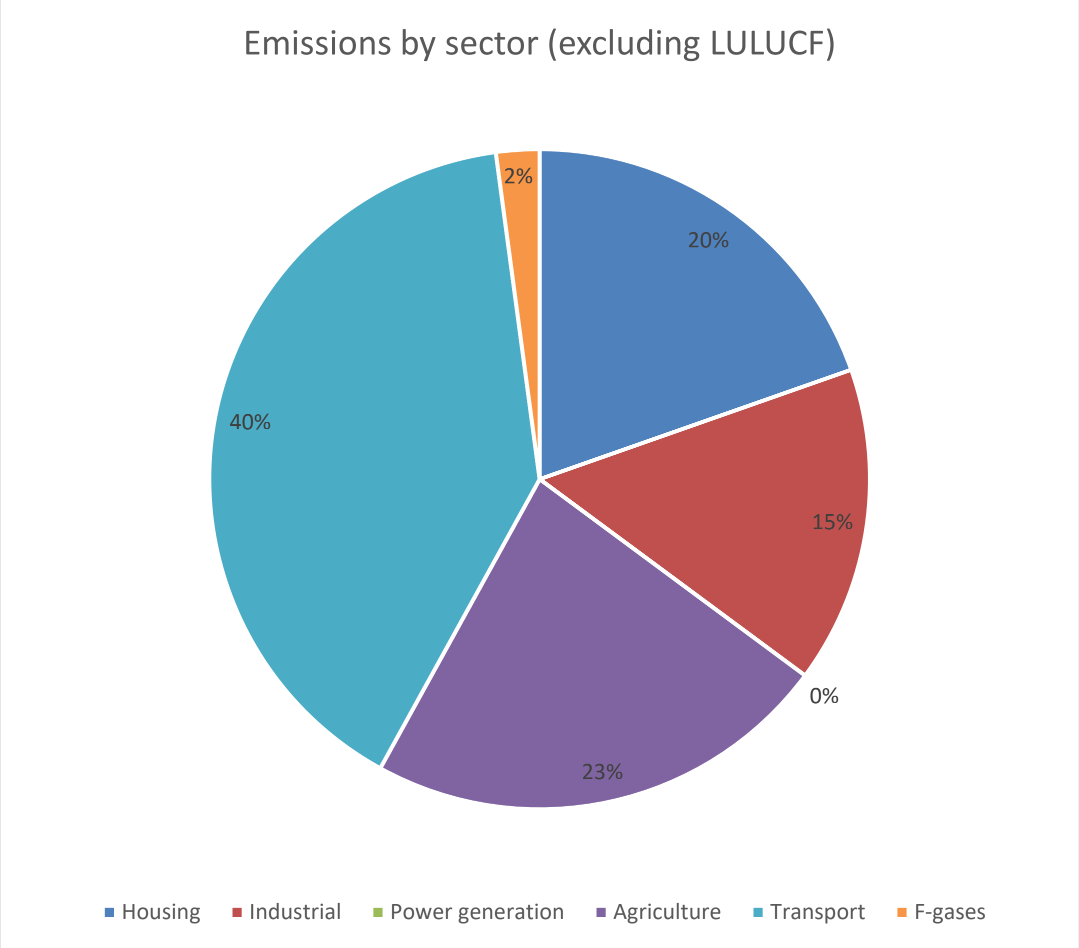

Figure 13 - Emissions by sector

Table 8 - Summary of emissions per sector (t CO_2e) in ST14	
Sector	**Emissions (t CO_2e)**
Housing	38,827
Industrial	30,725
Power generation	1
Agriculture	45,263
Transport	78,892
F-gases	4,200
Land Use, Land Use Change and Forestry	-2,886

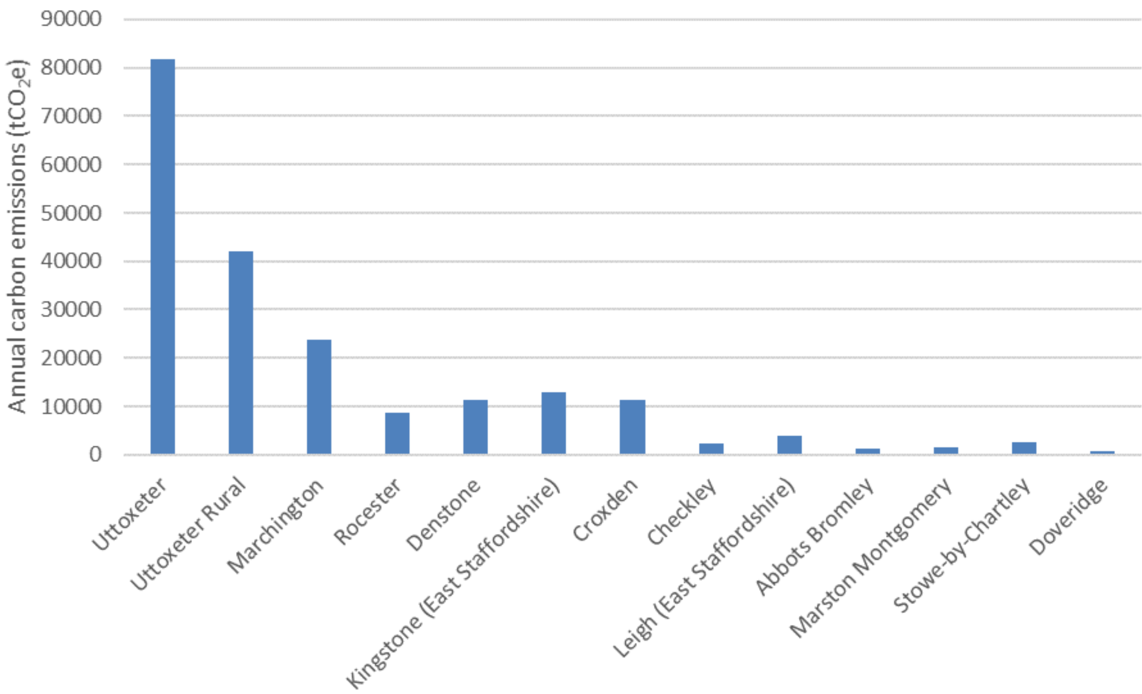

Figure 14 - Overall Annual Carbon Emissions by Parish (Source: CSE, 2021)

Table 9 - Parish Emissions and Contribution to Total

Name	TOTALS	Contributions to total emissions
Uttoxeter	81,668	40.0%
Uttoxeter Rural	42,087	20.6%
Marchington	23,823	11.7%
Rocester	8,712	4.3%
Denstone	11,403	5.6%
Kingstone (East Staffordshire)	12,781	6.3%
Croxden	11,441	5.6%
Checkley	2,415	1.2%
Leigh (East Staffordshire)	3,813	1.9%
Abbots Bromley	1,282	0.6%
Marston Montgomery	1,620	0.8%
Stowe-by-Chartley	2,612	1.3%
Doveridge	678	0.3%

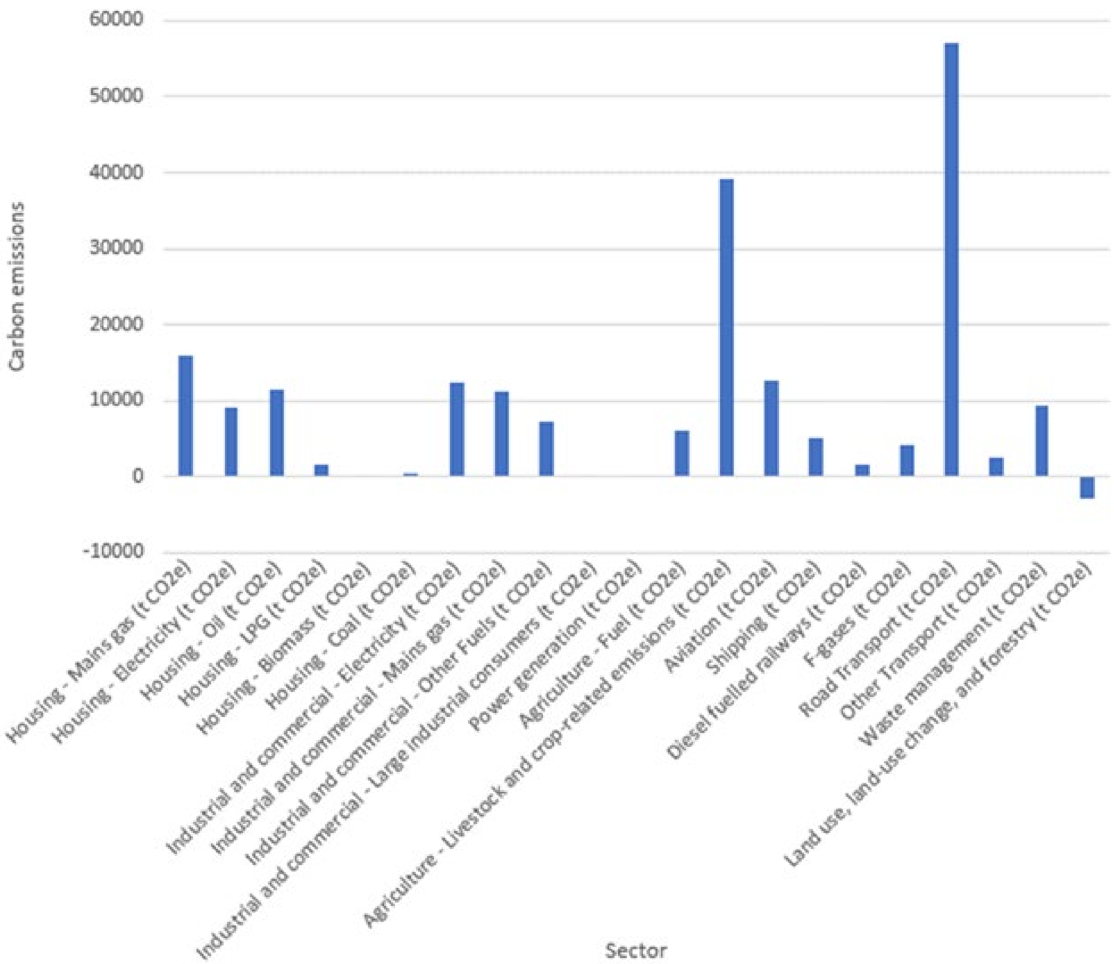

Figure 15 - Carbon emissions by sector in ST14

7.2.7 Figure 15 shows how road transport accounts for the largest proportion of emissions followed by livestock and crop agricultural emissions. LULUCF is responsible for emissions reductions by acting as a carbon sink and this is reflected in the graph as a negative value.

7.3 Housing emissions

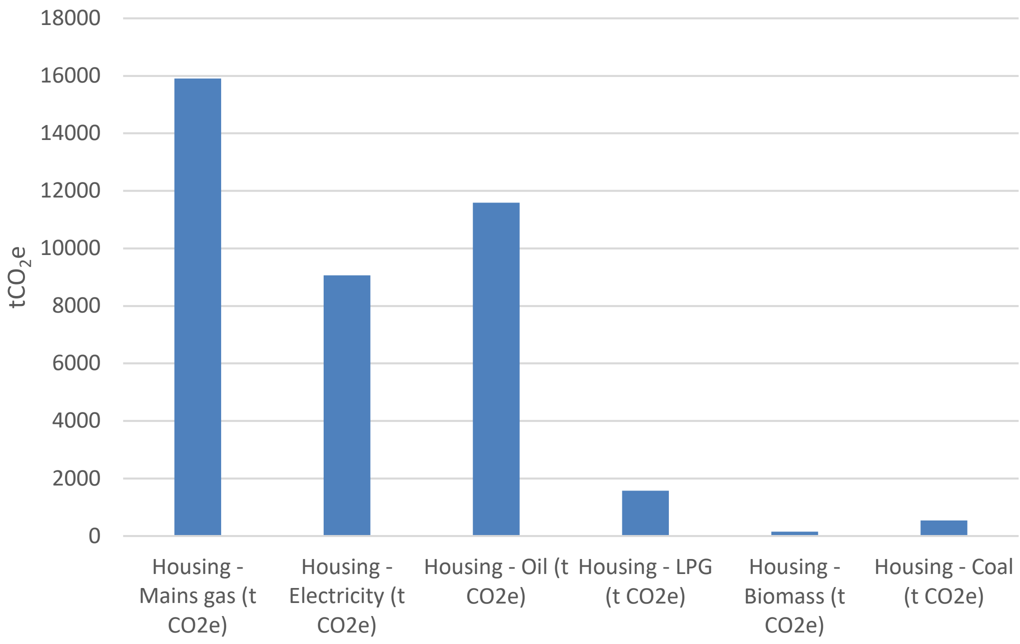

Figure 16 - ST14 Housing emissions

7.3.1 Figure 16 shows the two largest sources of emissions within homes in the ST14 area are natural gas and oil, which are used for space heating, domestic hot water and potentially at least some cooking. Electricity emissions are significant and would increase as a proportion of the total carbon emissions mix if the programme of electrification of heating was undertaken as an intervention.

7.3.2 Figure 17 shows the main sources of emissions within the industrial and commercial sector are from electricity and gas use. The data set does not record emissions for 'large' industrial consumers, and it is noted that there are no heavy industry assets within the ST14 boundary such as steelworks, aluminium smelts, oil refineries or chemical works, etc. It is noted that JCB Ltd operate facilities within the boundary and further work is required to confirm these emissions are fully reflected within the values presented, or whether they may be partly omitted for reasons of commercial sensitivity.

7.4 Industrial and commercial emissions

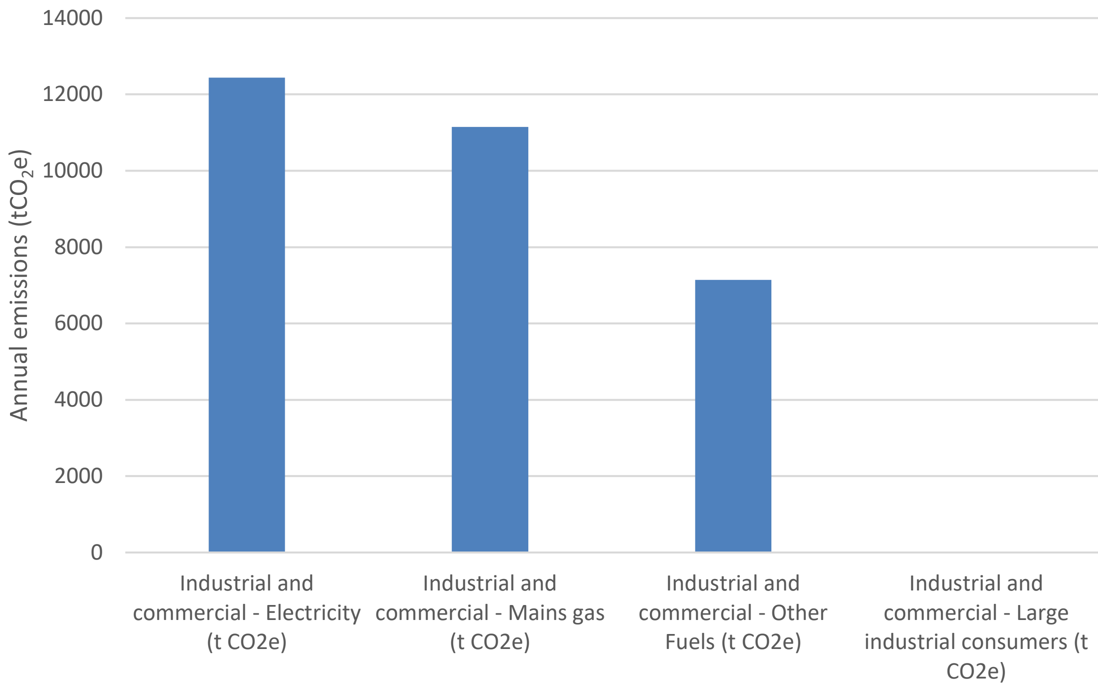

Figure 17 - Industrial and commercial emissions in the ST14 scope area (tCO_2e)

7.5 Agricultural emissions

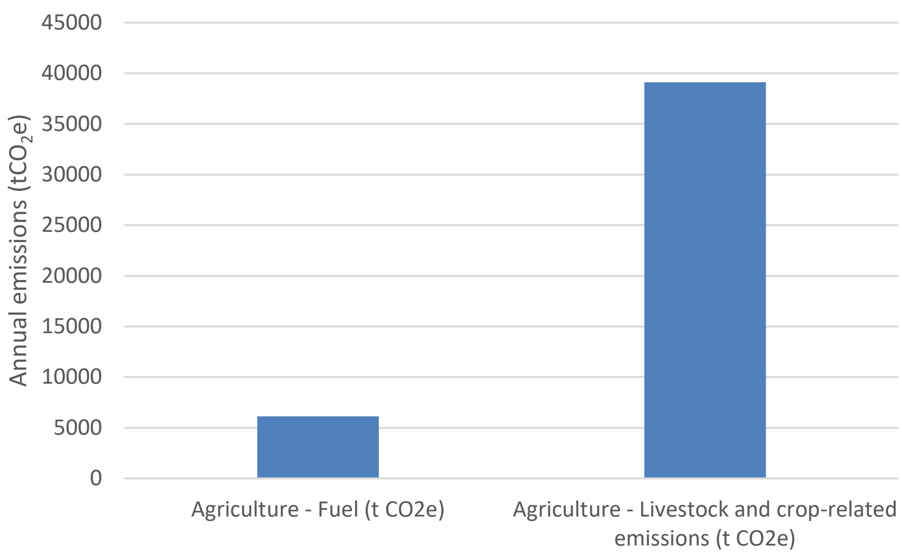

Figure 18 - Agricultural emissions in the ST14 scope area (tCO_2e)

7.5.1 Agricultural emissions from livestock and crops far outweigh those from fuel use. The dataset used by the CSE for livestock and crop-related emissions is the National Atmospheric Emissions Inventory. It appears from this data that the main cause of emissions in this sector is from methane and nitrous oxides which are GHGs. Appendix B and Appendix C show the regional emissions for these GHGs.

7.5.2 This coincides with the IPCC's Special Report on Climate Change and Land which suggests the major driver of methane and nitrous oxide emissions is agriculture[51].

7.5.3 Agriculture in the UK, in comparison to other sectors contributed to 68 % of total nitrous oxide emissions, 47 % of total methane emissions, 1.7 % of totally CO_2 emissions and 10 % of the total GHG emissions in the UK [52]. Majority of emissions from the agriculture sector come from enteric fermentation with a future breakdown illustrated in Figure 19.

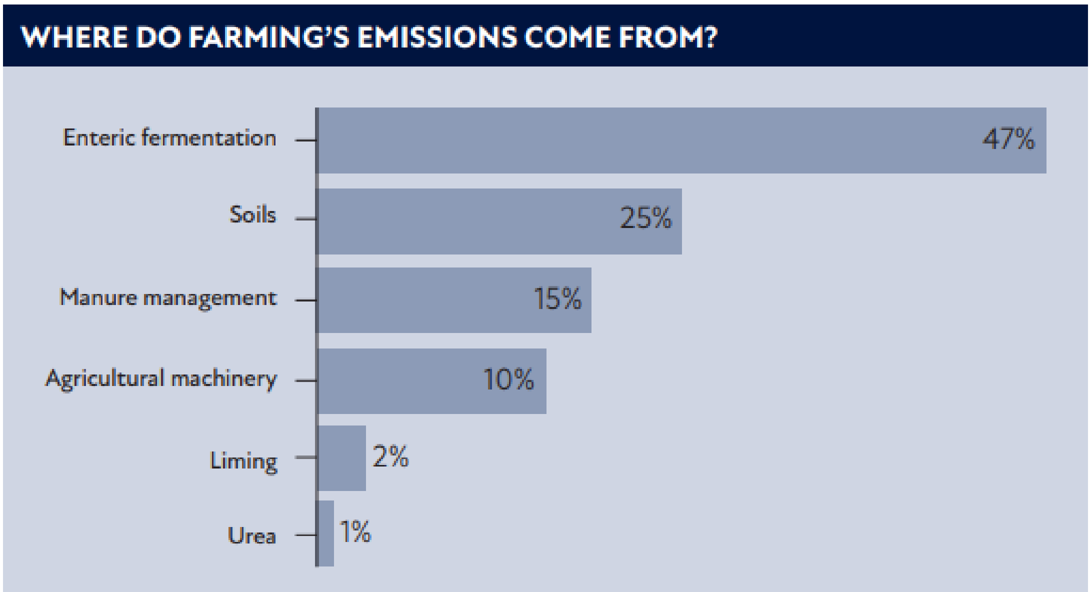

Figure 19 - Graph depicting the emissions from the UK agriculture sector

7.6 The UK dairy industry

7.6.1 In 2020, milk production in the UK was valued at £4.4 billion which equates to 16.4 % of the total agricultural output.[53] Since 1990, total emissions by the industry have fallen by 16 %. This reduction is mainly due to the average annual milk production per

[51] Carbon Brief (2019) *In depth Q&A: The IPCC's special report of climate change and land*. Available from: https://www.carbonbrief.org/in-depth-qa-the-ipccs-special-report-on-climate-change-and-land [Accessed 29 March 2022].

[52] DEFRA Department for Environment Food & Rural Affairs. 2021. Agri-climate report 2021. Available from: https://www.gov.uk/government/statistics/agri-climate-report-2021/agri-climate-report-2021 [Accessed 19 July 2022].

[53] CIEL Centre for Innovation Excellence in Livestock. 2022. Net Zero & Livestock: How Farmers can reduce emissions [online]. Available at: Net-Zero-Livestock-DOC-13th-may-interactive-LOW-RES.pdf (cielivestock.co.uk)

cow increasing from 5,151L in 1990 to 8,204L in 2020 (59 % increase), however other factors such as increased efficiency and mitigating effects are also contributors to the decrease in GHG emissions. Mainly, the contribution by the dairy industry to the agricultural sector's GHG emissions is in the form of CH_4 from slurry management and digestion of feed and N_2O emissions from the application of fertiliser and manure[54]. The carbon footprint of a litre of British milk is around 1.25kg CO_2e compared to a global average of 2.9kg CO_2e per litre.

7.7 Transport Emissions

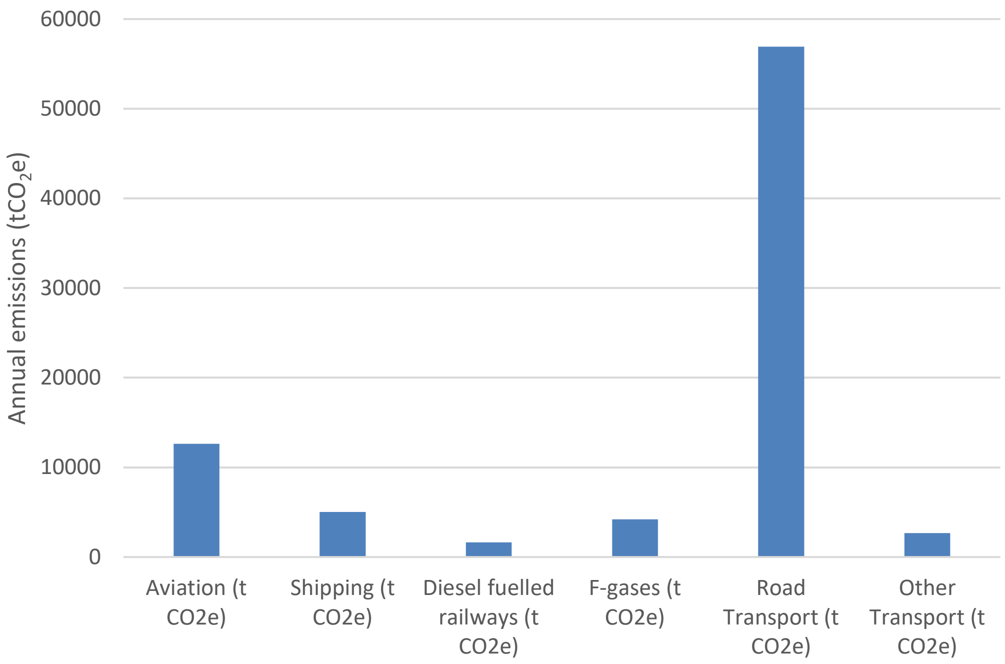

Figure 20 - Transport emissions in the ST14 scope area (tCO_2e)

7.7.1 Road transport accounts for by far the highest proportion of emissions with this sector, followed by aviation.

7.8 Transport Emissions – Road Haulage

7.8.1 Road haulage emissions account for a large proportion of transport emissions in the UK, largely because the majority of Light and Heavy Goods Vehicles (LGVs and HGVs) are fuelled by diesel.

7.8.2 Alternative options include the use of compressed biomethane (for example as currently used by Waitrose fleet and hydrogen. Compressed biomethane (CBM) can be produced form anaerobic digestors (AD), perhaps as part of a waste management

[54] ibid

operation, which is a useful low-carbon option that makes use of existing well understood technology. The biomethane is essentially identical to natural gas but is not produced from fossil fuels. The benefit is high quality combustion, mature engine technology and availability from potentially local farm-based AD facilities under contract. One of the limitations for the technology is availability of supply to support larger fleets, particularly if demand for CBM becomes more widespread. The other key limitation is that it is not a zero emission technology and carbon is still emitted from the vehicle during use.

7.8.3 Hydrogen vehicles are in development and are not beyond the demonstrator stage at the time of writing. It is highly likely that hydrogen fuelled HGV transport will gain a significant market share beyond 2030, however it seems unlikely that an accelerated shift to hydrogen prior to 2030 is achievable based on the technological and economic case. If the current significant increase in fuel prices is maintained over the coming years, then the case for moving to hydrogen may potentially be improved, depending on the source of the hydrogen. Hydrogen buses are already available and greater market penetration for the technology can be expected.

7.9 Transport Emissions – Private Vehicles

7.9.1 The International Energy Agency reports global transport activity rebounded and continued to grow in the final months of 2021. Road transport activity was expected to recover to pre-Covid-19 levels in the last months of 2021, with associated CO_2 levels to be just 5% lower than the 2019 level in 2021)[55]. Over half the decrease in national GHG emissions between 2019 and 2020 was from the reduction in emissions from transport, which was down 19.2% (23.5 $MtCO_2e$) due to national lockdowns[56]. Road transport is the most significant source of emissions within the transport sector, and in particular, passenger cars.

7.9.2 According to the Place Based Carbon Calculator (PBCC), the transport sector is the only sector of the UK economy where emissions are still rising. Their data for East Staffordshire suggests CO_2 emissions from cars were 1110kg CO_2e per person in 2018

[55] International Energy Agency (IEA) (2021), Tracking Transport 2020, IEA, Paris https://www.iea.org/reports/tracking-transport-2021 [Accessed 15 March 2022].

[56] Department for Business, Energy and Industrial Strategy (2022) *2020 UK Greenhouse Gas Emissions, Final Figures.* Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1051408/2020-final-greenhouse-gas-emissions-statistical-release.pdf [Accessed 15 March 2022].

which is above the England average. In addition, the number of cars per person in East Staffordshire was also higher than the England average.

7.9.3 Commuting is responsible for about 20% of all car journeys in the UK. However, with the right investment, many people could switch to sustainable travel options such as walking, cycling or public transport.

7.9.4 Electric vehicles (EV) reduce emissions overall, however, high volumes of emissions can be released during the battery manufacturing process.

7.9.5 Research has shown by 2030 EVs are estimated to deliver around a 76% LCA GHG reduction compared to an equivalent conventional petrol car[57].

7.9.6 EVs still contribute to air pollution (albeit to a lesser extent than combustion engine vehicles and only due to particulates from their tyres and brakes), traffic congestion, and road deaths.

7.9.7 The CCC advises that the UK needs to drive less, overall, to be in with any chance of meeting the emission reduction targets designed to tackle human-induced climate change. A reduction in the number of vehicles used and total vehicle distance travelled is likely to be an objective of any future strategy to achieve the 2030 target.

7.9.8 Transport emissions depend heavily upon the types of vehicles being used. The PBCC describes how not all vehicles have the same carbon emissions for each kilometre they travel. For example, smaller and lighter cars require less energy to move and so have lower emissions. Buses and trains can carry more people and so emissions per person will reduce for these modes of transport, providing that the routes are well used. Improvements in engine design can also reduce fuel consumption and emissions.

7.9.9 In 2021, there were 11,589 cars, 511 motorbikes and 2,874 other vehicles licenced within the ST14 boundary based on data extracted from the UK vehicle databases[58]. This totals 14,974 vehicles. The data shows how there are only 109 Ultra Low Emissions Vehicles (ULEV) registered in ST14 in Quarter 3 of 2021. This equates to 0.7% of total vehicles. Battery Electric Vehicles (a subset of ULEV) accounted for 0.4% of total vehicles. Plug in Hybrid Vehicles (also a subset of ULEV) accounted for 0.3% of total vehicles.

[57] Ricardo (2021) *Lifecycle Analysis of UK Road Vehicles.* Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1062603/lifecycle-analysis-of-UK-road-vehicles.pdf [Accessed 19 July 2022].

[58] Data on all licensed and registered vehicles, produced by Department for Transport, Statistical dataset: VEH0122 and VEH0134.

Table 10 - Registered Vehicles by type in ST14

Vehicle type	**Amount**
Car	11,589
Motorbike	511
Other	2,874
Total	**14,974**

7.9.10 It is unclear how exactly commuting will change after the COVID-19 pandemic. However, a significant increase in working from home is expected when the 2021 Census is published in Summer 2022. This has the potential to reduce transport emissions on a short-term basis.

7.9.11 Facilitating the use of ultra-low emissions vehicles (ULEVs), public transport, and human-powered modes of transport will lower emissions in the longer term. The following statistics using the latest available data for 2020 have been derived from vehicle databases (VEH0105, VEH0122, VEH0134[59] and TAXI0105[60]) published by the Department for Transport (unless stated otherwise).

7.10 Ultra-Low Emissions Vehicles

7.10.1 ULEVs are currently defined by the UK Vehicle Certification Agency (VCA) as having less than 75 grams of CO_2 per kilometre (g/km) from the tail pipe. Recognising advances in technology, the VCA expect to redefine an ULEV as a car or van that emits less than 50g/km CO_2 from 2021. Pure EV and other plug-in EV when driving in the all-electric mode, produce no tailpipe CO_2 or pollution[61].

7.10.2 There are 6 sites with electric vehicle charge points (EVCPs) in Uttoxeter, of which 1 site has free to use EVCPs. There is one further EVCP site in the ST14 boundary which is located at the JCB Golf & Country Club. With the introduction of a Building Regulations Part S in 2022 that will require all new builds to provide smart EV charging infrastructure, the uptake of EV in ST14 should be encouraged, to reduce overall transport emissions in the region.

[59] Data on all licensed and registered vehicles, produced by Department for Transport, Statistical dataset: VEH0105, VEH0122 and VEH0134.
[60] Department for Transport, Taxis, private hire vehicles and their drivers (TAXI), Statistical data set TAXI0105.
[61] https://www.vehicle-certification-agency.gov.uk/fuel-consumption-co2/fuel-consumption-guide/zero-and-ultra-low-emission-vehicles-ulevs/ [Accessed September 2021].

Table 11 - List of EVCP locations
List of EVCP locations in Uttoxeter
Trinity Square Car Park
Lidl Brookside Road
Bank House Hotel
Asda Uttoxeter
Tesco Superstore Uttoxeter
Premier Inn Uttoxeter

7.11 Local Transport Plan

7.11.1 The Staffordshire Local Transport Plan (LTP) looks in detail at the transport-related problems and challenges within the region, including transport behaviours. The implementation plan involves the following approaches:

- making the adoption of more sustainable travel behaviours easier for people by improving the viability of other travel modes such as public transport; and
- providing information on health, safe, and sustainable travel.

7.12 Energy Efficiency in ST14

7.12.1 Energy efficiency in buildings relates to the amount of electricity consumed by electrical equipment to achieve some effect, and the amount of heating fuel (or electricity) required to maintain a comfortable temperature within the building, or to meet process heat or hot water demand.

7.12.2 Electrical appliances are being produced with increasing ratings, normally codified as A, A+ or A++. The rating system will be reviewed over time to reflect that older inefficient equipment will cease to be available and to normalise the coding to reflect that the overall average is improving. Generally speaking, high rated electrical equipment for appliances that are in constant or frequent use, or that are very high powered, such as refrigerators, freezers, microwaves, large TVs and electric ovens will result in the lowest carbon footprint, notwithstanding that the carbon emitted in manufacture and supply of these is outside the emission boundary of the study.

7.12.3 A strategy for achieving net zero by 2030 within the ST14 area might look to promote switching to high efficiency appliances whenever a buying decision is being made, to accelerate the transition to more energy efficient buildings.

7.12.4 The heating of buildings is a significant energy demand and the rate of loss of heat through the building fabric (walls, floors, ceilings, and windows) to the outside is a key factor in how energy efficient a building is. Another key aspect is air tightness, which describes how well controlled the conditioned air within the building is, to prevent it leaving the building and needing to be replaced with new air that must then be conditioned (heated or cooled).

7.12.5 High fabric efficiency is achieved when the building structure has a low U-value. 2021 building regulations require dwelling walls to have a minimum U-value of 0.26 W/m^2K, which is most easily met by installing insulation. Generally, insulating lofts, walls and floors is a key step in improving the thermal efficiency of a building. Eliminating drafts, while ensuring that the building is properly ventilated and does not become damp, is another key step. Once these steps have been taken then the way in which heat is produced and supplied to the building can be made more efficient by improving control, reducing temperatures as far as is comfortable, avoiding heating the building when not necessary and following other best practice guidance that is freely available from reputable sources.

7.12.6 About 35 % of heat is lost through a building's walls, 25 % through the roof, 15 % through the floors, and 10 % through windows and doors[62]. This highlights the importance of adaptation and retrofit measures to improve the existing housing stock. The CCC recommends that to meet UK climate change emission reduction targets, all homes and other buildings need to be upgraded (wherever feasible) to reach an A or B rating as soon as possible.

7.12.7 It is likely that the overheating of buildings in summer and the associated thermal discomfort for occupiers will be an increasing impact of climate change. In 2018, around half (47 %) of English households reported always being able to cool down at night by opening a window. However, 9 % of households living in urban areas were less likely to be able to cool down at night by this method.

7.12.8 The Headline Report 2019-20[63] states that the energy efficiency of the English housing stock continues to improve. This was evident in all tenures apart from local authority dwellings where there was no significant increase. The social sector remains more energy efficient than the private sector. However, overheating appears to be more present in recently built properties than older homes.

7.12.9 A future strategy to deliver a carbon neutral outcome in ST14 by 2030 is likely to need to strongly promote residents and businesses taking these steps to reduce overall

[62] Morgan, Malcolm, Anable, Jillian, & Lucas, Karen. (2021). A place-based carbon calculator for England. Presented at the 29th Annual GIS Research UK Conference (GISRUK), Cardiff, Wales, UK (Online): Zenodo. http://doi.org/10.5281/zenodo.4665852.
[63] Ministry of Housing, Communities & Local Government. National Statistics (2020) 'English Housing Survey: Headline Report, 2019-20'. Crown copyright, London.

demand for heating, which in turn will facilitate the transition to more efficient heating technologies such as heat pumps which do not require natural gas to operate and which can then make decarbonisation of heat in the UK possible by eliminating the requirement for fossil fuels at the point of use.

7.12.10 According to the data collected by the Office for National Statistics, East Staffordshire 002 which covers North Uttoxeter has a median energy efficiency score of 69. Staffordshire 003 which covers South Uttoxeter and surrounding areas has a median energy efficiency score of 67 [64]. This would fall into the Band D energy efficiency category and is a slightly higher standard than the England average of 66.

7.12.11 For this study we have considered a ST14 property with the EPC rating as the median for Uttoxeter. This end-of-terrace property has an energy efficiency rating of 67 D. The potential for this property has with improvements could move it to an 84 B. By making the recommended changes could half the annual emissions from 2.4 tonnes of CO_2 to 1.2 tonnes of CO_2. The three suggested improvements for this property are:

- Low energy lighting
- Solar water heating
- Solar PV installation

[64] Office for National Statistics (2021) *Energy efficiency of housing in England and Wales: 2021.* Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/housing/articles/energyefficiencyofhousinginenglandandwales/2021 [Accessed 14 March 2022].

8 FORECAST CHANGES TO BUSINESS AS USUAL

8.1 Climate Change Impact

8.1.1 The IPCC series of reports has demonstrated beyond doubt that the impacts of climate change are real and will impact adversely on a global, national and local level. These will manifest over the coming decades and adaptation work will be required to protect existing infrastructure and to design resilience into new buildings and assets that are constructed in the coming years. Resilience and adaptation are very important areas and will impact on the strategic decision making when considering long term plans. This feasibility study considers a timescale out to 2030. It is considered that the effects of climate change will not have substantially changed the current conditions by 2030. It is noted that extremes of temperature, both hot and cold, are more likely and these events are likely to exaggerate existing issues such as heating and cooling costs and their corresponding carbon emissions. For the purpose of this study however a detailed evaluation of these impacts is not considered. This section provides a summary of the potential impact of climate changes that are expected to impact the region, and how this compares to the rest of the UK.

8.1.2 The most frequently used climate classification map is that of Köppen-Geiger[65]. The re-analysed Köppen-Geiger map from 2017[66] provides a higher resolution and is representative for the 25-year period 1986-2010. Figure 21 shows how the majority of the UK, including England, is classified under Köppen-Geiger as having a 'Cfb' climate.

[65] Kottek, M., J. Grieser, C. Beck, B. Rudolf, and F. Rubel, 2006: World Map of the Köppen-Geiger climate classification updated. Meteorol. Z., 15, 259-263. DOI: 10.1127/0941-2948/2006/0130.
[66] Rubel, F., K. Brugger, K. Haslinger, and I. Auer, 2017: The climate of the European Alps: Shift of very high resolution Köppen-Geiger climate zones 1800-2100. Meteorol. Z., 26, 115-125.

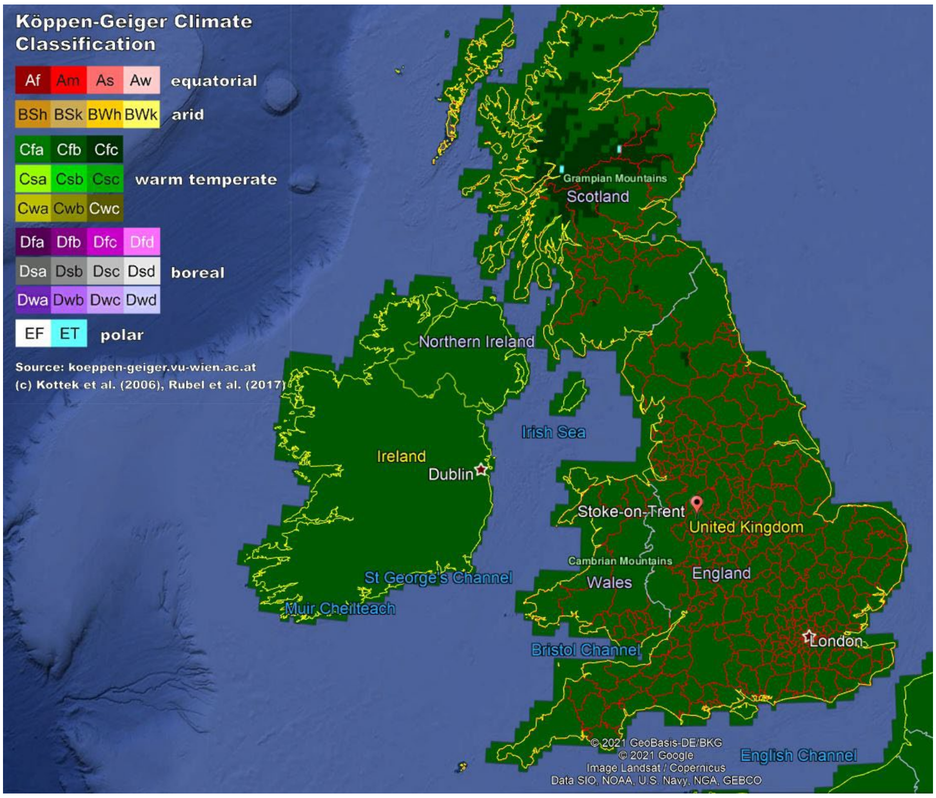

Figure 21 - The Köppen-Geiger climate classification map shows England as having a warm temperate oceanic climate, Cfb (Source: http://koeppen-geiger.vu-wien.ac.at/)

8.1.3 A Cfb climate is more commonly known as a temperate oceanic climate. Temperate oceanic climates are typically mid-latitude climates with warm summers and mild winters. The average temperature in all months will be below 22 °C and there is not an identifiable dry/wet season (i.e., precipitation rates are similar year-round).

8.2 Historic Weather Events and Impacts

8.2.1 The UK, including the Staffordshire area, has a history of adverse weather events. An increase in mean temperature intensifies adverse weather and increases the frequency of extreme events. Details of historic adverse weather events between 1990-2000 were obtained from weather records held by the UK Meteorological Office (Met Office)[67].

8.3 Regional Climate Change Projections

8.3.1 Climate change will have both direct (operational and performance-based) and indirect (securing of supplies and rising energy costs) impacts on residents and visitors to the city. The Climate Change Projections for the UK (UKCP18) are used to study the regional impacts of climate change. Regional and Local projections represent small

[67] https://www.metoffice.gov.uk/weather/learn-about/past-uk-weather-events [Accessed August 2021]

scale climate changes through a narrower sampling of uncertainty and provide the detail needed to inform local decision-making regarding adaptation.

8.3.2 The IEMA guidance 'Environmental Impact Assessment Guide to: Climate Change Resilience and Adaptation' (2020) explains how our climate is changing but there remain uncertainties in the magnitude, frequency and spatial occurrence, either as changes to average conditions or extreme conditions, which generally makes it difficult to assess the impacts of climate change in relation to a specific region or development project. Therefore, scientific assumptions must be made in order to assess the resilience of new developments to any future changes in climate.

8.3.3 Climate change projections for the UK (UKCP18) are based on global climate simulation models to explore regional responses to climate change. UKCP18 considers the effects arising from a series of emissions scenarios and Representative Concentration Pathways (RCP) which project how future climatic conditions in the UK are likely to change at a regional level, taking account of naturally occurring climate variations. Probabilistic projections provide a range of possible climate change outcomes and their relative likelihoods (ranging across 10^{th} to 90^{th} percentiles).

8.3.4 The UKCP18 dataset provides future climate change projections for land and marine regions as well as observed climate data for the UK. Analysing time series plume data from UKCP18 provides an indication of climate projections for the regional 25 km grid that encompasses Uttoxeter and the surrounding area.

8.3.5 Figure 22, Figure 23 and Figure 24 are based on the four Representative Concentration Pathways (RCP) and show how the climate in the region could change up to the year 2100, compared to a 1982-2000 baseline. The RCPs are used to analyse how different emission scenarios could affect climate projections. These range from RCP 2.6 where atmospheric emission concentrations are strongly reduced through to the worst-case scenario, RCP 8.5, where emission concentrations continue to rise unmitigated.

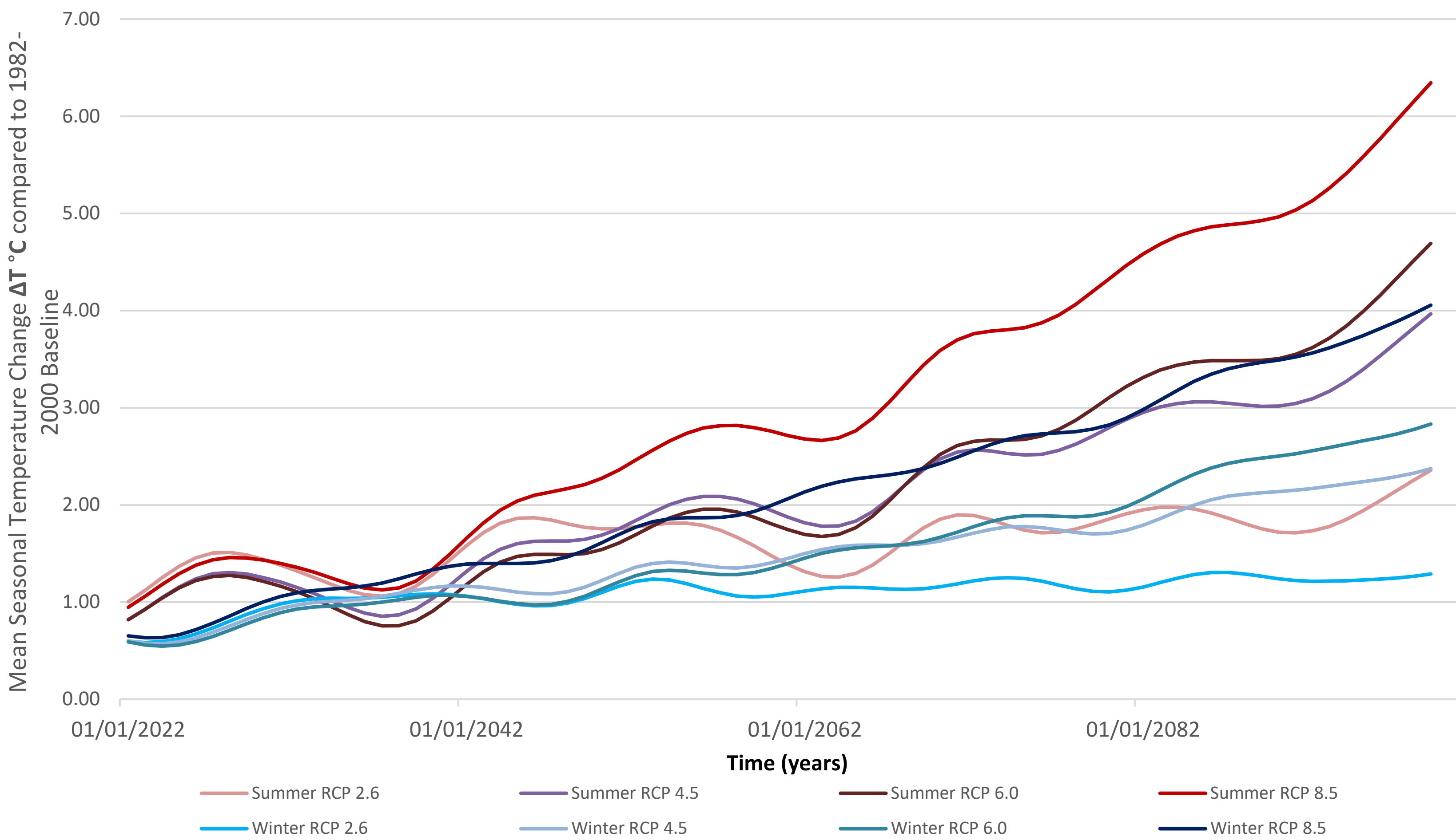

Figure 22 - Projected changes in seasonal Mean Air Temperature across four RCP scenarios, from 2022-2100 compared to the 1981-2000 baseline, using the probabilistic projections (50th percentile) for a 25Km grid around Uttoxeter.

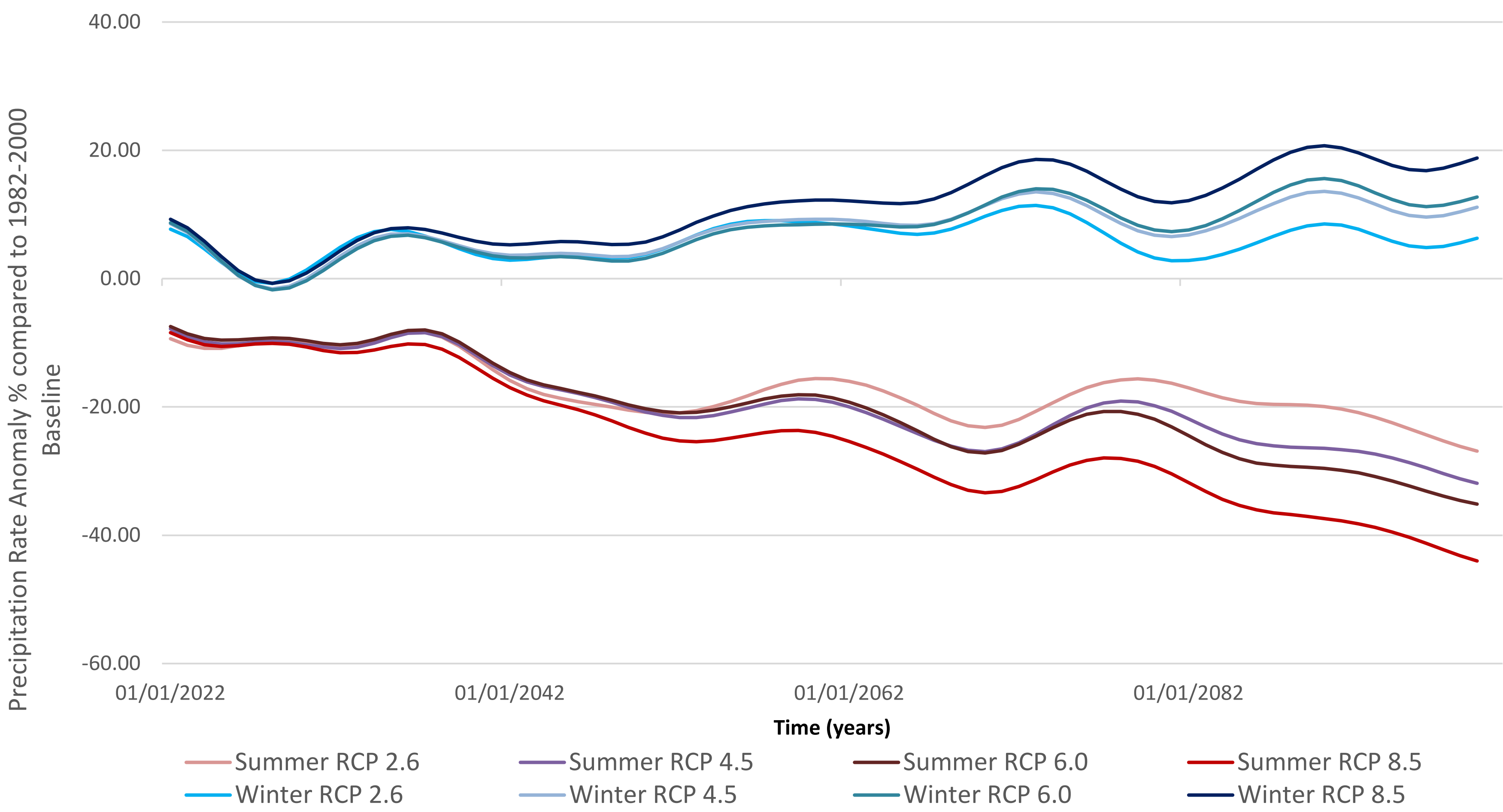

Figure 23 - Projected changes in seasonal Average Precipitation across four RCP scenarios, from 2021-2099 compared to the 1981-2000 baseline, using the probabilistic projections (50th percentile) for a 25Km Grid around Uttoxeter.

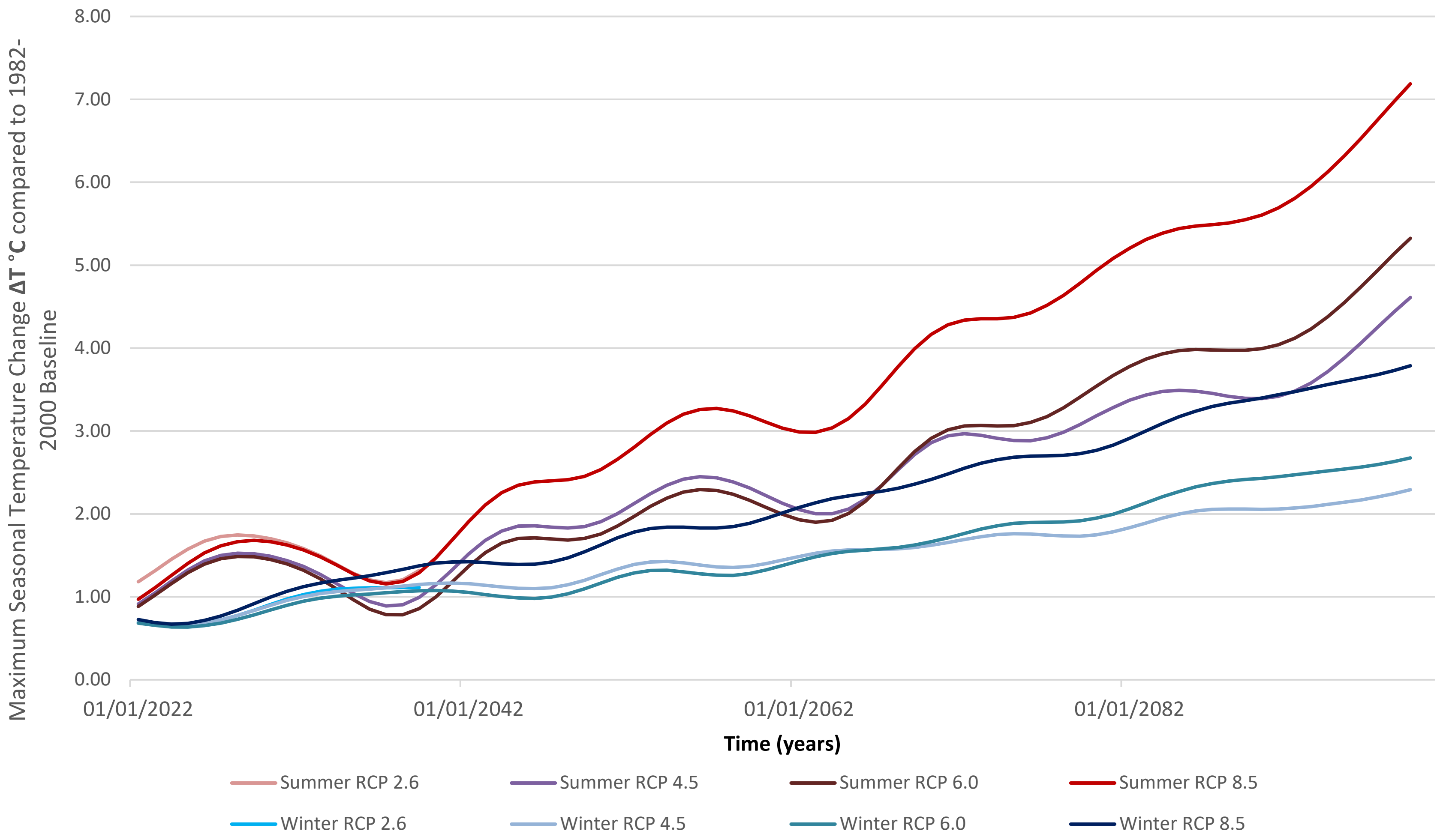

Figure 24 - Projected changes in seasonal Maximum Temperature across four RCP scenarios, from 2021-2099 compared to the 1981-2000 baseline, using the probabilistic projections (50th percentile) for a 25Km Grid around Uttoxeter.

8.3.6 All areas of the UK are projected to experience warming, which will be greater in the summer than in the winter. By 2050, the chance of summers being hotter than in 2018 is around 50 %. Not every summer will be hotter than the last, but heatwaves are likely to be longer and happen more often. Both summer and winter temperature records are expected to be regularly broken in the coming years. Between 2061 and 2080, an average temperature increases of 3°C to 6°C is predicted for the West Midlands area across all emissions scenarios.

8.3.7 Rainfall measurements fluctuate from year to year, making projections challenging but assumptions are possible based on previous trends. Summer rainfall is expected to occur from short-lived, high intensity showers and decrease overall, whereas winter precipitation is expected to increase. By 2070, extreme hourly rainfall intensity from a typically biennial event will increase by 25 %.

8.3.8 Extreme weather is predicted to become more frequent and intense. A summary of a range of projected changes to climate variables can be used to build-up a holistic view of future climate and assess potential impacts to determine a future climate baseline, using RCP 8.5 as a conservative approach. According to UKCP18, relative probabilities for specific outcomes are typically much higher near the 50 % cumulative probability level (median) of the distribution, than for outcomes lying either below the 10 % cumulative probability level or above the 90 % cumulative probability level.

8.3.9 The worst-case scenario presented in Table 12 indicates an increase in mean temperature in both summer and winter, which corresponds with seasonal precipitation increasing in winter and decreasing in summer. This highlights the need for all new development to be able to deal with the potential risks for both increased flooding and increased heatwaves. However, it is not expected to create a significant impact within the time horizon of the study.

8.4 Impacts from a changing climate

8.4.1 The impacts on ST14 from the effects of climate change are not likely to greatly influence emissions in 2030. We do not predict destruction to green infrastructure such as wetlands or woodlands, which would curb their ability to sequester carbon from the atmosphere. In the longer term, residential and non-residential buildings will need mechanical ventilation to mitigate the effects of overheating. This will require additional energy use. These measures are baked into the Building Regulations. Part O and Part H cover overheating and ventilation respectively.

8.4.2 Reduced precipitation during summer will impact crops and farmland and could result in lower yields. This could make diversifying land more attractive to farmers. Shelter for livestock has been identified as a benefit of woodland expansion, which will be more important as the climate warms. A further detailed study could assess the likely effects of climate change on the area.

Table 12 - Quantitative summary of future baseline for climatic variables in Uttoxeter

Season	Variable	Time Period	Median (50th percentile)
Winter	**Mean Temperature (ºC)**	2030s	1.14
		2090s	3.73
	Mean Precipitation (%)	2030s	5.78
		2090s	18.48
Summer	**Mean Temperature (ºC)**	2030s	1.26
		2090s	5.56
	Mean Precipitation (%)	2030s	-11.04
		2090s	-40.27

8.5 Population

8.5.1 The population within the ST14 postcode boundary is 20,789 persons[68]. We are not aware of any plans that will see this figure substantially increase or decrease in the period to 2030. As such the projection for emissions to 2030 has not included adjustment for population change. However, there are plans that do address the growth of population which include a mixture of developments on Brownfield and Greenfield sites in Uttoxeter such as Brookside Industrial Estate, JCB - Pinfold Road, Uttoxeter West and Hazelwalls, respectively. The Local Plan discusses the land allocation to meet the housing provision and states that in Uttoxeter, there is a total of 79 houses per year[69]

8.6 Transport

8.6.1 Annual baseline transport emissions are calculated to be 78,892 tCO_2e.

8.6.2 The Government intends to phase out diesel and petrol cars, with a ban on the sale of new vehicles of this type by 2030. Facilitating the use of ULEVs, public transport, public

[68] Centre for Sustainable Energy & University of Exeter (2022) *Impact Tool Community Carbon Calculator*. Available from: https://impact-tool.org.uk/using-impact [Accessed 15 March 2022].
[69] East Staffordshire Local Plan (2015) *Planning for change.* Available from: https://www.eaststaffsbc.gov.uk/sites/default/files/docs/planning/planningpolicy/localplan2012-2031/Local-Plan-2012-2031-FINAL.pdf [Accessed 19 July 2022].

cycle share schemes, and other sustainable modes of transport will lower emissions in the longer term.

8.6.3 The relationship between air quality and climate change is highly complex but is an important consideration due to the direct risk to human health. Taking actions to improve air quality across the city will not only support a healthier population but will also mitigate against the impacts of climate change. Cross boundary initiatives to improve the effectiveness of climate change policies should be considered, to develop the policy approach where it would lead to the reduction of emissions.

8.6.4 Improving fabric efficiency of existing houses can vastly reduce heating demand and could reduce domestic gas consumption significantly. A policy that is helping to reduce fuel bills and fuel poverty is in some instances likely to lead to increased energy consumption and carbon emissions. Climate change policies should be prioritised which both reduce carbon emissions and alleviate fuel poverty, and which avoid impeding progress in the other.

8.6.5 Transitioning from gas combustion to electricity where possible will result in lower emissions with the decarbonising national grid and will be aligned to the aims of the UK Government's Net Zero Strategy.

8.7 Renewable Energy Generation

8.7.1 This study has scoped out grid connected renewable energy generation on the basis that such renewable deployment would contribute, albeit only to a very limited extent, to the reduction in national grid carbon factor for electricity. As such the marginal impact will be very limited in terms of decarbonisation impact for ST14.

8.7.2 A further study could consider commercial roof mounted solar PV or PV on adjacent land. Such a study would need to consider land ownership, current use and planning restrictions along with more detailed assessment of the building-level consumption as commercial building systems can be large and the internal electricity demand and co-incidence of generation and consumption on site becomes relevant.

8.8 Housing

8.8.1 The East Staffordshire Local Plan suggests Uttoxeter would require a housing supply of 630 new houses between 2022-2030. These houses need to match current Part L building regulations which would ensure Target Emission Rates are met. Given the FHS and more stringent energy efficiency targets, the impact from these additional houses is likely to be negligible and will not greatly contribute to territorial emissions.

8.9 Industrial

8.9.1 WA are not aware of any significant changes to the industrial landscape of the region. Any substantial changes such as a large employer moving into, or away from the region will impact territorial emissions.

8.10 Business As Usual flightpath

8.10.1 The annual carbon emissions for each year to 2030 can be plotted based on predicted carbon factors and policy statements for expected change in the ST14 scope area. Plotting these annual emissions creates a BAU flightpath which is a projection of how the carbon footprint will change during the period without any local intervention. This BAU flightpath identifies grid decarbonisation as an expected reduction to carbon emissions. The total CO_2 emissions arising from the use of electricity within the ST14 scope area are presented in Figure 25, which shows the predicted impact arising from grid decarbonisation.

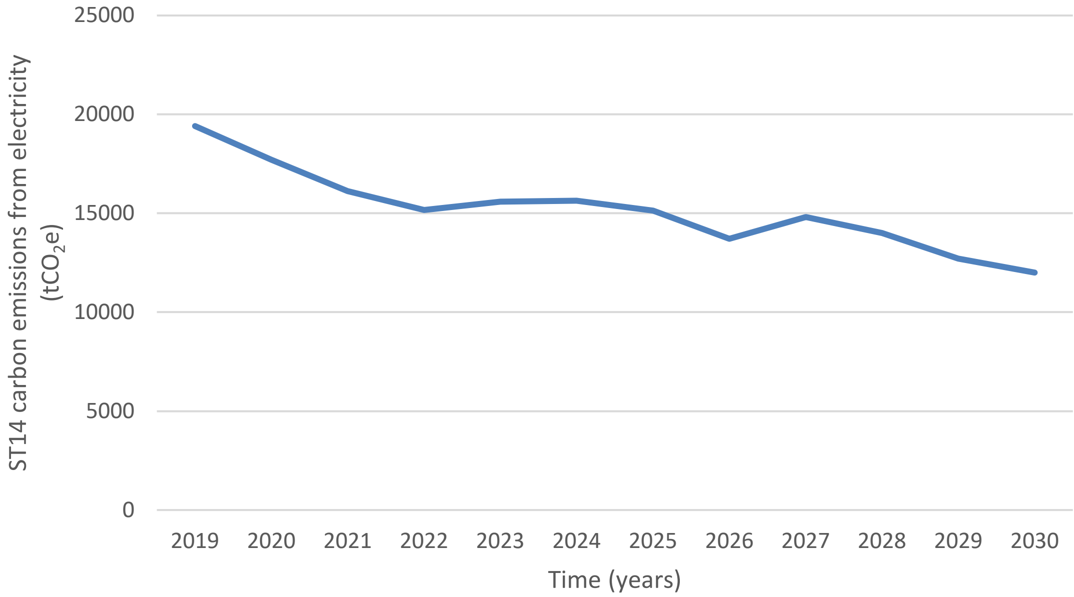

Figure 25 - Emissions impact from decarbonisation of the grid

8.10.2 Total ST14 emissions with the inclusion of the projected grid decarbonisation is presented in in Figure 26, highlighting the relatively small contribution that decarbonisation of grid electricity will make to the overall baseline. This is because the emissions arising from electricity are currently not the major source of emissions in the rural ST14 setting, where it is transport and agricultural emissions that are dominant.

8.10.3 The relatively limited impact of grid decarbonisation under the business as usual scenario could be increased through electrification of transportation and heat. With the available data it was not possible to evaluate the likely potential impact of electrification of heat in the commercial and industrial sector where the balance between process, space and hot water heating is not known. The impact of electrification of heat in the domestic heat segment is considered within the study.

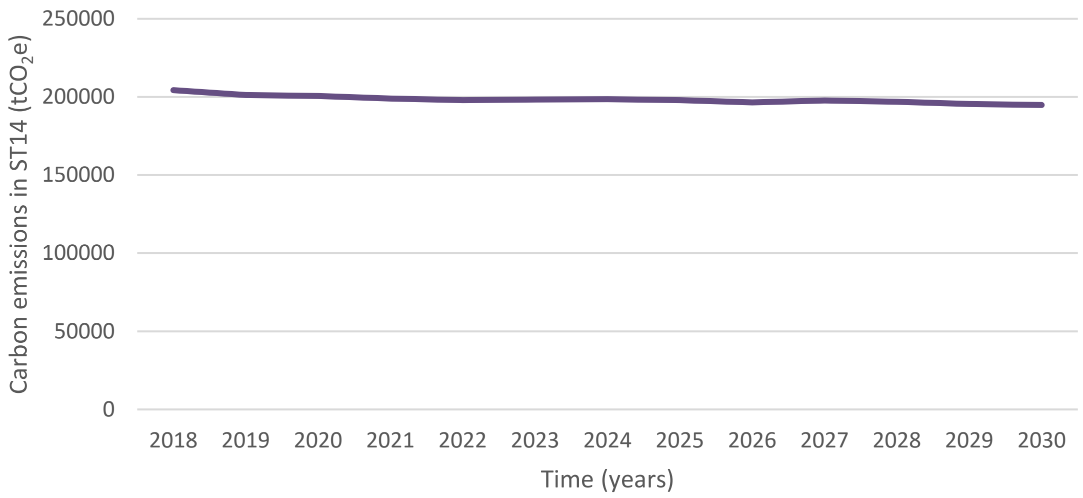

Figure 26 - BAU flightpath for emissions in the ST14 poscode boundary reflecting grid decarbonisation

8.10.4 As Figure 26 indicates, the impact of grid decarbonisation on the footprint of ST14 will not be highly significant in the business as usual scenario due to the emissions arising from the use of electricity being a relatively small component of total emissions. Electrification of heating (switching to heat pumps) will increase the amount of exposure to the benefit of grid decarbonisation. However, the main carbon contributors in the scope area were found to be transport and agricultural emissions and there are currently no stated plans to transition to an alternative fuel source, or change the status quo with farming, by 2030 which could be built into the projection.

8.11 Sixth Carbon Budget Projection

8.11.1 Meeting the UK's Sixth Carbon Budget targets would require a reduction in UK greenhouse gas emissions of 78% by 2035 relative to 1990[70].

[70] Climate Change Committee (2020) *The Sixth Carbon Budget: The UK's path to Net Zero.* Available from: https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf [Accessed 31 March 2022].

This is equivalent to a 63% reduction in 2035, based on 2019 levels. For this estimation, the 2018 baseline emissions total was also used for the year 2019.

8.11.2 A flightpath in line with these targets is presented in Figure 27. A linear interpolation between these figures is displayed. In 2030 this would leave 115,832 tCO_2e residual emissions. This projection considers 2019 emissions to be at the same level as the baseline 2018 year.

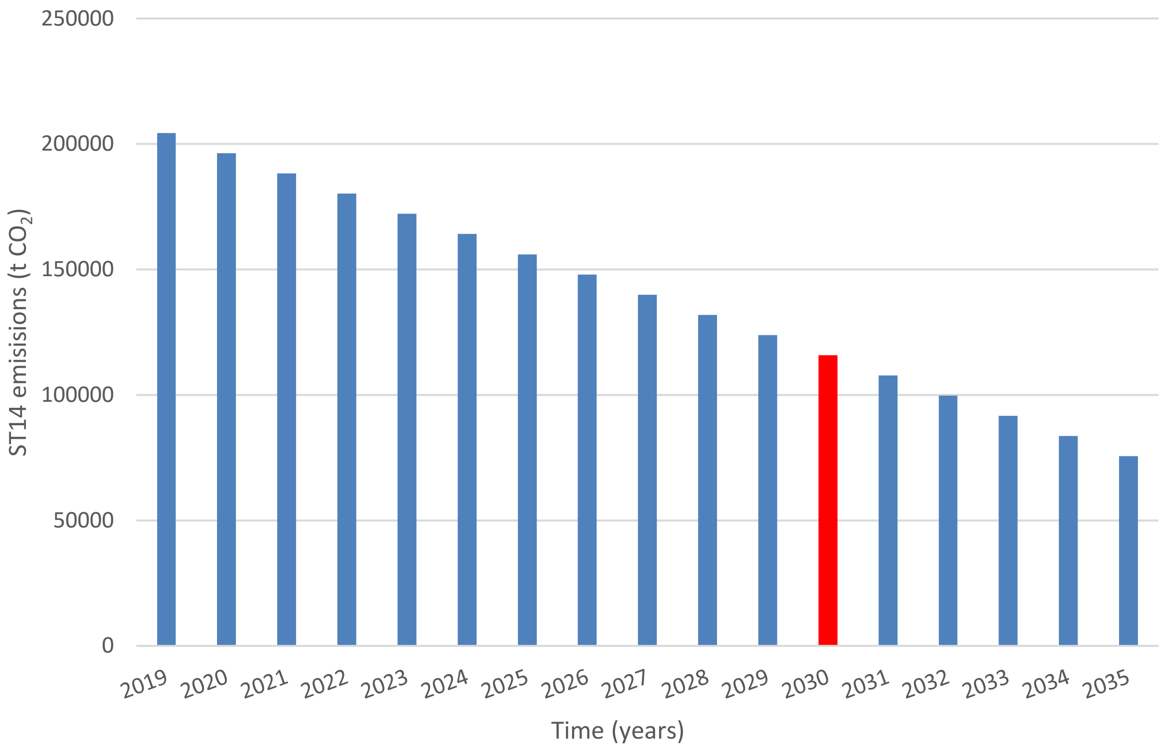

Figure 27 - Sixth Carbon Budget Projection: ST14 emissions (t CO_2) with linear progression to 2035

8.11.3 The Sixth Carbon Budget projection shows a carbon reduction target, in line with national recommendations by the CCC.

8.12 Summary

8.12.1 Total GHG emissions in the ST14 postcode boundary in 2019 is estimated to be 204,335 tCO_2e per annum. The BAU scenario suggests there would be a total of 194,884 tCO_2e emissions in 2030.

8.12.2 This equates to a reduction of 9,451 tCO_2e in 2030.

SECTION TWO

Evaluating the interventions

9 INTERVENTIONS

9.1.1 This section discusses what could be done to support the delivery of the 2030 target to be net zero carbon. This builds on the assessment within Section One that considers the current emissions and the current expected trajectory for carbon emissions based on existing plans and interventions.

9.1.2 An intervention is a defined action or activity that is intended to result in a reduction in carbon emissions at a measurable scale and usually in an identifiable time period. This could be through an initiative to install new equipment (such as solar panels) or it could be a behavioural change activity aimed at encouraging people to consume less energy through their actions.

9.1.3 It is recognised that some of these activities will happen at a small scale under the BAU scenario with no driving action or intervention. For example, people will most likely continue to move towards using electric vehicles over time. It is likely to assume that, as gas prices increase and gas boilers are no longer in favour, a greater number of people will move towards fitting heat pumps in their homes under the business as usual scenario. However, it is assumed that this will be a low level trend and the interventions described in this report are based on the assumption that they would be intended to produce a pronounced shift within the current decade, at a rate far above what is reasonably likely to happen under the current policy and market conditions.

9.1.4 The Sustainable Uttoxeter project has ten working group themes. Interventions will be paired with working groups as an indication of which group might be best suited to address the intervention. Most interventions consider housing emissions and do not spread the full range of the working groups. However, each intervention was matched to a new working group. This is not intended to be prescriptive but as an indication of how the tasks could be divided.

9.2 Domestic Energy Performance Improvements

9.2.1 EPCs indicate how energy efficient a building is and give it a rating between A (efficient) to G (inefficient). They also suggest costs for improvements and likely carbon emissions from use of the building. EPCs are issued by accredited domestic energy assessors. In the UK, EPCs are required whenever a property is built, sold or rented.

9.2.2 The typical ST14 house discussed in Section 6 has not been named. This property is presented only as an example and the homeowner was not contacted, nor were the properties visited for the purpose of developing these conclusions. This property has suggested improvements alongside costs and CO_2 savings. As a guide, the improvements given on the EPC can act as an indication of potential housing improvements for the region.

9.2.3 Figure 28 shows the improvements on the EPC alongside costs.

Recommendation 1: Low energy lighting

Low energy lighting

Typical installation cost	£25
Typical yearly saving	£25
Potential rating after carrying out recommendation 1	68 | D

Recommendation 2: Solar water heating

Solar water heating

Typical installation cost	£4,000 - £6,000
Typical yearly saving	£41
Potential rating after carrying out recommendations 1 and 2	71 | C

Recommendation 3: Solar photovoltaic panels, 2.5 kWp

Solar photovoltaic panels

Typical installation cost	£3,500 - £5,500
Typical yearly saving	£308
Potential rating after carrying out recommendations 1 to 3	84 | B

Figure 28 - Example EPC

9.2.4 Recommendations 1 & 2 show the improvements alongside costs. The UK Government target is for all homes to have an EPC rating of C or higher by 2035[71]. In this typical house, a spend of £4,025 - £6,025 would achieve that target.

9.2.5 This could be considered a ballpark figure for a typical energy performance improvement cost. This would reduce the annual CO_2 emissions from the house from 2.4 tonnes of CO_2 to 1.2 tonnes per year.

9.2.6 For comparison, a second house with an EPC rating of 67 D was considered within Uttoxeter. This property has six recommendations. These can be seen in Figure 29 and Figure 30.

[71] Energy Live News (2021) *All Homes to Have EPC rating of C by 2035: The Challenge.* Available from: https://www.energylivenews.com/2021/04/08/all-homes-to-have-epc-rating-of-c-by-2035-the-challenge/ [Accessed 21 March 2022].

Recommendation 1: Floor insulation (solid floor)

Floor insulation (solid floor)

Typical installation cost	£4,000 - £6,000
Typical yearly saving	£67
Potential rating after carrying out recommendation 1	69 | C

Recommendation 2: Low energy lighting

Low energy lighting

Typical installation cost	£25
Typical yearly saving	£20
Potential rating after carrying out recommendations 1 and 2	70 | C

Recommendation 3: Heating controls (room thermostat)

Heating controls (room thermostat)

Typical installation cost	£350 - £450
Typical yearly saving	£32
Potential rating after carrying out recommendations 1 to 3	71 | C

Figure 29 - Example EPC

Recommendation 4: Replace boiler with new condensing boiler

Condensing boiler

Typical installation cost	£2,200 - £3,000
Typical yearly saving	£55
Potential rating after carrying out recommendations 1 to 4	73 | C

Recommendation 5: Solar water heating

Solar water heating

Typical installation cost	£4,000 - £6,000
Typical yearly saving	£36
Potential rating after carrying out recommendations 1 to 5	74 | C

Recommendation 6: Solar photovoltaic panels, 2.5 kWp

Solar photovoltaic panels

Typical installation cost	£5,000 - £8,000
Typical yearly saving	£269
Potential rating after carrying out recommendations 1 to 6	84 | B

Figure 30 - Example EPC

9.2.7 This property has the potential to reduce its emissions of 3.9 tonnes CO_2 annually to 2.0 tonnes with all suggested improvements on the EPC.

9.2.8 It should be noted that in both cases, solar PV has the highest potential energy performance improvements.

9.2.9 To average the emissions savings from these two EPCs gives an annual reduction of 1.55 tCO_2. If this was applicable to the whole region, 9,916 homes x 1.55 tonnes = 15,369 tCO_2 mitigated.

9.2.10 Figure 31 provides an estimate of CO_2 mitigation if suggested improvements were actioned, considering typical ST14 houses as applicable to the entire study area. These suggested improvements have not included the installation of heat pumps.

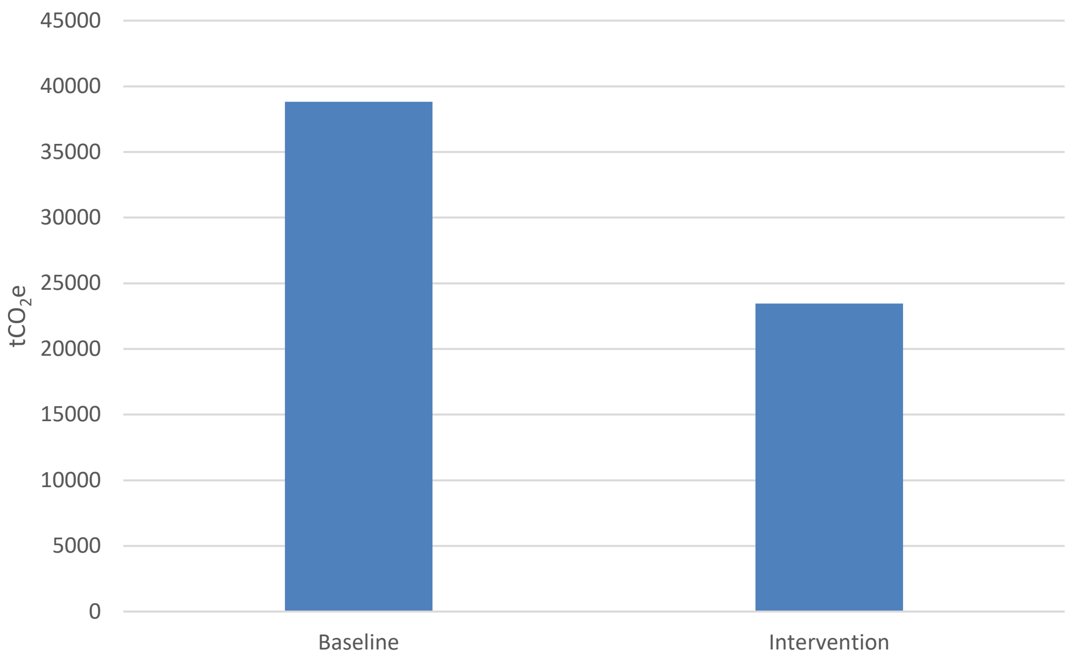

Figure 31 - EPC improvements intervention

9.2.11 Figure 32 shows how EPC improvements might look over time. This allows for slower works at the beginning of the decade with an acceleration towards 2030. This is to account for likely mobilisation time and an expected growth in supply chain capacity.

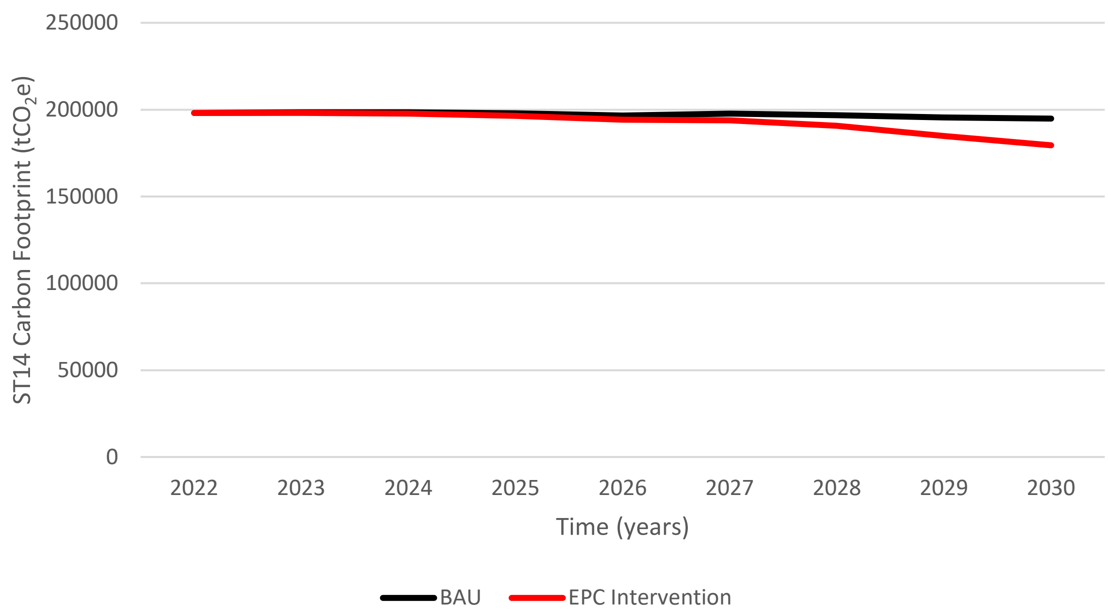

Figure 32 - EPC Interventions

9.2.12 We believe this intervention will be best addressed by the Housing & Planning working group. This intervention will take place over the next few years leading up to 2030. The working group will need to recognise EPC data is an incomplete picture of the housing stock. EPCs only cover a proportion of the housing stock within the boundary. The working group should build relationships with the installers to gain a more accurate understanding of the energy performance of the housing stock in ST14.

9.3 Heat Pumps

9.3.1 Heat pumps are a technology solution that absorbs heat in one location and rejects it into another location. In refrigeration applications heat pumps absorb heat from within the space and reject it to the outside. When operating in heating mode that process is reversed, so heat is absorbed from outside and rejected into the internal space. This is most efficiently done when the temperature differential between those two locations is relatively small, for example 30-40 degrees. Heat pumps also function best when the area they are absorbing heat from is not too cold, so there are some design and operational challenges when using them in settings where the outside temperature can fall low and remain low for prolonged periods.

9.3.2 Heat pumps do not create energy, but rather they simply use electricity to move heat. The carbon footprint of the electricity depends upon how it was generated, so if a heat pump is utilising grid electricity in the UK, then the carbon footprint of the heat (or cooling effect) that is supplied to the internal space will be defined by the carbon footprint of the grid at the time the electricity was used. If the heat pump operates using entirely renewable electricity then there is no operational carbon footprint.

9.3.3 If renewable electricity was very cheap and in great supply, then the efficiency of heat pumps is less of a consideration. However, in the near term electricity costs and the limited availability of renewable electricity means that it is best to operate heat pumps in applications where they will run efficiently. This means using them in low-temperature applications wherever possible, for example supplying underfloor heating systems, or using them with low temperature radiator or fan convectors. Traditional properties in the UK have utilised wet heating systems that use radiators normally paired with a gas boiler, warm air blowers or direct electric heating (with the night-storage types including thermal storage in order to reduce costs by using off-peak electricity). Heat pumps are expected to be able to operate with a wet radiator system and could supply a warm air system, however some modification to those systems would be required in order to achieve the expected comfort levels for the occupants.

9.3.4 The assessment methodology considered the data provided by East Staffordshire Council. It was recognised that properties with existing wet heating systems would be easier and cheaper to fit with heat pumps. The data allowed for the total properties with EPC data to be split into three categories: properties with heat pumps, properties with wet systems, properties without wet systems. This data split is shown in **Table *13***.

Table 13 - Assessment of potential properties viable for heat pump installation

Main heating system	**Amount using EPC data**	**Total ST14 properties estimate**
Heat pump (ASHP or GSHP)	65	110
Wet system	5,066	8,586
Without wet system	713	1,208
Total	5,844	9,904

9.3.5 Table 13 extrapolates the EPC data to consider if the dataset was typical of the wider ST14 area. For this calculation it considers EPC data to be precisely 59% of total properties.

9.3.6 The data suggests 87% of properties have existing wet systems which would be most suitable for fitting heat pumps.

9.3.7 Domestic emissions represent approximately one fifth of all emissions in ST14. Natural gas combustion in dwellings produced 15,911 tCO_2e in 2018 which equates to 8% of total emissions in the area. Improving fabric efficiency of existing houses can vastly reduce heating demand and could reduce domestic gas consumption significantly. The energy use of a home can also vary widely according to the choices and behaviours of the occupants. Encouraging a beneficial change in the way occupants use their heating, ventilation or hot water can achieve significant savings in both cost to households and reduction in domestic emissions.

9.3.8 According to the CSE emissions data, 8% of total emissions in ST14 are due to domestic gas use. This equates to 16,347 tCO_2e. Reversing the 2017 conversion factor for kWh (Net CV) of natural gas gives 79,885,647 kWh.

9.3.9 Therefore, this would suggest if all properties in ST14 had their gas boilers replaced with heat pumps, this would reduce emissions from 16,347 tCO_2e to 3,066 tCO_2e. Further detail on this calculation can be seen in Table 14.

Table 14 - Calculation for replacement of gas boilers with heat pumps

79,885,647 kWh_g	multiplied by 0.85 (average boiler efficiency)	67,902,800 kWh_{th}
67,902,800 kWh_{th}	divided by 3.5 (COP for heat pump)	19,400,800 kWh_e
19,400,800 kWh_e	multiplied by 0.15806 (Projected 2030 electricity carbon factor)	3,066.5 tCO_2e

9.3.10 This would reduce domestic gas heating emissions by 13,281 tCO_2e.

9.3.11 The second largest emitter within homes is oil, this equates to 11,586 tCO_2e. Reversing the 2017 conversion factor for kWh (Net CV) of burning oil gives 44,635,358 kWh.

9.3.12 If all homes that used oil fired boilers switched to heat pumps, this would reduce emissions from 11,586 tCO_2e to 1,512 tCO_2e per year. Further detail on this calculation can be seen in Table 15.

Table 15 - Calculation of oil boiler replacement by heat pumps

44,635,358 kWh	multiplied by 0.75 (boiler efficiency)	33,476,518 kWh
33,476,518 kWh	divided by 3.5 (COP for heat pump)	9,564,719 kWh
9,564,719 kWh	multiplied by 0.15806 (Projected 2030 electricity carbon factor)	1,511.8 tCO_2e.

9.3.13 This would reduce domestic oil heating emissions by 10,074 tCO_2e per year.

9.3.14 This intervention would suggest switching all gas and oil home heating systems to heat pumps would decarbonise homes by 23,355 tCO_2e in 2030. Figure 33 shows the impact of this intervention against total domestic emissions.

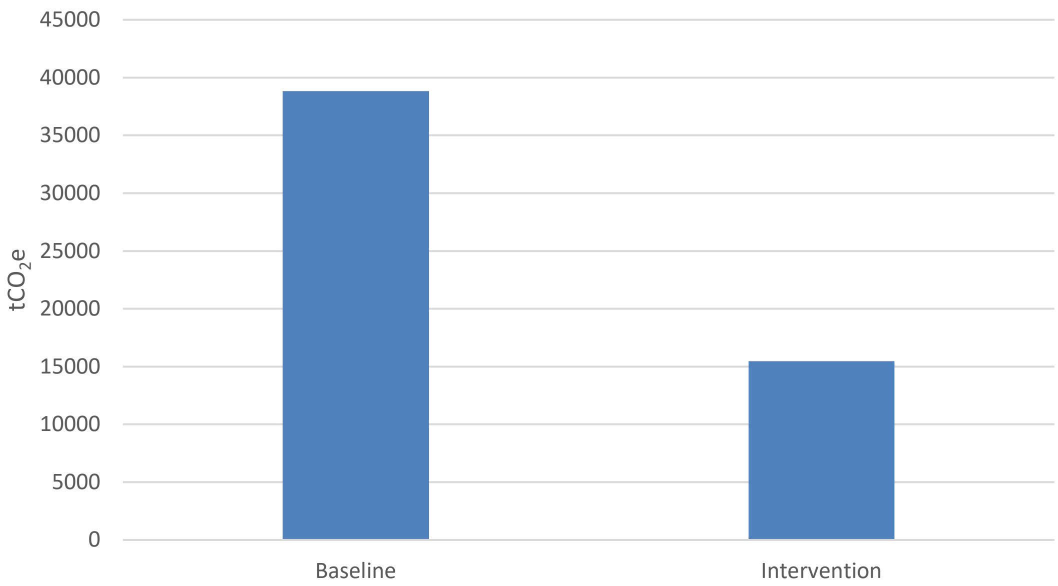

Figure 33 - Heat pump intervention

9.3.15 This solution is applicable to the majority of heat demand cases, from domestic hot water (DHW) to space heating. Process heating requiring steam and high temperature water are not expected to be circumstances where heat pumps would operate efficiently. The study has not identified the proportion of this type of demand within the overall energy load in the scope area, however given the nature of the businesses and industrial processes known to be within the scope boundary it is not expected that this type of demand does not make up a significant proportion of the total.

9.3.16 Figure 34 shows the impact on emissions of heat pumps over time. It considers an increase in supply towards the end of the decade to allow time for mobilisation and supply chain capacity to be increased. The graph accounts for both projected grid decarbonisation as well as a gradual uptake of heat pumps as the decade progresses.

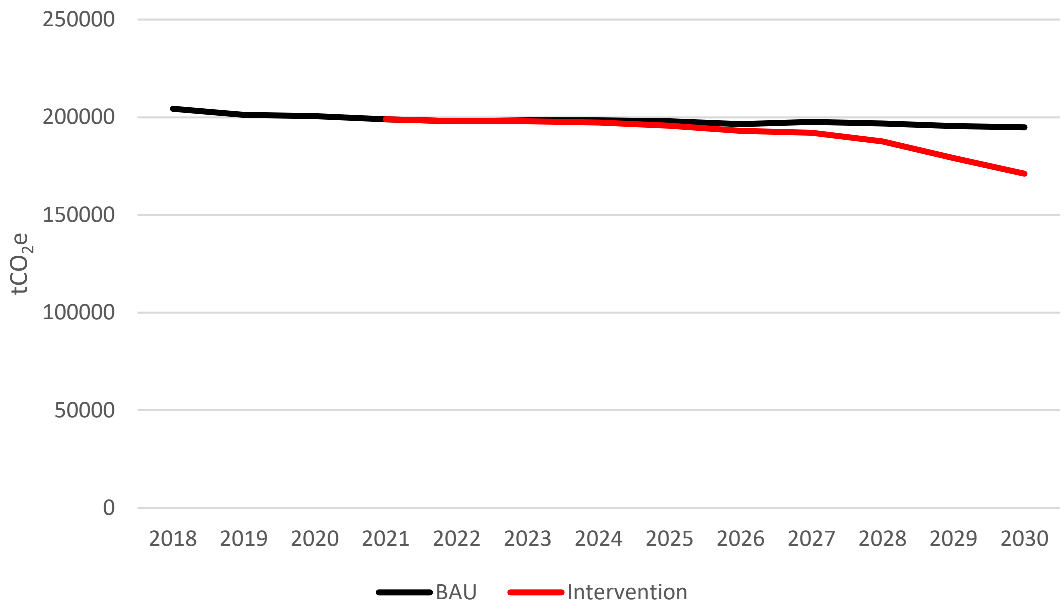

Figure 34 - Decarbonising domestic oil and gas with heatpumps

9.3.17 An example of an Air Source Heat Pump can be seen in Appendix A.

9.3.18 We believe this intervention will be best addressed by the Energy & Water working group.

9.4 Solar PV

9.4.1 Photovoltaic solar cells work by using the natural light falling on the surface to produce an electric current. In recent years the technology has reduced in cost due to large scale manufacture, especially in China, and optimisation of the production process and the technology itself.

9.4.2 In this feasibility study, the main focus when discussing solar renewable energy will be on PV technology. Solar thermal solutions are available and can be useful, however where solar panels are referred to it will be PV unless stated otherwise. Solar panels are relatively lightweight and are able to be roof mounted on most structures. One advantage of solar power is the relatively predictable output, especially when looking at the total energy output over the course of a year. For this reason, it is relatively reliable to predict the total output from PV, based on the latitude of the project, and then the local project characteristics such as orientation, pitch and the level of shading (if any).

9.4.3 The methodology used to assess the PV potential for domestic buildings in the ST14 area was to consider two sample areas and assess the potential by examining the roof types, pitches and orientation to identify the likely PV potential. The density of PV deployable to the sample area was then extrapolated to the total number of dwellings within the ST14 area to indicate an approximate maximum capacity that could be deployed. In each sample area 100 buildings were considered.

9.4.4 It is important to note that these are very high-level estimations only for the potential additional solar PV capacity within ST14 and the area has not been fully assessed for feasibility. While this method is intended to give an impression of the likely scale of potential for roof PV, it is not sufficiently robust to be the basis for long term strategic planning, and further investigation would be required to improve the confidence level for the extrapolated values.

9.4.5 The total number of domestic properties in ST14 is 9,916. Table 16 shows the results from the sample extrapolated to the entire study area.

9.4.6 For this study it is assumed that each set of panels can generate 850 kWh per kW installed per annum. A typical system size is 3kW and the following calculation considers if the sample average was applied to the total number of properties in the study area.

Table 16 - High level assessment of likely domestic photovoltaic capacity

Roof orientation	Sample percentage	Total domestic properties
East, West or North facing	40%	3,966
Existing solar PV	5%	308
South facing roofs without visible PV	55%	5,454

9.4.7 The annual potential for solar PV on South facing roofs without existing PV is 13,907,700kWh.

9.4.8 As an assumption that 75% of roofs that do not face South are suitable for PV but with a reduced production rate at 80% output. This would result in a reduced annual rate of perhaps 680 kWh per kW installed, producing an additional annual potential of 8,090,640kWh of renewable electricity.

9.4.9 Therefore, the total potential annual energy generation of domestic solar PV is estimated to be 21,988,340kWh.

9.4.10 WA have used BEIS energy projections[72] to forecast the grid carbon intensity in 2030. The projected carbon factor of 0.15806 is used to estimate the level of emissions will be displaced by solar PV in 2030. This could result in 34,755 tCO_2e being mitigated. Subject to there being sufficient energy demand to use all this generation.

9.4.11 While solar PV will be a relatively cheap part of the solution, the true impact is difficult to accurately quantify. The reason for this is the seasonal disparity between generation. In the summer, more energy would be generated than each property could use. This would result in electricity be put back onto the national grid. During the winter, a low amount of energy will be generated, and homes will need draw electricity from the national grid.

9.4.12 We believe this intervention will be best addressed by the Energy & Water working group.

9.5 Domestic solar PV case study

9.5.1 The Devon Solar Together scheme invited homeowners to invest in rooftop solar which enabled them to procure the technology at a low cost. The scheme saw nearly 7000 panels installed over 535 homes with a total capacity of 2065kW[73].

9.5.2 Brighton & Hove City Council have benefitted from the SOLARISE project which has seen solar panels fitted on a number of council housing developments across the city[74].

9.5.3 Solar panels were fitted to a development of new flats and monitoring has shown that residents were saving around 35% on the unit costs of their electricity bills.

9.5.4 An image of solar photovoltaic panels can be seen in Appendix F.

9.6 Potential for Renewable Energy Generation

9.6.1 The potential for grid connected renewable energy generation is not considered within the scope of this feasibility study. Renewable energy generation which connects

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[72] Department for Business, Energy & Industrial Strategy (2019) *Updated Energy and Emissions Projections 2018.* Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794590/updated-energy-and-emissions-projections-2018.pdf [Accessed 24 March 2022].

[73] Devon County Council (2022) *Energy from homeowner's solar project 'equivalent to a small solar farm.'* Available from: https://www.devon.gov.uk/news/energy-from-homeowners-solar-project-equivalent-to-a-small-solar-farm/ [Accessed 15 July 2022].

[74] Brighton & Hove City Council (2022) *Celebrating solar's power to reduce bills and carbon emissions.* Available from: https://www.brighton-hove.gov.uk/news/2022/celebrating-solars-power-reduce-bills-and-carbon-emissions [Accessed 15 July 2022].

directly to the grid would contribute to the reduction in the national grid carbon intensity, rather than achieving a local reduction as would be the case were it connected directly a consuming site within the scope boundary. The marginal reduction in grid carbon intensity from field-based grid-connected renewables within ST14 is unlikely to have a significant and measurable impact on the grid carbon factor decarbonisation of the ST14 region and is therefore not considered.

9.7 Supply Chain Analysis

9.7.1 Any programme of work to deliver an increase in deployment of a technology within an area will be impacted by the supply chain capacity to deliver it. If an assumption were made that every existing domestic property were to be converted to use heat pumps by 2050 then the required rate of installation would be 354 per annum until that date. If the likely number of properties that could made good use of PV were installed by 2050 then the rate of installation would be 213 per year.

9.7.2 The current aspiration is to achieve carbon neutrality in the ST14 area by 2030. This will require technologies to be fitted prior to 2030. Heat pump and solar technologies are much more impacted by global supply chain issues. It is noted that even if an early move were made to install PV and heat pumps at scale across the scope area the challenge is very significant. In practical terms it is not expected to be viable to achieve a large scale shift of both PV and heat pumps by 2030, however as PV is relatively straightforward and less intrusive to install it may be that, with an attractive financing model, a significant roll-out could be achieved in the time.

9.7.3 A strategy to achieve net zero by 2030 may consider early action to identify how sufficient installer capacity will be available to deliver any increased roll-out as part of the delivery model for achieving the target. An initiative to increase training in order to build capacity may be helpful.

9.7.4 MCS accredited electrical contractors were identified who should be able to carry out PV installations within the ST14 area. Note that the listing of a contractor is not an endorsement or recommendation, but rather an acknowledgement of potential installer capacity to support increased deployment of PV in the scope area. The current number of installers is unlikely to represent a bottleneck at the current rate of PV deployment, however in order to maximise the level of PV deployment by 2030 a significant increase in installer capacity may be required.

9.7.5 If all identified local solar PV contractors were fully deployed for 50 weeks a year, over 7 years (2023-2030), each contractor would need to be fitting 4 properties per week.

This scale is likely to present a supply chain problem. Uptake is likely to be slow and would therefore increase the number of installations which would be needed at the end of the decade.

9.7.6 A list of local solar PV suppliers can be seen in Table 17, which is shown only to indicate the likely scale of capacity in the area and is not a recommendation or endorsement of any particular provider.

Table 17 - Local PV solution providers

Solar PV Installer	Address
Solar Star Power Ltd https://solarstarpower.com/	The Hub Dovefields Industrial Estate Uttoxeter ST14 8HU
Park Home Energy Limited https://parkhomeenergy.co.uk/	Unit 5F Cresswell Lane Cresswell STOKE-ON-TRENT ST11 9RD
Noble Green Energy https://noblegreenenergy.co.uk/	Badgers Farm, Willow Pit Lane Hilton DERBY DE65 5FN
Project Better Energy Limited https://www.zanussisolar.co.uk/	Lakes Court Lancaster Business Park Needwood DE13 9PD
EBRL – Eco Builds & Renewables Ltd https://www.ebrl.co.uk/	Unit 10, Riverside Industrial Estate Power Station Road Rugeley WS15 2YR
A1 Solar UK Ltd http://www.a1solaruklimited.co.uk/	1 Church Croft Gardens Rugeley WS15 2HT

9.7.7 Electrical contractors were identified who should be able to carry out heat pump installations within the ST14 area. As mentioned previously, the listing of a contractor is not an endorsement or recommendation, but simply an acknowledgement of potential installer capacity to support increased deployment of PV in the scope area.

9.7.8 It is noted that the number of prospective installers at this time is limited, and this is likely to represent a significant capacity bottleneck if heat pump deployment rates were to increase under any local programme. An increase in installer capacity may be helpful to address this and this might be achieved by creating an installer framework to improve ease of access for customers to access installers. A programme to encourage additional contractors to offer heat pump installations, perhaps at the same time as PV installations, may also help to alleviate any potential bottleneck.

9.7.9 If all identified local heat pump contractors were fully deployed for 50 weeks a year, over 7 years (2023-2030), each contractor would need to be fitting 8 properties per week. This scale is likely to present a supply chain problem. Uptake is likely to be slow and would therefore increase the number of installations which would be needed at the end of the decade.

9.7.10 A list of local heat pump suppliers is listed in Table 18, although this may not be a comprehensive list and other solution providers may be available. The list is presented only to indicate the current likely supply chain capacity in the area and is not a recommendation or endorsement of any company.

Table 18 - Examples of local heat pump providers.

Local Heat Pump Installer	Address
Total NRG Ltd https://www.total-nrg.co.uk/	Unit 28A Blythe Business Park Cresswell Lane Cresswell Stoke-on-Trent ST11 9RD
Conduction Heating UK LTD https://www.conductionheating.co.uk/	187 Western Rd Michleover Derby DE3 9GT
Heatcore Ltd https://www.heatcoreltd.co.uk/	5 Pye Green Rd Cannock WS11 5RY

9.8 Carbon Sequestration and Natural Capital

Carbon Sequestration

9.8.1 It is recognised that an offsetting strategy using Nature-based Solutions has the potential to enhance local natural capital and improve biodiversity.

9.8.2 The process of carbon sequestration involves capturing and storing atmospheric carbon dioxide. It is being promoted as a method of reducing the amount of atmospheric CO_2 as part of reducing climate change.

9.8.3 It can be promoted by natural means through retention and enhancement of planted areas (e.g. seeking additional tree/ vegetation planting) or through protection of existing carbon rich areas such as peatlands/ lowland bog.

9.8.4 With regards to peatland, there is no identified areas within the ST14 boundary. It is not considered feasible to introduce peatland to the area.

Natural Capital

9.8.5 According to the UK Government, a definition for natural capital is set out in the HM Treasury Green Book: Appraisal and Evaluation in Central Government[75]. On Page 63 it states:

"Natural capital includes certain stocks of the elements of nature that have value to society, such as forests, fisheries, rivers, biodiversity, land and minerals. Natural capital includes both the living and non-living aspects of ecosystems. Stocks of natural capital provide flows of environmental or 'ecosystem' services over time. These services, often in combination with other forms of capital (human, produced and social) produce a wide range of benefits. These include use values that involve interaction with the resource and which can have a market value (minerals, timber, freshwater) or non-market value (such as outdoor recreation, landscape amenity). They also include non-use values, such as the value people place on the existence of particular habitats or species."

9.8.6 Natural England have produced a series of indicators alongside a Natural Capital Atlas which considers approaches in specific areas of England. The Staffordshire atlas[76] (No.35) provides an assessment of asset quantity and quality of the Staffordshire region, outlining the ecosystem services these bring to people.

9.8.7 The capacity for ST14 to balance residual emissions with Nature-based Solutions is based on an overall assessment of the area. The ST14 postcode area covers around 11,000ha.

[75] HM Treasury (2022) *The Green Book: Central Government Guidance on Appraisal and Evaluation.* Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1063330/Green_Book_2022.pdf [Accessed 19 July 2022].

[76] Natural England (2021) *Staffordshire. Natural Capital Atlas: Mapping indicators*. Available from: http://publications.naturalengland.org.uk/publication/6672365834731520 [Accessed 29 March 2022].

9.9 Biochar

9.9.1 Biochar is charcoal which is used for soil improvement instead of fuel. It is created through a process called pyrolysis which requires heating biomass in the absence of oxygen. It has three main benefits:

- Carbon sequestration
- Biofuel (syngas is produced as a by-product)
- Soil fertility (can improve soil nutrients and water retention)

9.9.2 Biochar has the benefit of sequestering carbon as soon as it is produced.

9.9.3 There is a risk that biochar application could have an adverse effect on soil fertility in some areas, dependant on the soil pH.

9.9.4 Costs have been identified as a limiting factor. In the UK, the cost of biochar production (transport and spreading on the soil) may be around £100 - £400 per tonne.

9.9.5 If 80% of the total area of ST14 was available for the application of biochar, this would result in approximately 387,200 tCO_2e sequestered per year using the Environment Agency (EA) estimation of 44 tCO_2e/ha/year[77]. This would require 264,000 tonnes per year. It is important to recognise that this will require material to be transported and applied to soils which requires energy.

9.9.6 The main restriction on this approach is likely to be the availability of biowaste as a suitable feedstock for biochar. Although biochar can be made from anything organic, feedstocks from biowaste, particularly crop residues are most suitable. Different feedstocks result in different biochar yields and different physical and chemical properties.

9.9.7 Using the EA costs as a ballpark figure, if total BAU 2030 emissions were balanced with biochar, this would cost between £13,257,415 and £53,029,659 per annum.

9.9.8 A biochar carbon code has not yet been created but there are currently seven projects which have been awarded funding for Phase 1 of the Direct Air Capture and Greenhouse Gas Removal programme[78] which involve the use of biochar.

[77] Environment Agency (2021) Achieving net zero: A review of the evidence behind potential carbon offsetting approaches. Available from: https://assets.publishing.service.gov.uk/media/60cc698cd3bf7f4bcb0efe02/Achieving_net_zero_-_a_review_of_the_evidence_behind_carbon_offsetting_-_report.pdf [Accessed 07 February 2022].

[78] UK Government (2022) Phase 1 of the Direct Air Capture and Greenhouse Gas Removal programme. Available from: https://www.gov.uk/government/publications/direct-air-capture-and-other-greenhouse-gas-removal-

9.9.9 This programme aims to identify approaches for removing CO_2 or other GHGs from the atmosphere and drive innovation in these. While pilots and demonstrators are likely to be small, the objective of the programme is to find scalable approaches which are economically viable (<£200 per tonne CO_2e removed) and drive innovation.

9.9.10 Phase 2 of the competition is currently open to applications.

Table 19 - Biochar potential

Total administrative boundary	80% of total area estimated to be rural (arable and improved grassland)	Abatement potential	Requirements	Co-benefits
11,000ha	8,800ha	387,200 tCO_2e/ year	Dependant on the availability of biowaste for feedstock. Dependant on the availability of pyrolysis facilities. Assumes an application rate of 30t per hectare per year.	Can improve soil fertility. Can improve soil water and nutrient capacity. Can reduce soil N_2O emissions. Biochar production produces syngas which can be used as a biofuel (although this production is relatively low).

9.9.11 The main constraint on using biochar is likely to be the availability of biowaste as a feedstock for biochar. It has been estimated that around 3 to 20 Mt is available for this purpose each year in the UK[79]. The total land cover of the UK is 24,193,000 hectares[80]. ST14 as a proportion of the UK is 0.045%. This would give a proportional figure of

technologies-competition/projects-selected-for-phase-1-of-the-direct-air-capture-and-greenhouse-gas-removal-programme#bio-waste-to-biochar-b-to-b-via-hydrothermal-carbonisation-and-post-carbonisation

[79] Simon Shackley, Jim Hammond, John Gaunt & Rodrigo Ibarrola (2011) The feasibility and costs of biochar deployment in the UK*, Carbon Management*, 2:3, 335-356

[80] World Bank (2021) *Land Area (sq.km) – United Kingdom.* Available from: https://data.worldbank.org/indicator/AG.LND.TOTL.K2?locations=GB

135,000 tonnes to 900,000 tonnes of biowaste which could be available for biochar production. This ballpark figure would support the suggestion there is likely to be enough biowaste to meet the demand for biochar within ST14. However, there are other uses for biowaste such as for use in aerobic digestion or combustion which could displace fossil fuel use.

9.9.12 This option is also dependant on successful demonstration and scalability. There is evidence to suggest biochar could quickly become a key offsetting approach as the UK Government's Direct Air Capture and Greenhouse Gas Removal programme proceeds.

9.10 Local competences for biochar

9.10.1 When designing a biochar offsetting strategy, thought must be given to emissions from transporting the feedstock and biochar. Mersey Biochar: Carbon Negative Community Energy project was one of the projects within the Phase 1 of the Direct Air Capture and Greenhouse Gas Removal program[81]. The project supports woodland management by putting local waste wood to use.

9.10.2 This type of project could be replicated with local wooded areas as a possible feedstock for biochar. Ash dieback is a fungal disease affecting the common ash tree. While this causes challenges for woodland managers, it could provide an opportunity for supplying a feedstock for biochar.

9.10.3 The location of pyrolysis facilities can also prove a challenge. In the case of ST14, one of the most advanced pyrolysis facilities in the country is 40 miles away in the Energy and Bioproducts Institute, which is a part of Aston University, Birmingham. These facilities have already been demonstrating use of biochar for carbon offsetting.

9.11 Woodland Creation

9.11.1 The total claimable sequestration rate using the Woodland Carbon Code (WCC) of a new 1-acre mixed woodland would be approximately 386 tCO_2e over the 100-year period. Appendix D presents the assumptions used in the calculator.

9.11.2 Co-benefits to woodland creation include:

- Water storage and purification
- Recreational and cultural benefits

[81] UK Government (2022) Phase 1 of the Direct Air Capture and Greenhouse Gas Removal programme. Available from: https://www.gov.uk/government/publications/direct-air-capture-and-other-greenhouse-gas-removal-technologies-competition/projects-selected-for-phase-1-of-the-direct-air-capture-and-greenhouse-gas-removal-programme

- Wellbeing benefits
- Improved biodiversity
- Increased shade in a warming climate
- Effective flood control when used at scale
- Improved air quality

9.11.3 Possible revenue streams for woodland creation include:

- England Woodland Creation Offer
- Woodland Creation Planting Grant

9.11.4 While the planting of suitable trees in appropriate locations where they can develop and mature properly is advisable and offers numerous benefits to the local ecosystem and in adapting to climate change, it is apparent from Figure 35 and Figure 36 that any programme of tree planting is not going to deliver sequestration impact within the target period. If the carbon accountancy method used is to record the long-term (lifetime) benefit of the planted trees as though it has already been achieved, then a near-term contribution to the target is achievable. However, it should be noted that this approach relies upon those trees being preserved throughout their growth and requires a significant area of land in order to achieve a meaningful impact on the carbon target.

9.11.5 From a visual assessment using Google Earth it has been estimated that 750 hectares of land are currently wooded. This is equivalent to 7% of the total region.

9.11.6 The aim of the UK Government is to increase woodland cover to at least 12% in England by 2050[82].

9.11.7 If woodland was planted on 5% of ST14 land, 550 hectares would need planting.

9.11.8 According to the WCC calculation, there would be no claimable carbon sequestration until year ten which is after the 2030 target. Considering the total cumulative claimable carbon sequestration over the 100-year period would equal a total of 524,574 tCO_2e.

9.11.9 It is important to recognise a strategy for planting on agricultural land would impact the sequestration potential of biochar, which was estimated using this land. Whilst woodland creation might only be responsible for offsetting small amounts of CO_2

[82] UK Government (2021) *The England Trees Action Plan 2021-2024.* Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/987432/england-trees-action-plan.pdf [Accessed 24 March 2022].

emissions in 2030, it is accompanied by a plethora of ecosystem services to support people and the environment. These co-benefits should be considered when designing a carbon offsetting strategy to avoid "*carbon tunnel-vision*". We believe this intervention will be best addressed by the Biodiversity working group.

Sequestrn to year	Total project carbon sequestration (tCO_2e)	20% risk buffer (tCO_2e)	Total claimable carbon sequestration (tCO_2e)	*Average total claimable sequestration per hectare by year x (tCO_2e/ha)*
5	0	0	0	*0*
10	7	1	6	*6*
15	32	6	26	*26*
20	104	21	83	*83*
25	191	38	153	*153*
30	253	51	202	*202*
35	299	60	239	*239*
40	335	67	268	*268*
45	366	73	293	*293*
50	402	80	322	*322*
55	419	84	335	*335*
60	431	86	345	*345*
65	441	88	353	*353*
70	446	89	357	*357*
75	451	90	361	*361*
80	457	91	366	*366*
85	462	92	370	*370*
90	466	93	373	*373*
95	481	96	385	*385*
100	483	97	386	*386*

Figure 35 – WCC Calculator

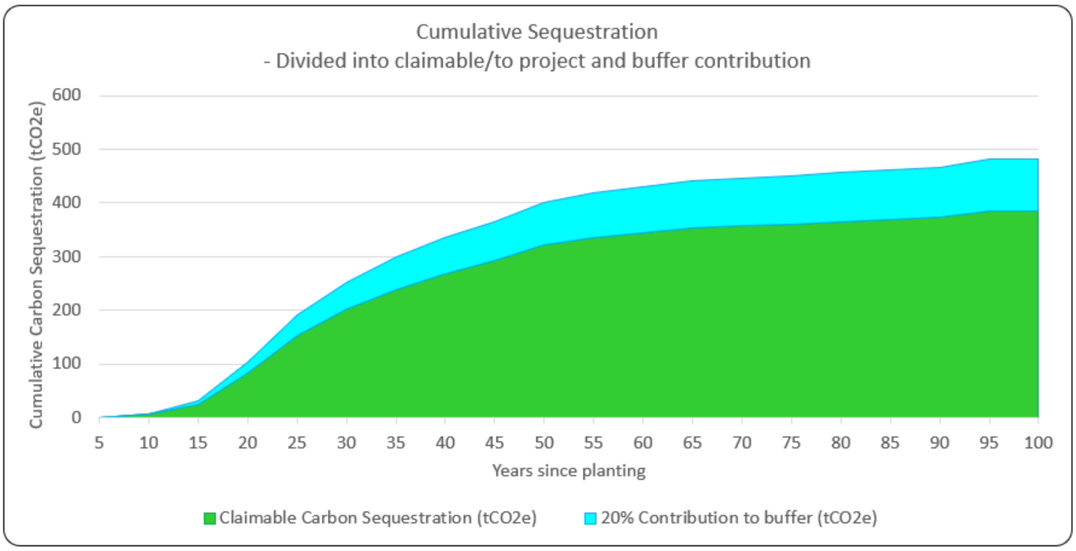

Figure 36 – WCC Calculator Graph

9.12 Summary

9.12.1 The feasibility scenario where total emissions are balanced in 2030 is presented in Figure 37. This graph shows the BAU scenario with grid decarbonisation juxtaposed with emissions including the interventions.

9.12.2 As to avoid double counting emissions, only the EPC improvements scenario was included when considering domestic emissions.

9.12.3 According to the World Resources Institute (WRI) [83] 70% of emissions from agriculture can be reduced. This was included to show the visual representation of how interventions could impact this sector.

9.12.4 Figure 37 shows the role biochar could have in balancing emissions to achieve the net zero target. Residual emissions to be offset would be 142,477 tCO_2e. It is important to note, this approach requires a consistent application year on year. This approach would cost between £9,973,390 and £38,468,790.

9.12.5 In effect, it could be employed in 2030 to achieve the goal as sequestration is immediate. It also has the benefit of not competing for land and could improve agricultural yield.

9.12.6 This offsetting approach is still being demonstrated and currently there is no certified Biochar Carbon Code.

[83] World resources institute (2020) *Regenerative Agriculture: Good for Soil Health, but Limited Potential to Mitigate Climate Change*. Available from: https://www.wri.org/insights/regenerative-agriculture-good-soil-health-limited-potential-mitigate-climate-change [Accessed 13 April 2022].

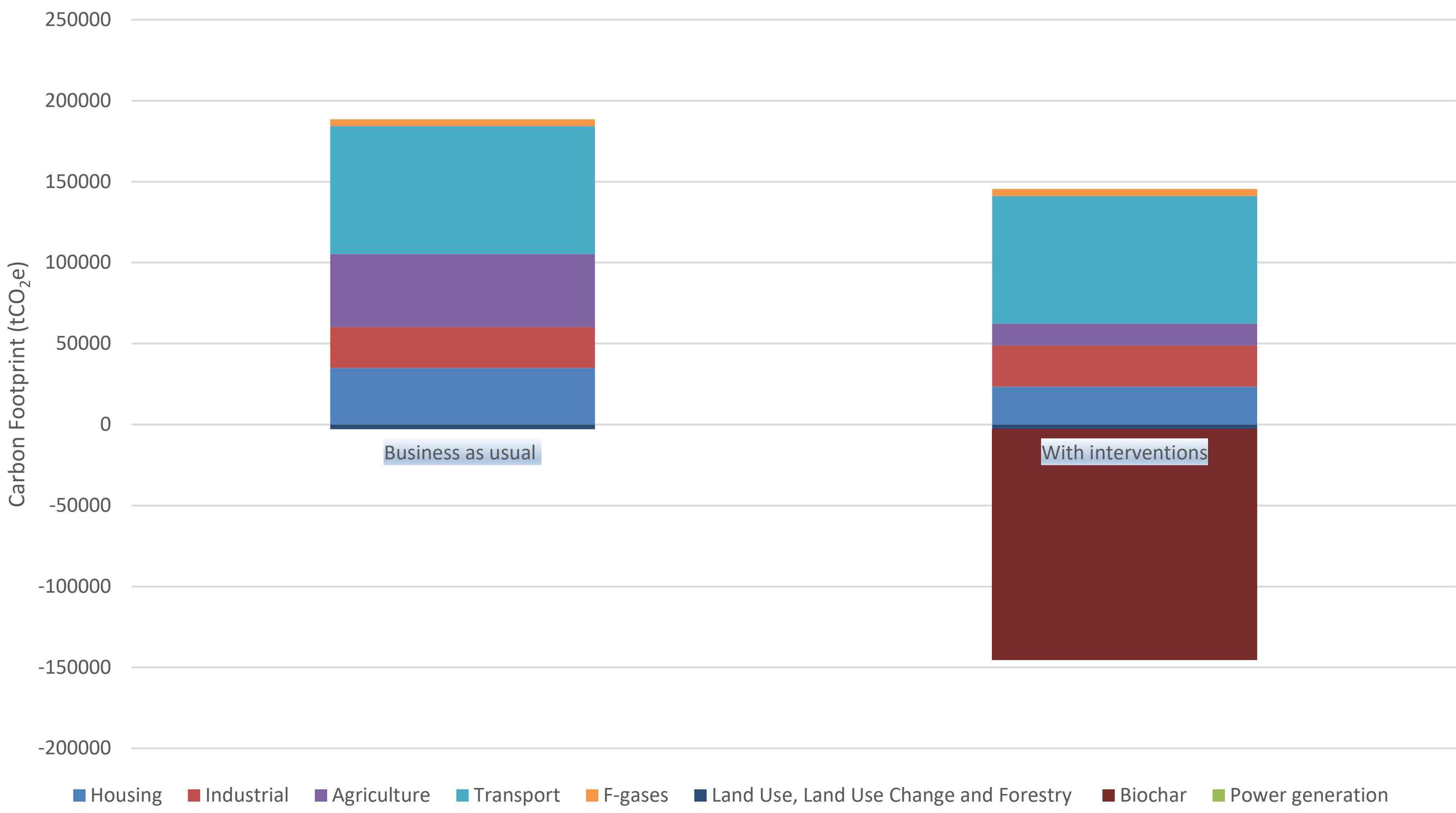

Figure 37 - Illustration of scale of required interventions and offsetting to achieve a carbon neutral outcome in the ST14 postcode area in 2030

10 RECOMMENDATIONS

10.1 Key interventions

10.1.1 The three key interventions which were investigated in this study are:

- Heat Pumps
- Domestic Solar PV
- Hydro Schemes

10.1.2 Fitting all homes with gas and oil home heating systems to heat pumps would decarbonise homes by 23,355 tCO_2e in 2030.

10.1.3 This study suggests installing solar PV on all houses could reduce emissions by 34,755 tCO_2e in 2030. Subject to there being sufficient energy demand within the homes to use all this generation.

10.1.4 Small scale river hydro was considered for this study. Based on the available information it appears unlikely that a viable and low-risk scheme could be implemented that would have a measurable and significant impact on the carbon emission footprint of the scope area.

10.1.5 These interventions would take 58,110 tCO_2e from the BAU scenario of 194,884 tCO_2e. There would be residual emissions of 136,774 tCO_2e.

10.1.6 Figure 37 demonstrates a 2030 scenario where agricultural emissions have also been reduced.

10.2 Agricultural emissions

10.2.1 This report shows the biggest source of emissions for ST14 are from agriculture - livestock and crop-related emissions (39,128 tCO_2e) and road transport (56,938 tCO_2e). The development of a strategy to deal with these emissions will be essential to decarbonising the ST14 area.

10.2.2 One solution to lowering agricultural emissions would be to convert some of the land to other uses, such as woodlands which can act as a natural carbon sink. However, this would decrease food security at a time of global turmoil and uncertainty in the food markets. There is an argument which suggests if crop yield is reduced, a forest could be cleared elsewhere to replace the lost production.

10.2.3 The WRI suggest a range of solutions to reducing agricultural emissions[84]. They proposed these interventions could reduce global agricultural emissions by more than 70%. The key solutions which are best suited to this sector's emissions in ST14 are:

- Reduce food loss and waste
- Shift diets
- Increase crop yields
- Increase pasture productivity
- Reduce enteric fermentation
- Improve manure management
- Reduce emissions from manure left on pasture
- Increase nitrogen use efficiency
- Reduce energy emissions
- Reforestation

10.2.4 The full range of global agricultural solutions can be seen in Appendix E which, if delivered, could substantially reduce the emissions from this segment.

10.2.5 Reducing food loss, waste and diet shifts would address the ST14 consumption emissions in the first instance. These solutions would only start to have a larger impact on ST14's emissions if these behaviours were adopted by the population more widely and therefore impact the food supply from the local agricultural sector.

10.2.6 The remaining solutions would all impact on ST14 territorial agriculture emissions.

10.2.7 A recent study which has gained a lot of media attention investigated the effects on cow's methane emissions from adjusting the cow's diets[85]. The researchers fed the cows small amounts of seaweed mixed in with their feed. The results showed over an 80% reduction in methane emissions. An agricultural intervention could consider adjusting the diets of cows to mitigate methane emissions within the ST14 boundary.

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[84] World resources institute (2020) *Regenerative Agriculture: Good for Soil Health, but Limited Potential to Mitigate Climate Change*. Available from: https://www.wri.org/insights/regenerative-agriculture-good-soil-health-limited-potential-mitigate-climate-change [Accessed 13 April 2022].

[85] Roque, B. M., *et al.* (2021) Red seaweed (Asparagopsis taxiformis) supplementation reduces enteric methane by over 80 percent in beef steers. *Plos One.* Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0247820 [Accessed 13 July 2022].

10.3 Road transport emissions

10.3.1 Road transport accounts for the largest proportion of emissions in ST14. Largely, this sector is expected to decarbonise over time through increased electrification which will be promoted through national policy changes. For example, the UK Government has banned the sale of new petrol and diesel cars from 2030. This indicates there will be a shift towards EVs in the coming years, however based on current policy drivers this is unlikely to significantly shift the carbon emissions for this segment before 2030.

10.3.2 ST14 can support this shift through an increase in the provision of EV charging points.

10.3.3 There is an indication larger road haulage could be fuelled by hydrogen as this sector also looks to decarbonise.

10.4 Anti-Idling

10.4.1 Air pollution is a major environmental risk to health. Leaving the engine running while your vehicle remains stationary is known as idling. It is highly polluting and can produce as twice the amounts of emissions as an engine in motion. The pollutants such as carbon monoxide and oxides of nitrogen have a significant effect on the air quality affecting the air we breathe in. Studies have shown that in the UK, 32000 deaths per year[86] are subjected to air pollution of which 1.2% are reported in Staffordshire[87]. Idling causes issues related to health and environments. Therefore, cutting out idling would significantly improve the air quality especially in congested areas whilst also contributing to cost savings and carbon reduction. The overall benefits of cutting out idling or anti-idling are:

- Reduced carbon emissions
- Reduced fuel emissions
- Noise reduction
- Improved air quality

10.4.2 Several case studies on anti-idling implementation are briefly described below.

10.4.3 Oxford City Council implemented an anti-idling campaign aimed to promote clean travelling behaviours for parents of school children. With the help of volunteers, it

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[86] GOV.UK. 2022. *Air pollution: applying All Our Health*. [online] Available at: <https://www.gov.uk/government/publications/air-pollution-applying-all-our-health/air-pollution-applying-all-our-health> [Accessed 5 July 2022].

[87] Staffordshire.gov.uk. 2022. *Staffordshire Gov.*. [online] Available at: <https://www.staffordshire.gov.uk/DoingOurBit/Get-Inspired/Clean-green-and-safe/Air-aware/Turning-your-car-off.aspx> [Accessed 5 July 2022].

encouraged people to use lower carbon footprint methods such as walking, cycling and public transport[88].

10.4.4 Tower Hamlets Council introduced a #BreathClean campaign whereby vehicle users idling would receive a £20 fine. Their aim was to tackle air pollution as idling in the region had been linked to 7% of deaths. Reading Borough Council also implemented the £20 penalty for idling and have reported 75% success rate of using this.

10.4.5 London Borough of Southwark Authority introduced £80 penalty fine to all vehicles idling and refusing to switch off the engine. Results have shown the drivers were willing to comply when informed about the fine.

10.4.6 TRL Limited have conducted a study on idling vs nonidling. They used the same vehicle, over the same test cycle, under two conditions. By not idling, almost half of the carbon and oxides of nitrogen emissions are saved89.

10.4.7 Jeffrey Haulage, a transport company operate a modern fleet of 40 tractor units and 80 trailers in the UK distributing regular products such as food, beverages, paper, and electrical equipment. They implemented an idling report functionality of their telematics system which enabled access to stationary vehicles with the engine running unnecessarily. Results have shown that £913 per driver had been wasted each year.

10.4.8 One of the best ways to tackle idling vehicles is to hold a day of action and by implementing the following key steps:

- Select your idling hotspot by focusing in areas where idling cars are a particular issue.
- Tell people what you are doing and why by publishing on social media to tell everyone about your campaign.
- Work with local schools and community. If your hotspot is nearby a school, there will be lots of ways to get them involved when running the campaign such as setting up events talking to drivers at hotspot idling locations.
- Evaluate your success by communicating the results and seek for improvement to help tackle idling.

[88] Douglas, J., 2020. *Vehicle Idling: the role of Warwick District Council in anti-idling enforcement and awareness*. p.5.

[89] GOV.UK. 2022. *Air pollution: applying All Our Health*. [online] Available at: <https://www.gov.uk/government/publications/air-pollution-applying-all-our-health/air-pollution-applying-all-our-health> [Accessed 5 July 2022].

10.5 Bus carbon reduction case studies

10.5.1 Effective transport is vital for the economy. A case study in the UK shows us that Manchester is the second most congested region outside of London. Transport plays a large contribution to air pollution and emissions as road transport contributes to 31% carbon emissions, 65% oxides of nitrogen and 79% particulates. With the government introducing a net zero emissions target by 2050, investment in greener buses in the city and airport. Overall, they have achieved almost a 1 million litres savings of diesel a year, annual reduction of 2400 tonnes of carbon emissions and a decrease of oxides of nitrogen emissions and particulates by 9% and 7% respectively[90].

10.5.2 By implementing a project similar to Zero Carbon Rugeley, this would create an opportunity to include electric buses which together can significantly reduce the carbon emissions associated with road transport. This would also reduce energy costs whilst simultaneously boosting local economic regeneration and social integration[91].

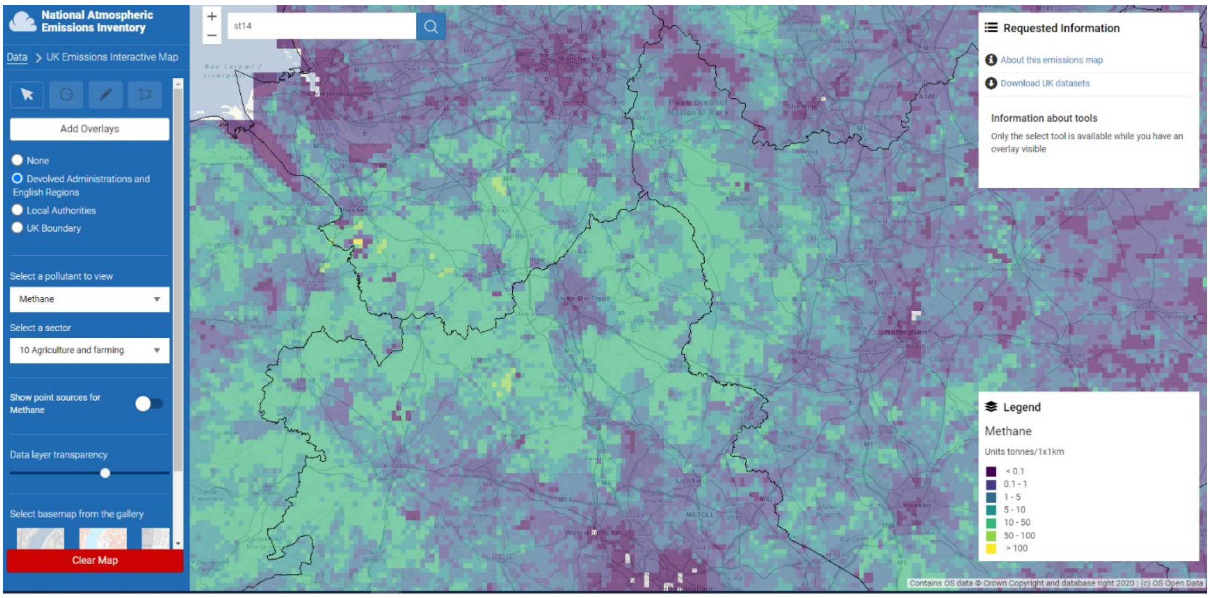
10.5.3 Orkney invested in a 7.8 million project lead by European Marine Energy Centre (EMEC) focused on implement an affordable, low carbon energy system for the future. The project includes initiatives such as electric buses, green hydrogen storage and transport. Studies have shown the inclusion electric buses improved lowering the carbon emissions within the area[92].

[90] 2019. *Electric bus investment delivers cleaner air, better health and a stronger economy*.
[91] Rugeleypower.com. 2021. *Zero Carbon Rugeley project – Rugeley Power Ltd*. [online] Available at: http://www.rugeleypower.com/zero-carbon-rugeley-project [Accessed 7 July 2022].
[92] Orkney.gov.uk. 2022. *New Year, New Buses*. [online] Available at: https://www.orkney.gov.uk/News?postid=4974 [Accessed 7 July 2022].

APPENDICES

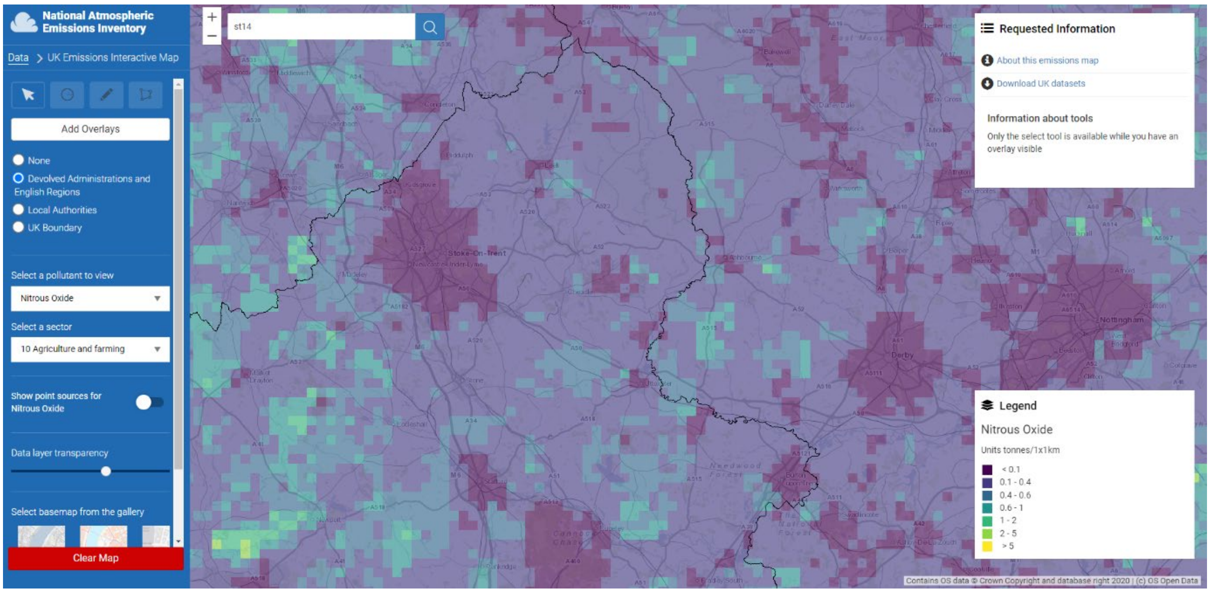
Appendix A - Example of a Mitsubishi Ecodan ASHP[93]

Appendix B – National Atmospheric Emissions Inventory ST14 Methane Emissions



93 (www.mitsubishi-electric.co.nz/images/product/large/PUHZ-W50VHA-EHPT20X.jpg)

Appendix C – National Atmospheric Emissions Inventory ST14 Nitrous Oxide Emissions



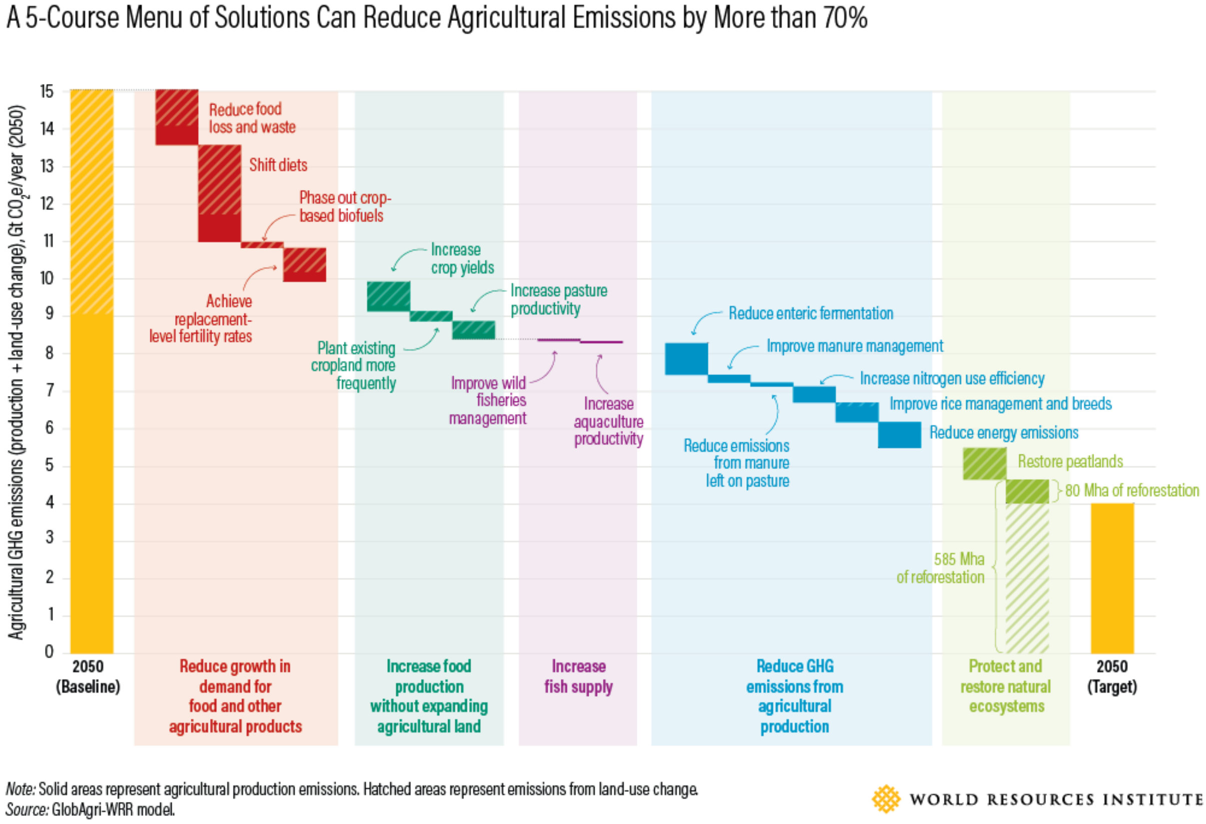
Appendix D – Woodland Carbon Code Calculator Inputs

Project Name:			**Small mixed native woodland**
Calculation Completed by:			Rupert Gale
Date calculation completed:			08-Feb-22
Project Start Date (date planting was completed)			01-Jan-23
Country			England
If in England, applying for Woodland Carbon Guarantee?			*Yes*
If in the Guarantee, 10-yearly or 5-yearly verifications?			*10-Yearly*
Project Basics			
Management & Species			
Net area Broadleaf minimum intervention / no thinning (ha)			1.00
Net area Broadleaf thinned (ha)			0.00
Net area Conifer minimum intervention / no thinning (ha)			0.00
Net area Conifer thinned (ha)			0.00
Total net planting area (ha)			**1.00**
Total Emissions from establishment		**tCO_2e/ha**	**tCO_2e**
		-2.23	**-2.23**
Soil type, preivous landuse and establishment technique			
Soil Type			Mineral
Previous Landuse			Pasture
Site Preparation Technique			Low disturbance: Hand turfing, inverted, hinge & trench mounding, patch scarification, subsoiling, drains
% Topsoil Carbon Lost			00
Soil C emissions from site prep	**Area (ha)**	**tCO_2e/ha**	**tCO_2e**
Total soil carbon emissions	1.00	0.0	**0.0**

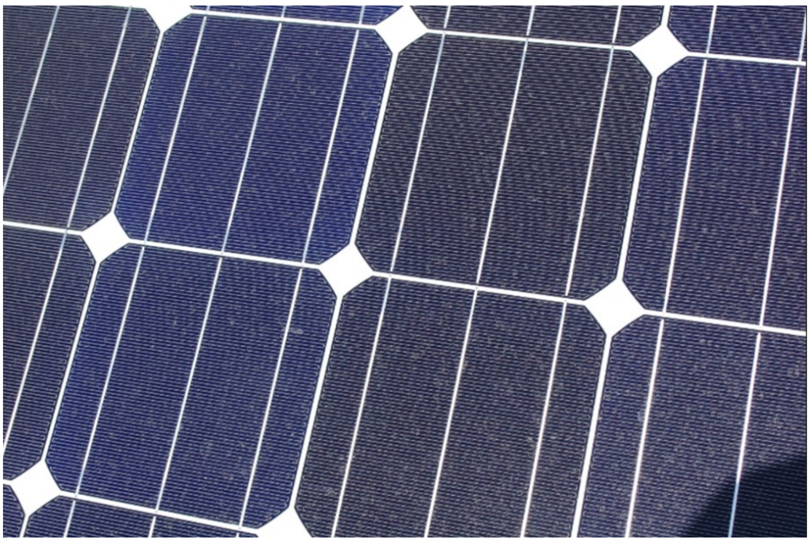
Sectn No:	Actual Species	Actual Spacing (m)	Management Regime	% of Area if mixture	Area (ha)
	Ash	0.0	Select Mgmt Regime	25.00%	0.25
	Oak (robur/petrae	0.0	Select Mgmt Regime	25.00%	0.25
	Beech	0.0	Select Mgmt Regime	25.00%	0.25
	Silver birch	0.0	Select Mgmt Regime	25.00%	0.25
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Select Species	0.0	Select Mgmt Regime	0.00%	0.00
	Woody Shrubs	*Specify Species here*		0.00%	0.00
Total Area				**100.0%**	**1.00**

** NOTE The species mix table is not required to complete a small woods calculation, but it is required as a record of the species mix of the project to complete validation.

Appendix E - World Resources Institute: Reducing agricultural emissions



Appendix F – An example of a photovoltaic panel



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