Final Report

Climate Change Adaptation & Mitigation

Staffordshire County Council

Project number: 60625972

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Quality information

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Executive Summary

AECOM has been commissioned to provide technical support to develop an evidence base for new energy and sustainability policies being considered for Staffordshire County Council and its eight constituent Local Authorities. This report is the final deliverable, which summarises the findings with respect to sustainability-focused interventions that the Authorities should consider as part of their emerging Local Plans. This report follows an interim deliverable (the Baseline Report) that was issued in March 2020. A further update to the Baseline Report is issued alongside this Final Report; these two reports should be read in conjunction with one another.

Note: For ease and reference throughout this report, a glossary is provided on page 12.

Summary of Policy Recommendations

Reducing CO_2 Emissions in the Built Environment

Carbon emissions in the built environment should be minimised wherever possible. For new buildings, Local Authorities should look to set the highest level of building performance standards for energy use and CO_2 emissions that can practically and viably be achieved. Authorities should also look to implement an Energy and Heat Hierarchy. In addition to regulated emissions, which are covered by Building Regulations, these policies should also seek to reduce unregulated emissions and embodied carbon.

Policies should seek to ensure that proposals are ‘futureproofed’ to facilitate the uptake of LZC technologies, particularly those that deliver low carbon heat (such as ASHPs) and provide on-site renewable electricity generation and storage (such as PV and battery technologies).

Although setting standards for new buildings will be important for avoiding future increases in CO_2 emissions (as set out in the Baseline Report), a bigger challenge is in the existing stock. Local Authorities should review opportunities to promote energy efficiency measures and the uptake of LZC technologies through methods such as enforcement of the Minimum Energy Efficiency Standards and Part L2B of the Building Regulations, along with behavioural change and awareness programmes. Councils should also seek to lead by example by developing carbon management and reduction plans for their own assets (e.g. council housing). It will also be important to ensure that any fuel poverty initiatives align with the Net Zero target, particularly if these involve installing or upgrading gas central heating systems.

Local Authorities may also wish to consider establishing a Carbon Offset Fund that developers can contribute to in lieu of on-site CO_2 savings. This fund would be used to deliver carbon offsetting and reduction projects such as large-scale LZC installations and / or installations on existing built infrastructure (e.g. solar car parks), afforestation, and peatland restoration.

For more information on reducing CO_2 emissions from buildings, see Section 3.1.1.

It is acknowledged that some of these recommendations will be affected by the Government’s consultations on the Future Homes Standard and the ‘Planning for the Future’ White Paper. Furthermore, Local Planning Authorities would need to have the resources to assess and monitor outcomes, or administer schemes such as a Carbon Offset Fund. Although these factors could present challenges, it is worth emphasising that buildings contribute significantly to total CO_2 emissions and one of the key ways that Local Authorities can mitigate those effects is via the planning system. This is discussed in Section 3.1.1 and further information about the White Paper is provided in Appendix A.

Holistic Interventions in Development

In order to ensure that development proposals adopt a holistic approach to sustainable design, Local Authorities should consider requiring applicants to undertake a BREEAM or HQM assessment (or similar). The sustainability strategy should be described in a standalone Sustainability Statement or as part of the Design and Access Statement.

There are a variety of opportunities to incorporate holistic sustainability interventions into the public realm that can be adopted in individual development proposals or at a wider masterplanning scale. For example:

- Co-locating green corridors (including trees, parks, gardens, and other areas of landscaping) with pedestrian and cycle routes, and to integrate these with sustainable drainage systems (SuDS) or other blue infrastructure such as canals, ponds and river networks;

- Integrating LZC technologies into the existing built environment, e.g. using PV canopies and battery storage systems for EV chargepoints and other street infrastructure; and
- Specifying sustainably-sourced materials with low environmental impacts and high albedo for use in landscaping and the urban realm. These can be used to replace traditional materials when carrying out upgrade or maintenance work (e.g. for road and path surfaces). This should include reused or recycled materials where possible, which helps to reduce the demand for raw materials and can contribute to wider goals in relation to waste reduction.

All developments should seek to incorporate circular economy principles such as:

- Designing out waste;
- Lean design;
- Designing for flexibility and adaptability; and
- Designing for deconstruction and reuse.

The adoption of circular economy design measures can contribute towards wider goals, objectives or strategies that Local Authorities may have in place, particularly in relation to waste reduction.

For more information on holistic sustainability interventions, see Section 3.1.2.

Sustainable Transport

Local Authorities should seek to enhance the provision of EV chargepoints across the County. In doing so, they should seek to maintain dialogue with key market participants (e.g. Western Power Distribution (WPD) and the Government's Office for Low Emission Vehicles) to identify opportunities to work together to facilitate the transition to EVs, and ensure that policy and efforts to support this transition are aligned with market developments.

Similarly, Local Authorities should aim to keep informed of any significant changes in hydrogen vehicle markets as they continue to develop, to ensure that policies, spatial strategies and infrastructure provision respond appropriately.

There may be opportunities to co-locate PV canopies with existing or future parking provision, an approach that would contribute towards increasing EV infrastructure while also increasing the provision of LZCs (see below).

For more information on sustainable transport, see Section 3.2.

Low and Zero Carbon Technologies

In order to meet their climate change commitments, Local Authorities will need to facilitate a step change in the provision and uptake of LZC technologies, including large-scale and strategic installations. Local Authorities should consider adopting a policy stance with a presumption in favour of such technologies, while setting local criteria for acceptability that reflect the UK's legal commitment to achieve Net Zero emissions by 2050.

The technologies that are likely to offer the greatest opportunities, based on considerations such as physical resource, technological maturity, annual electricity generation, and cost effectiveness, are onshore wind and PV farms.

Although there are significant existing Local Plan and national policy constraints regarding onshore wind development, this study has found that **there is no technical basis for the current levels of restriction on wind energy development in Staffordshire.** This applies to existing and draft Local Plan policies that restrict wind energy development to specific sites and / or place caps on the numbers of wind turbines that will be permitted. This report has confirmed the findings of earlier studies which found that there is considerable wind resource across the County.

Analysis indicates that LZC technologies in Staffordshire currently generate around 366 GWh of renewable electricity annually, equivalent to just under 10% of electricity demand (which in 2018, totalled 3,722 GWh). In order to meet Staffordshire's electricity demands using renewably-generated electricity alone, the following renewable capacity would need to be provided:

- 3,900 MW of PV, equivalent to solar farms totalling around 4,874 hectares (49 km^2) – roughly 2% of the land area of Staffordshire;

  or

- 1,775 MW of large-scale onshore wind, which could be delivered using roughly 700 large turbines. Wind farms of this scale would require a land area of around 20,000 hectares (200 km^2), which is roughly 7% of the land area of Staffordshire, although they could be co-located with other uses (e.g. agriculture).

Our analysis suggests that, due to the constrained land area in Tamworth and Cannock Chase, these areas will inevitably rely on renewable energy generated elsewhere (i.e. in order local authorities) in order to reach Net Zero. However, looking at the county as a whole, our analysis has shown that there is a significant amount of land that could be potentially suitable for large-scale LZC installations such as PV and wind, on the basis that it is not subject to specific policy constraints, environmental or other landscape designations. However, it is important to emphasise that site-specific feasibility studies would be required to confirm suitability which would also depend on the proximity and capacity of existing or planned power infrastructure. In order to reach Net Zero, a step change in LZC deployment will be required and this should be taken into account when planning upgrades to infrastructure, particularly for major new developments.

It is noted that Ofgem requires electricity grid networks to be fully utilised, and that this means that DNOs are obliged to target capacity growth in areas where the demand is expected to increase. It is also important to note that the costs of enhancing grid capacity usually fall on the applicant who requests the additional capacity (albeit mechanisms do exist that allow some of this capital investment to potentially be recovered from third parties in the future). Engagement with WPD is therefore recommended in order to build a greater understanding of where capacity exists on the grid network, and what plans WPD are aware of in terms of future grid enhancements.

Several existing Local Plans promote the use of biomass as a fuel source, but this technology is no longer recommended for widespread adoption in light of its detrimental effect on air quality and concerns about sustainable supply chains. Local Authorities should review these policies and consider adding restrictions or clarifications related to issues such as air quality impacts and sustainable sourcing, and emphasise the preference for use of efficient heating technologies powered by renewable electricity (e.g. heat pumps).

This study has identified that there may be opportunities to utilise WSHPs in wastewater treatment works, legacy mining assets, and rivers or other waterbodies, although a detailed assessment is outside the scope of this report. It is recommended that these options are investigated in more detail in the future, particularly where there are large masterplan developments planned within the county.

All Local Authorities should also undertake further detailed assessments of opportunities to incorporate PV arrays into existing built infrastructure, including industrial sites and car parks.

For more information on LZC technologies, see Section 4.1.

Carbon Sequestration & Natural Capital

This study has identified a range of opportunities to increase rates of carbon sequestration in Staffordshire, such as woodland creation, peatland restoration, agroforestry, and adopting agricultural practices and technologies (AP&T) that both increase carbon storage and decrease emissions from land use practices.

In particular, there are opportunities to:

- Increase sequestration on Council-owned land (e.g. areas of greenspace including parks and gardens; linear parcels and green infrastructure such as verges and green spaces alongside roads; and the ‘greening’ of grey infrastructure in urban settings);

- Secure carbon sequestration through tree planting via accredited UK offset schemes such as those run by the Woodland Carbon Code (WCC) and the Woodland Trust; and

- Drive and influence increased sequestration across public and private landholdings through the services that Local Authorities already deliver, using their role and influence as community leaders and major employers, and their regulatory and strategic functions.

This study has also identified potential sources of funding to support such schemes. For example, actions to mitigate climate change qualify for funding under the proposed Environmental Land Management (ELM) scheme which will provide public money to pay land managers in England for the ecosystem services they deliver, which could facilitate financial support for agroforestry and peatland restoration projects. There are also capital and maintenance grants available to support woodland creation.

Local Authorities should seek to identify opportunities to deliver these types of projects within Staffordshire, and particularly on Council-owned land. In addition to carbon sequestration, they offer a range of additional co-benefits, including in relation to the ecosystem, air quality, amenity, biodiversity, and human health.

For more information on carbon sequestration and natural capital, see Section 4.2.

Climate Risk and Adaptation

The impacts associated with climate change risks are already being felt. Local, regional, national and global trends for climate change will rise in line with emissions that have already been released to the atmosphere, exacerbating the hazards that occur naturally, and magnifying the impacts experienced. Policies should therefore seek to ensure that developments are 'resilient' to climate change risks and the influence that a high-emission projection scenario could have.

Safeguarding against future climate impacts is a cross-cutting issue and should be integrated with approaches to achieve a pathway towards low and zero carbon. This may include measures such as requiring on-site renewable energy generation, diversifying transportation links and ensuring development allocations are designed to be resilient to chronic and acute climate change impacts such flooding and biodiversity migration.

This study identified a range of adaptation measures that could be implemented to increase the resilience of development areas to the effects of climate change. These measures address flooding (both fluvial and surface water), heat and cross-cutting climate hazards.

Climate change impacts are disproportionately felt within society, impacting the most vulnerable communities. In this regard, parallels can be drawn between the COVID-19 pandemic and climate change, which presents an opportunity to expand our understanding of resilience and sustainable development, and building a greener and more resilient economic recovery that promotes inclusivity.

As a truly cross-cutting issue, it is challenging but necessary to set policy for climate change adaptation. Local plans can act as a tool for Councils to both enhance and implement resilience and adaptation measures through spatial strategy, masterplanning and urban design and development management policy.

For more information on climate risk and adaptation, see Section 5.

Opportunities to Deliver Benefits on Council-Owned Assets

This study has identified various opportunities for the Councils to implement climate change mitigation and adaptation measures on their existing landholdings and assets. These include energy efficiency upgrades to existing buildings, the provision of EV infrastructure in Council-owned car parks and buildings, and the use of Council-owned land to deliver carbon offsetting and sequestration projects such as renewable electricity generation and woodland creation / habitat restoration.

It is recommended that the Councils seek to adopt a leadership role in reducing CO_2 emissions by implementing best practice measures wherever possible. This would build on the Baseline Report's assessment of current CO_2 emissions, by developing an appropriate carbon management and reduction strategy.

For Local Authorities that have set a Net Zero target in advance of the 2050 UK-wide deadline, it is important to recognise that although demand reduction, fuel switching and LZC energy generation are top priorities, carbon offsetting via renewables and sequestration via natural capital projects will almost certainly be required to some extent. Councils should therefore undertake further research to understand the specific opportunities that might be available, e.g. by undertaking a survey to understand the condition and types of existing landholdings and habitats.

Appendix G contains an overview of potential delivery and funding mechanisms that could be used to support these types of projects.

Other Recommended Actions

Some of the changes that will be needed in order to ensure that Staffordshire as a whole can both mitigate and adapt to the impacts of climate change will rely on broader trends and changes that are outside of the Councils' control. Therefore, we recommend that:

- The Councils should proactively support other Local Authorities and organisations in delivering the actions required to reach Net Zero; and
- The Councils should take steps to lobby the Government to achieve more rapid decarbonisation across key priority areas, including higher energy efficiency standards for new and existing buildings, policies that support the uptake of LZC technologies, and the development of low carbon transport and infrastructure.

Next steps

Based on the findings of this report, the Councils should consider the following immediate next steps:

- **Disseminate findings of this report to relevant departments and internal stakeholders within each Local Authority.**
- **Begin the process of reaching out to external stakeholders**, including other local authorities, Local Enterprise Partnerships, utility companies (e.g. WPD, Severn Trent Water, South Staffordshire Water, National Grid), government departments / agencies (e.g. Department for Transport, Department of Environment, Food and Rural Affairs, and the Forestry Commission), and others (e.g. WRAP) to identify opportunities for collaboration and engagement.
- **Review any ongoing or near future projects that are relevant to the policies or other actions described in this report to ensure that activities are well-coordinated and integrated.** This would include, for instance: plans for significant new developments (especially those in town centres, high energy users or large industrial installations); any strategies or programmes related to waste reduction, sustainable transport / mileage reduction, or reducing fuel poverty; pilot projects for smart meters, renewable technologies, or energy saving behaviour change initiatives; in addition to the Council's general strategies for building management and vehicle fleet replacement.

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Glossary

Notation	Definition
AC	Alternating Current
AONB	Area of Outstanding Natural Beauty
AP&T	Agricultural Practices & Technologies
AQMA	Air Quality Management Area
ASHP	Air Source Heat Pump
BEIS	Department for Business, Energy & Industrial Strategy
BEV	Battery Electric Vehicles
BNG	Biodiversity Net Gain
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Mechanism
C&I	Commercial & Industrial
CAMS	Catchment Abstraction Management Strategy
CAP	Common Agricultural Policy
CCC	Committee on Climate Change
CEF	Carbon Emission Factor
CHP	Combined Heat and Power
CIBSE	Chartered Institution of Building Services Engineers
CIRIA	Construction Industry Research and Information Association
CO_2	Carbon Dioxide
COP	Coefficient of Performance
CPN	Chargepoint Network
DC	Direct Current
DECC	Department of Energy & Climate Change
DEFRA	Department for Environment, Food & Rural Affairs
DEH	Direct Electric Heating
DfT	Department for Transport
DHN	District Heating Network
DHW	Domestic Hot Water
DNO	Distribution Network Operator
EA	Environment Agency
EfW	Energy from Waste
EIA	Environmental Impact Assessment
ELM	Environmental Land Management
EMS	Environmental Management Systems
ENG	Environmental Net Gain
EPC	Energy Performance Certificate
EV	Electric Vehicle
FCS	Favourable Conservation Status
FiT	Feed-in Tariff

Notation	Definition
FSC	Forest Stewardship Council
GBS LEP	Greater Birmingham and Solihull Local Enterprise Partnership
GGBS	Ground Granulated Blast-furnace Slag
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GLA	Greater London Authority
GSHP	Ground Source Heat Pump
HIF	Housing Infrastructure Fund
HQM	Home Quality Mark (assessment mechanism)
HRA	Housing Revenue Account
HSVI	Heat Socio-Spatial Vulnerability Index
ISO	International Organisation for Standardization
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
LA	Local Authorities
LDO	Local Development Order
LEP	Local Enterprise Partnership
LNRS	Local Nature Recovery Strategy
LULUCF	Land Use, Land-Use Change & Forestry
LZC	Low and Zero Carbon
MEES	Minimum Energy Efficiency Standards
MOD	Ministry of Defence
MSW	Municipal Solid Waste
NCC	Natural Capital Committee
NEED	National Energy Efficiency Data-Framework
NEVO	Natural Environment Valuation Online
NFVI	Neighbourhood Flood Vulnerability Index
NOABL	Numerical Objective Analysis Boundary Layer
NPPF	National Planning Policy Framework
OLEV	Office for Low Emission Vehicles
PEFC	Programme for the Endorsement of Forest Certification
PHEV	Plug-in Hybrid Electric Vehicles
PM or PMx	Particulate Matter
PPA	Power Purchase Agreement
PPG	Planning Practice Guidance
PV	Photovoltaic
REPD	Renewable Energy Planning Database
RRS	Regional Renewables Statistics
SAC	Special Area of Conservation
SAP	Standard Assessment Procedure
SCC	Staffordshire County Council

Notation	Definition
SEG	Smart Export Guarantee
SHW	Solar Hot Water
SRF	Short Rotation Forestry
SuDS	Sustainable Urban Drainage System
TCPA	Town and Country Planning Association
UGF	Urban Greening Factor
UHI	Urban Heat Island
UK-GBC	UK Green Building Council
UKCIP	UK Climate Impacts Programme
ULEV	Ultra-Low Emissions Vehicle
VOCs	Volatile Organic Compounds
WCC	Woodland Carbon Code
WCF	Woodland Carbon Fund
WCaG	Woodland Carbon Guarantee
WCPG	Woodland Creation Planning Grant
WPD	Western Power Distribution
WRAP	Waste and Resources Action Programme
WSHP	Water Source Heat Pump
WWTW	Waste Water Treatment Works

1. Introduction

1.1. Purpose of this Report

AECOM has been jointly commissioned by Staffordshire County Council (SCC) and eight Local Authorities (LA) within Staffordshire to provide technical support to develop an evidence base for new energy and sustainability policies within the relevant forthcoming Local Plans.

This report summarises the findings of Stage 2 of the study. Please see Section 1.2 below for a summary of the scope of this assessment.

Stage 1 of the study (which was summarised in a Baseline Report that was issued to stakeholders in March 2020) provided an overview of the current emissions baseline and potential future emissions scenarios, as well as an appraisal of the climate baseline against which future climate risks could be identified. The results from Stage 1 of the study will be used to inform the Stage 2 analysis. Please see Section 2 for a summary of the findings from the Baseline Report.

1.2. Scope of the Current Assessment

Stage 2 of the study is focused on three key themes, as outlined below.

1.2.1. Reducing Energy Demand

Design measures and building standards will play a key role in reducing the energy demand and associated CO_2 emissions in any new-build development that is delivered. They will also help to prepare new developments in adapting to the anticipated effects of climate change.

The analysis summarises the key topics, principles and standards related to the conservation of energy in buildings, and describes measures that work well in combination to deliver a holistic approach to sustainable design. This is drawn from what is a significant body of industry guidance and best practice, and summarises measures that can be implemented at an urban planning level, as well as at a building level.

The analysis also quantifies the potential scale of a dedicated carbon offsetting fund, based on the levels of proposed new development across each of the Local Authorities, and accounting for potential future changes in UK Building Regulations. This fund could be used to collect payments from developers in lieu of the carbon savings required by policy. The potential for this fund to finance carbon offsetting projects, for example retrofitting existing properties or developing large renewable energy or nature-based solutions projects, is investigated.

A summary of the changes that are likely to occur in relation to the adoption and roll-out of Electric Vehicles (EVs) and other Ultra-Low Emission Vehicles (ULEVs) is also provided.

1.2.2. Offsetting & Sequestering Emissions

This theme explores opportunities to offset CO_2 emissions through the use of Low and Zero Carbon (LZC) energy technologies, along with opportunities to sequester (i.e. remove) CO_2 from the atmosphere through nature-based solutions, such as tree planting and changes in land management practices.

Recognising the scale of the challenge involved in reaching Net Zero carbon emissions, the analysis describes the potential scale of LZC energy capacity that could be delivered, based on a standard methodology for carrying out high-level regional LZC energy assessments. Then, to put this into context, an estimate is provided of the amount of LZC capacity that would be needed in order to meet 100% of Staffordshire's electricity demands using renewably-generated electricity. The intention is to highlight the scale of the challenge involved in achieving the UK-wide decarbonisation targets, to inform potential policy responses. The discussion is informed by Geographic Information System (GIS) spatial analysis of grid infrastructure capacity and other relevant constraints.

Increasing carbon sequestration rates through changes in land use and land management offers an alternative means of mitigating climate change, while also offering a range of environmental, economic and social co-benefits. Key opportunities for Staffordshire are discussed with reference to the types of existing habitats found across the County. Consideration is also given to options for delivering improvements on Council-owned landholdings, and participating in accredited schemes which aim to support the use of nature-based solutions as a means to reduce emissions (e.g. the Woodland Carbon Code).

1.2.3. Climate Risks

This section provides an overview of the key climate risks impacting the existing built environment in Staffordshire, along with those that are relevant to proposed new development locations, with a particular focus on issues related to flooding and overheating. The analysis seeks to identify the climate risks that are most relevant to key development typologies and the County as a whole, using a variety of metrics and spatial analyses. These are then used to develop a comprehensive set of interventions that can be used to inform policy measures relating to climate change adaptation.

1.3. Policy Recommendations and Other Potential Responses

The policy recommendations provided in this report will build on the analysis presented in previous sections, along with the Baseline Report. The primary focus is on policies that could be addressed through future Local Plans (or Supplementary Planning Guidance documents). Although these recommendations vary widely in the level of ambition, detail and topic areas covered, if adopted they should be taken into account in any future Strategic Environmental Assessments or Sustainability Appraisals that may be carried out.

In addition to policy recommendations, consideration will also be given to other potential response measures and actions that the Local Authorities can take to ensure that Staffordshire will be able to achieve challenging decarbonisation targets, while mitigating, and adapting to, the impacts of future climate change.

Note: Potential Future Changes to the Planning System

Following the preparation of the Baseline Report and draft Final Report, the Planning for the Future consultation White Paper was published by the Ministry of Housing, Communities and Local Government (MHCLG) on 6th August 2020. This consultation document sets out a package of proposed measures that, if implemented, would comprehensively transform the current planning system in England. The stated aim is to streamline and modernise the planning process, including to improve design and sustainability outcomes.

Although the outcome of the consultation is uncertain, we acknowledge that some of the proposals it contains would, were they to be adopted as legislation, directly impact on how Councils can respond to the Climate Emergency and therefore would potentially affect the ability of Councils to set some of the policy recommendations in this report. For more information, please see Appendix A.

1.4. Structure

The report is structured as follows:

- **Section 2** – Provides an overview of the findings presented in the Baseline Report issued in March 2020.
- **Section 3** – Describes sustainable building standards and holistic design interventions that can help to reduce energy use and CO_2 emissions, along with the potential impacts of switching towards the use of ULEVs.
- **Section 4** – Outlines the potential opportunities for strategic LZC energy technologies and discusses the scale of current and potential carbon sequestration in different habitats across Staffordshire.
- **Section 5** – Assesses the key climate change related risks and vulnerabilities that are most relevant to Staffordshire.
- **Appendices** – The appendices contain additional details of the assumptions, methodologies and sources of information used to develop the analysis and recommendations in the main report.

2. Baseline Study Findings

The Baseline Report was issued in March 2020, after which stakeholders provided feedback and comments. These were collated in a Comments Register, which allowed all comments to be tracked and actioned accordingly; some required amendments to be made to the analysis and/or the Baseline Report. These amendments have been integrated into a further revision of the Baseline Report (Rev03).

2.1. Policy Context

Most of the Local Authorities are undergoing updates to their Local Plans. Many of the Authorities have also declared a Climate Emergency, or are in the process of doing so, and have set target dates for achieving Net Zero emissions either for the Council's own activities and / or on an area-wide basis. Whilst the target dates for Net Zero vary from Authority to Authority, several are targeting 2030. The policy positions for each Authority are summarised in Table 2.1.

Table 2.1: Summary of policy positions by Local Authority

Authority	Local Plan update	Climate Emergency Declaration (and target year, if applicable)
Cannock Chase District Council	Yes	Yes (2030 target)
East Staffordshire Borough Council	No	No
Lichfield District Council	Yes	No
Newcastle-under-Lyme Borough Council	Yes	Yes (2030 target – under review)
South Staffordshire District Council	Yes	Yes
Stafford Borough Council	Yes	Yes (2040 target)
Staffordshire Moorlands District Council	Yes	Yes (2030 target)
Tamworth Borough Council	Yes	Yes (2050 target; 2030 aspiration)
Staffordshire County Council	n/a	Yes

2.2. Baseline Fuel Consumption

The fuel consumption was presented for each Local Authority, broken down by fuel type (e.g. natural gas, electricity, etc.) and by sectoral usage (e.g. dwellings, road transportation, etc.). Overall, energy use is dominated by natural gas (33.7%), petroleum products (42.2%) and electricity (20.2%), which together account for over 96% of the total for Staffordshire County as a whole, with the remaining c.4% being met by manufactured fuels, bioenergy& waste, and coal fuels. This trend is broadly consistent with what was observed for individual Local Authorities. Notable exceptions include:

- **Lichfield**, which is shown to be more reliant on natural gas (48.9%) and less reliant on petroleum products (17.2%)
- **Newcastle-Under-Lyme**, which sources almost half (46.4%) its energy from natural gas
- **South Staffordshire**, which sources more than half (53.8%) of its energy from petroleum products
- **Staffordshire Moorlands**, which sources almost 10% of its energy from coal

Almost all of the energy used in Staffordshire is used in one of three sectors: industrial and commercial buildings (27.5%), domestic buildings (35.6%) and road transport (34.6%), which together account for almost 98% of all fuel consumption. On the whole, this trend is consistent with what is observed for individual Local Authorities. Notable exceptions include:

- **Lichfield**, for which the industrial and commercial building sector (50.2%) is significantly higher than the domestic building sector (34.2%), and road transport (15.6%) is significantly lower than in other Authorities. This may explain why petroleum consumption is lower in Lichfield than in other Authorities.
- **Newcastle-Under-Lyme**, where energy consumption in industrial and commercial buildings (14.3%) is significantly lower than in other sectors, and energy consumption in domestic buildings (56.1%) is higher.

2.3. Baseline Greenhouse Gas (GHG) Emissions

The baseline Scope 1, 2 and 3 GHG emissions in Staffordshire are estimated to be 6,421 ktCO_2e per year, as reported within the SCATTER database, an online tool that has been developed by BEIS for use in estimating emissions at a Local Authority level. Of this total, Scope 1 and 2 emissions (i.e. those associated with fuel consumption and electricity used within the area boundary) account for roughly 5,407 ktCO_2e (84.2% of the total).

The analysis presented in the Baseline Report demonstrates that, since 2005, Scope 1 and 2 CO_2 emissions have decreased by around 25%. Roughly half of this change is attributed to the rapid decrease in the carbon intensity of grid electricity ('grid decarbonisation').

Looking forward to 2050, grid decarbonisation alone could theoretically result in a further 15% decrease in emissions compared with 2017 levels. Furthermore, although future emissions are highly uncertain, it is estimated that:

- New development in Staffordshire (in line with Local Plan targets) could increase emissions by roughly 5%, although the actual amount could be less depending on future changes in Building Regulations and sustainable construction practices;
- Switching to ULEVs could result in around a 28% decrease in annual CO_2 emissions, but the savings could improve even further in the event of future grid decarbonisation; and
- Better standards for new buildings, combined with grid decarbonisation and switching to ULEVs, could decrease total emissions by over 50% compared with 2017 levels. Additional measures to decrease energy demand and promote the use of LZC electricity instead of fossil fuels would provide further benefits.

These scenarios represent just a few of the steps that will need to be taken to reach the goal of achieving Net Zero emissions in the future.

Opportunities for reducing emissions (through improved building design standards and encouraging the uptake in ULEVs across the County), offsetting emissions (via renewable energy projects) or sequestering carbon already in the atmosphere (via nature-based solutions) is a key focus for Stage 2 of the study. These findings are presented in subsequent sections of the current report.

2.3.1. Note: Impacts on Scope 1, 2 & 3 emissions

As discussed in the Baseline Report, the primary focus of this study is on reducing Scope 1 & 2 emissions. When discussing area-wide emissions, this refers to emissions that arise from the use of fuel or electricity within the area boundary. Other emissions – from the wider supply chain, commuting, and so on – are referred to as Scope 3 emissions. Put simply, when undertaking an area-wide emissions baseline, one area's Scope 3 emissions are another area's Scope 1 & 2 emissions.

There are a variety of positive actions that Local Authorities, organisations and individuals can take, particularly when switching to the use of more local sourcing, supply chains, produce and renewable energy, that might reduce the overall emissions to Earth's atmosphere, but would appear to increase the Scope 1 & 2 emissions in that specific area. This is a complex topic and it is difficult to forecast how these changes might occur and how the overall positive results can be quantified. However, as a general caveat to this report we would support any actions that can be shown to reduce CO_2 emissions overall even if these appear on the 'balance sheets' for Local Authorities in Staffordshire.

2.4. Climate Risks

The analysis presented in the Baseline Report demonstrates that Staffordshire is exposed to seven key climate hazards; severe storms and gales, cold and snow, river flooding, surface water flooding, heat waves, drought and wildfires. Between them, these hazards present 20 climate risks and their associated impacts that new development could be exposed to in both current day and future scenarios, across the natural environment, infrastructure and the people and the built environment sectors.

Climate change is expected to exacerbate and enhance the impacts experienced throughout Staffordshire, due to warmer, wetter-winters and hotter, drier summers, with an increase in the frequency and intensity of extreme weather events.

For each risk identified, impact statements were developed, manifesting as negative impacts or opportunities (positive impacts). Negative impacts were shown to outnumber opportunities by over four-to-one.

The aim of the second stage of the study is to develop recommendations that the Local Authorities can adopt and implement within their Local Plans to help increase resilience to climate change and the risks identified in the Baseline Report. The process of further informing and then developing recommendations has been broken down into the following aspects, the findings of which are presented in the subsequent sections of the current report:

- A Staffordshire-wide baseline of exposure to flooding and vulnerability;
- How different development typologies can influence climate risk;
- Vulnerability to climate risks; and
- Intervention options and recommendations for policy wording.

3. Reducing Energy Demand

A key part of decarbonising Staffordshire will be to reduce the demand for energy as much as possible, in order to both limit the CO_2 emissions associated with meeting the demand for energy, and to reduce the pressure to deliver additional sources of LZC energy. This section considers opportunities to reduce energy demand in new and existing buildings and transportation.

3.1. Sustainable Design Measures

3.1.1. Energy Performance and CO_2 Emissions Standards

This section of the report considers the performance standards that could be used to reduce energy demand and CO_2 emissions in new domestic and non-domestic developments.

3.1.1.1. Background

In addition to the local Net Zero targets set by individual Local Authorities in Staffordshire, the UK has a legal commitment to reduce greenhouse gas emissions by 100% (i.e. achieve Net Zero emissions) by 2050. This goal cannot be met without a significant reduction in CO_2 emissions from all sectors. It is estimated that fuel use in buildings currently accounts for roughly 58% of total emissions in Staffordshire. As discussed in the Baseline Report, if new development in the County matches current median levels of fuel consumption, CO_2 emissions in Staffordshire would increase by around 5% by 2050 (all other factors being equal).

A report by the Tyndall Centre[1] found that, in order to meet the UK's commitments under the Paris Climate Agreement, cumulative CO_2 emissions in the UK would have to adhere to a strict carbon budget from now through to the year 2100. Based on 2017 CO_2 emissions, the entire carbon budget for the West Midlands would be used up within the next 7 years. It is clear that urgent action is required to reduce emissions, so although the increase from new development is small relative to the total, any increase will make the target that much harder to achieve.

The environmental and financial cost of delay is significant, even if standards are increased progressively over time. For example, a study conducted on behalf of the Committee on Climate Change found that the lifetime carbon emissions (over 60 years) of a house built with a gas boiler in 2020 and then retrofitted with a heat pump in 2030 would be around three times higher than if a heat pump was fitted at the outset.[2] This is illustrated in Figure 3-1 below (source: Figure E.1 of the CCC report). At a national level, the report found that, *'each year of delay in adopting lower-carbon heat technologies could result in several million tonnes of avoidable carbon emissions.'*

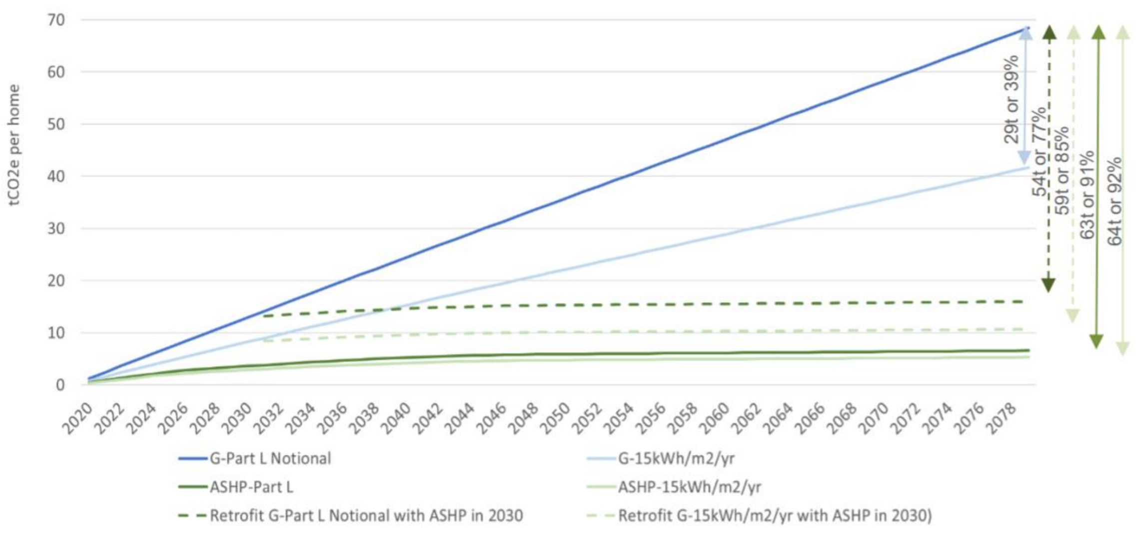

Figure 3-1. Comparison of cumulative CO_2 emissions from a house built to different energy performance standards. Source: CCC (2019)

[1] Tyndall Centre, *'Quantifying the implications of the United Nations Paris Agreement for the West Midlands'* (2020). Available at: https://carbonbudget.manchester.ac.uk/reports/WM/

[2] Currie Brown and AECOM on behalf of the Committee on Climate Change, *'The costs and benefits of tighter standards for new buildings'* (2019). Available at: https://www.theccc.org.uk/wp-content/uploads/2019/07/The-costs-and-benefits-of-tighter-standards-for-new-buildings-Currie-Brown-and-AECOM.pdf

Local Authorities should therefore look to set the highest level of building performance standards for new buildings that can practically and viably be achieved, and should do so as soon as possible. In addition, the Authorities should consider opportunities to improve the performance of the existing building stock, as this represents a high share of total emissions.

(As will be discussed in Section 3.1.1.3, due to the embodied carbon already locked away within the existing stock, the lifecycle carbon emissions from high performing new buildings (which will result in significant emissions from the new construction) may be higher than if existing buildings were retained and retrofitted. This means that the latter is often preferable from a lifecycle carbon perspective, though the outcomes are highly project specific.)

3.1.1.2. Policy Context

The Zero Carbon Homes Policy announced by the Government in 2006 would have required all new homes to be Zero Carbon by 2016; however, the policy was withdrawn in 2015. The Housing Standards Review undertaken in 2014/15 proposed to standardise performance requirements nationally, and this was codified by the Deregulation Act (2015), but the relevant provision was never enacted. In March 2019, new Planning Policy Guidance was issued, which confirmed that:

- For domestic buildings, Local Authorities can require new buildings to achieve up to a 19% improvement in CO_2 emissions compared with Part L 2013, equivalent to the (now defunct) Code for Sustainable Homes Level 4; and
- For non-domestic buildings, Local Authorities are 'not restricted or limited' in the energy standards they can set.[3]

At the time of writing, therefore, although Local Authorities are currently able to set higher standards of building energy performance than those outlined in the Building Regulations, it is unclear whether this will remain the case. According to the Government's Future Homes Standard Consultation document:[4]

> *'As we move to the higher energy standards required by Part L 2020 and the Future Homes Standard, there may be no need for local authorities to seek higher standards and the power in the Planning and Energy Act 2008 may become redundant.'*

Therefore, although this section will address different options for introducing building performance standards, it is important to note that they may not be enforceable in the future. There are however other measures that Local Authorities can take to ensure that buildings are futureproofed and to ease the transition to a low carbon built environment that will also be addressed.

A key risk regarding the ability of Local Authorities to set and enforce standards which are higher than national standards is presented by the recently published White Paper 'Planning for the Future', which is currently out for consultation. Please refer to Appendix A for more details.

3.1.1.3. Existing Standards

In addition to the mandatory building energy performance standards set in Part L of the Building Regulations, there are various voluntary UK and international standards that set higher targets. Table 3.1 (see overleaf) presents a brief overview and comparison of some of these standards, focusing on those that are most commonly in use in the UK.[5] The table also includes the current Part L 2013 requirements and those that are laid out in the Future Homes Standard consultation.

These standards vary significantly in scope, calculation methodology, and assessment / validation procedures. Targets can be set based on metrics such as:

- Demand for space heating and / or cooling;
- Primary energy demand;
- Total energy consumption (i.e. delivered energy);
- CO_2 emissions;
- Amount of renewable energy generated on-site (for instance, in Passivhaus Plus); or
- Energy efficiency rating (in the case of BREEAM Domestic Refurbishment schemes).

[3] https://www.gov.uk/government/speeches/planning-update-march-2015
[4] Ministry of Housing, Communities & Local Government, *'The Future Homes Standard: Consultation on changes to Part L and Part F of the Building Regulations for new dwellings'* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/852605/Future_Homes_Standard_2019_Consultation.pdf
[5] CIBSE, *'TM60: Good Practice in the Design of Homes'* (2018)

Table 3.1. Comparison of building design standards

	Part L 2013	Future Homes Standard Option 1	Future Homes Standard Option 2	BREEAM 'Outstanding'	Home Quality Mark (HQM)	Energiesprong	Passivhaus	Passivhaus Plus	EnerPHit
Description	Current performance standard of UK Building Regulations (2013).	Would equate to roughly a 20% improvement on Part L 2013, likely to be achieved through very high fabric efficiency standards.	Would equate to roughly a 31% improvement on Part L 2013 through fabric energy efficiency measures (not as high as in Option 1) plus the use of LZC technologies.	BREEAM 'Outstanding' requires a reduction in regulated CO_2 emissions, compared with Part L 2013 standards. Additional credits can be achieved for achieving up to a 100% reduction (i.e. Net Zero) regulated emissions.	HQM was developed by the BRE as a rating system that can signal to householders how well the building performs based on various sustainability indicators, including energy use and CO_2 emissions.	Originally developed by the Dutch government to promote energy efficient retrofitting, this is a performance standard for new build and refurbishment.	Originally developed in Germany, this is a performance standard that aims to meet annual heating requirements with very low energy input.	Similar to the Passivhaus Standard, this scheme also requires renewable energy generation on-site or nearby, resulting in Net Zero emissions.	This is the Passivhaus Institute standard aimed at energy efficiency refurbishment schemes, which can achieve energy and CO_2 savings of 75-90%.
Relevant building types	Domestic and non-domestic	Domestic only	Domestic only	Non-domestic only [separate standards for domestic refurbishment]	Domestic only	Domestic only	Domestic and non-domestic	Domestic and non-domestic	Domestic and non-domestic retrofits
Scope	Regulated energy use only	Regulated energy use only	Regulated energy use only	Core requirements relate to regulated energy use, but additional credits can be achieved for reducing or offsetting unregulated energy use. There is consideration of lifecycle CO_2 emissions from certain materials, but no set target.	As for BREEAM	Regulated and unregulated energy use	Regulated and unregulated energy use	Regulated and unregulated energy use	Regulated and unregulated energy use
Target values	Based on a notional building with a similar built form, targets are set for: • CO_2 emissions • Fabric energy efficiency • Minimum performance standards for building elements and fixed services	Typical 20% improvement on Part L 2013 CO_2 emission rates. New targets based on: • Primary energy • CO_2 emissions • Householder affordability • Minimum performance standards for building elements and fixed services	Typical 31% improvement on Part L 2013 CO_2 emission rates, or around a 22% improvement in typical flats (due to less roof space for LZCs) New targets as for Option 1 (see left)	A bespoke metric is used which accounts for operational energy demand, primary energy consumption and regulated CO_2 emissions An 'Outstanding' rating requires at least 40% improvement on Part L 2013	As for BREEAM	Space heating demand <30 kWh/m^2/yr Net zero delivered energy over the course of the year	Space heating demand <15 kWh/m2/yr Primary energy demand <60 kWh/m^2/yr	Space heating demand <15 kWh/m^2/yr Primary [renewable] energy demand <45 kWh/m^2/yr	Compliance can be achieved via a 'component' method which uses Passivhaus-certified products, or via the 'energy demand' method which sets a space heating target dependant on climate zone. In Staffordshire the target would be 25 kWh/m^2/yr
Fabric energy efficiency standard	Typically, 45-50 kWh/m^2/yr for flats and 55-60 kWh/m^2 /yr for houses	Fabric energy efficiency target to be replaced by those listed above	As for Option 1 (see left)	None	None	Minimum performance standards for building elements and fixed services	Space heating demand <15 kWh/m^2/yr	Space heating demand <15 kWh/m^2/yr	As for Passivhaus (see left) – but only if seeking compliance via the 'energy demand' method
Renewable energy requirement?	No	No	No, but this would typically be required to meet the targets	No	No	No	No, but this would typically be required to meet the targets	Yes, renewable energy generation >60 kWh/m2/yr of building footprint	No

It is important to understand that not all emissions associated with buildings are captured by the standards described above. Part L (2013), the Future Homes Standard, BREEAM and HQM only address CO_2 emissions resulting from the use of fixed services and appliances, i.e. heating, cooling, ventilation, hot water, and lighting. These are referred to as 'regulated' CO_2 emissions (see row 4 in Table 3.1). 'Unregulated' CO_2 emissions are those that result from the use of other (typically electrical) appliances (such as fridges, home entertainment systems, etc.).

There are additional emissions associated with the production, manufacture, construction, maintenance, repair and demolition of buildings. These are known as 'embodied' CO_2 emissions, and can represent 30-70% of the total CO_2 emissions, as illustrated in Figure 3-2 below, which is adapted from the UK Green Building Council report.[6]

To reach Net Zero across the whole of the UK, it will be necessary to implement policies that address a broader range of emissions that occur over the building's lifecycle, at all stages of the supply chain. The need to address the embodied emissions associated with the construction of new buildings should therefore be considered at a policy level and encouraged for all new development.

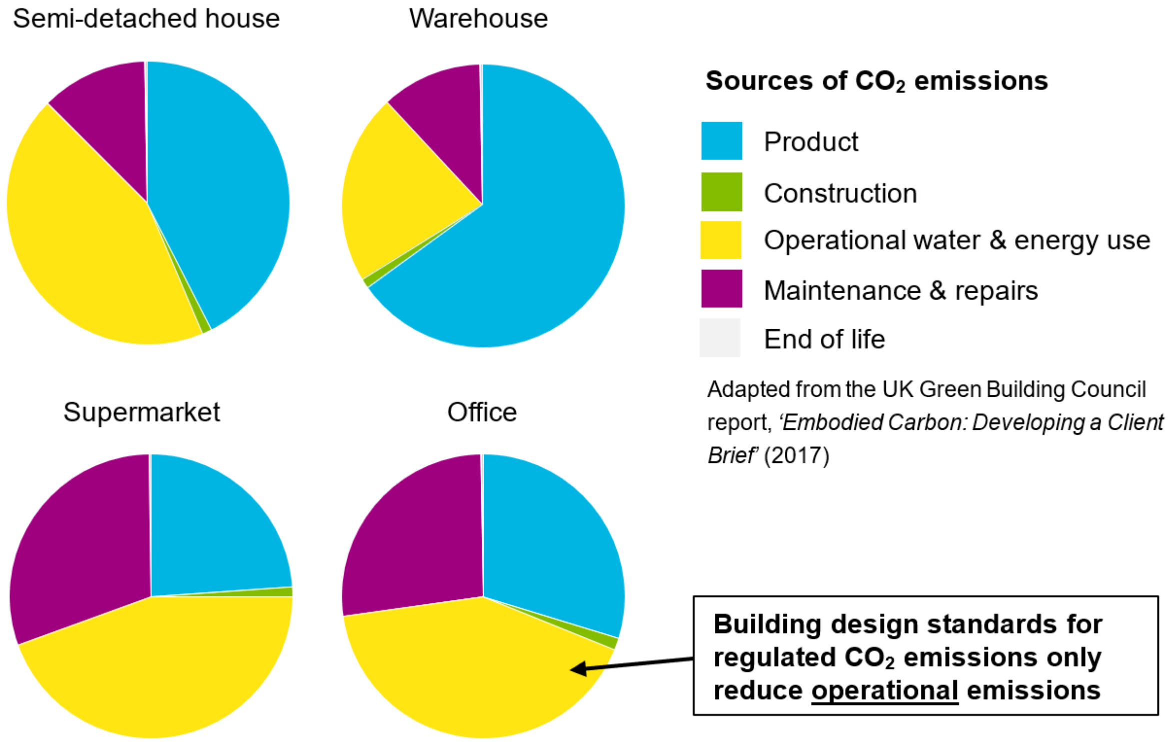

Figure 3-2. Illustration showing the relative proportion of CO_2 emissions from operational carbon (in yellow) compared with embodied carbon over a 30-year period. Source: UK-GBC (2017)

Furthermore, it should be noted that most compliance calculations rely on modelled estimates of the building's energy demands and CO_2 emissions, but that, in real-world operation, these tend to be significantly higher than design estimates suggest. For example, research undertaken by Innovate UK, which examined the in-use performance of a selection of low carbon development schemes, found that, even though CO_2 emissions were significantly lower than in typical buildings, in-use CO_2 emissions from domestic buildings were typically 2-3 times higher than predicted, and those from non-domestic buildings were nearly 4 times higher.[7,8]

In addition to setting higher building design standards, therefore, Local Authorities should consider requiring developers to undertake post-construction monitoring. This will be crucial in order to help bridge the 'performance gap' described above (between predicted or modelled emissions and those in-use emissions observed in the real world) and ensure that the levels of CO_2 reduction as indicated prior to construction are actually achieved.

[6] UK Green Building Council, *'Embodied Carbon: Developing a Client Brief'* (2017).
[7] Innovate UK, *'Building Performance Evaluation Programme: Findings from domestic projects'* (2016). Available at: https://www.gov.uk/government/publications/low-carbon-homes-best-strategies-and-pitfalls
[8] Innovate UK, *'Building Performance Evaluation Programme: Findings from non-domestic projects'* (2016). Available at: https://www.gov.uk/government/publications/low-carbon-buildings-best-practices-and-what-to-avoid

3.1.1.4. Impact on Energy Demand and CO_2 Emissions

As a rough estimate, if all new buildings were built to achieve Net Zero *regulated* emissions, the increase in County-wide CO_2 emissions due to new development (compared with 2017 levels) could be limited to 1-3% rather than the 5% increase described in the Baseline Report.[9] Assuming that the remaining emissions would be due to unregulated electricity use, this could be limited even further depending on the rate of national grid decarbonisation. (This estimate does not include the embodied CO_2 emissions associated with the construction of new buildings.)

Although this figure is relatively small compared to total emissions, the key point is that *any* increase in CO_2 emissions will make the Net Zero targets harder to achieve. In particular, as will be discussed in Section 4.1, any increase in energy demands will put pressure on grid infrastructure, and will need to be met with additional deployment of renewable energy technologies.

Recognising that the existing building stock represents 58% of total emissions in Staffordshire, however, it is clear that significantly greater CO_2 reductions would be achieved by upgrading them to standards such as those listed in Table 3.1, and by installing energy efficient heating technologies.

Upgrading the existing stock is a major challenge for Local Authorities, which have limited ability to influence the performance of existing buildings that are not Council-owned, except where planning permission is being sought e.g. for a major extension or refurbishment project. Nonetheless, to illustrate the scale of improvement that might be achievable, Figure 3-3 compares the typical emissions for existing dwellings in Staffordshire to the emissions of equivalent buildings that are retrofitted to achieve a 50% reduction in heat demand, and then ***either*** fitted with direct electric heating (DEH) ***or*** an air source heat pump (ASHP).

The CO_2 emissions in Figure 3-3 are based on a rough calculation[10] that considers the relative efficiency of different heating systems, and is not a prediction of actual CO_2 emissions. However, it shows that reducing heat demand and then switching to a heat pump could potentially reduce CO_2 emissions from a typical dwelling by up to 60%, based on the current carbon intensity of the electricity grid. The positive effect is magnified if the electricity grid continues to decarbonise, with potential CO_2 reductions of up to 80% per dwelling in the future.

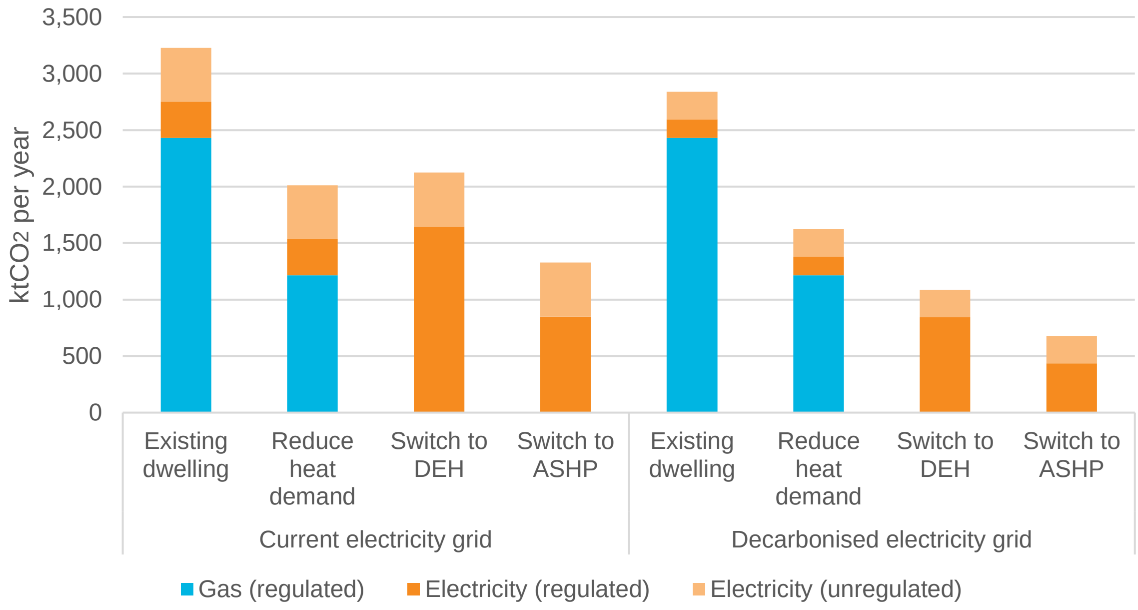

Figure 3-3. Estimated CO_2 savings that could be achieved in typical dwellings – based on different scenarios for regulated CO_2 emissions, heating system and electricity grid decarbonisation

It is important to ensure that, if higher performance standards are introduced, these are accompanied by other related measures to ensure that buildings are comfortable and adaptable to climate change, and mitigate the risk of unintended consequences such as overheating, moisture or ventilation issues. This is particularly important for

[9] This depends on the standards set by UK Building Regulations and the proportion of CO_2 emissions that are assumed to be captured by modelled estimates carried out for Part L compliance.
[10] See Appendix B for more details.

homes that are designed or retrofitted to achieve high levels of airtightness, to avoid the risk of poor ventilation or indoor air quality.[11,12] For more information on how buildings can adapt to climate change, refer to Section 5.

3.1.1.5. Costs of Meeting Higher Standards

Analysis previously carried out by AECOM and Currie Brown on behalf of the Committee on Climate Change (CCC, 2019) considered the cost implications of achieving energy performance standards equivalent to those listed above for a range of building types.[2] The study found that, for new buildings, the uplift in cost ranged from around 1%-4% of the total build cost. Note that, if certification is being sought from an independent scheme, there will be additional costs compared with achieving standard Part L compliance (e.g. design, assessment and validation).

An impact report produced as part of the Future Homes Standard Consultation[13] indicates that the proposed new standards would result in the following increase in build costs for new homes:

Table 3.2. Future Homes Standard Consultation – Uplift in typical build costs for different building types

	Option 1 (20% uplift)	Option 2 (31% uplift)
Detached house	£4,200	£6,520
Semi-detached house	£2,560	£4,850
Mid-terraced house	£2,200	£4,740
Flats	£2,070	£2,260
Average (based on build mix)	£2,870	£4,620

These costs should be weighed against the wider benefits of reducing energy demand and CO_2 emissions, including potential savings on energy bills. The Government estimates that Option 1 would save occupants of a typical semi-detached home £60 per year on energy bills, compared with £260 savings with Option 2. In addition, there is evidence that more sustainable homes and buildings may result in a higher sale or rental value, which means that some of the additional cost could be recovered in enhanced values.

Consideration should also be given to the opportunity costs that may occur if new buildings are *not* capable of meeting these requirements. The costs of retrofitting buildings to an equivalent standard are significantly higher than those for new buildings (although still lower than the cost of demolishing and rebuilding a house).

For **domestic buildings**, the cost of installing energy efficiency measures and low carbon heating systems can be three to five times higher if they are retrofitted, compared with installing them in new homes. The cost depends on which measures are installed, but can range from around £16,000 per home (CCC, 2019) to upwards of £75,000 per home, as in the case of Energiesprong deep energy retrofitting projects.[14]

Non-domestic buildings exhibit a wider range of outcomes, but as a rough estimate, the costs of installing energy saving measures and technologies may be 3 to 10 times higher when they are retrofitted than when they are installed in a new building (CCC, 2019).

This indicates that some form of incentive scheme and regulatory change will almost certainly be required in order to improve the existing building stock to the level that would be required in order to reach Net Zero emissions.

It is important to note that the additional costs associated with introducing higher standards can also change rapidly over time. For instance, research conducted by Element Energy on behalf of a group of Local Authorities found that, from 2011 to 2013, the cost of building to meet the (now withdrawn) Code for Sustainable Homes standard

[11] For more information about avoiding common issues when retrofitting existing buildings, see for example the STBA publication *'Planning Responsible Retrofit of Traditional Buildings'* (2015). Available at: https://historicengland.org.uk/images-books/publications/planning-responsible-retrofit-of-traditional-buildings/responsible-retrofit-trad-bldgs/

[12] For more information about the risk of overheating in new homes, see AECOM, *'Research into overheating in new homes: Phase 1 report'* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/835240/Research_into_overheating_in_new_homes_-_phase_1.pdf

[13] See *'Table 5: Additional Capital Costs'* of the Future Homes Standard Consultation Impact Assessment (2019)

[14] Evidence gathered as part of the Energiesprong programme indicates that costs have decreased radically over time, and research by the Green Alliance suggests that these could come down to around £35,000 per home on average. Green Alliance, *'Reinventing Retrofit: How to scale up home energy efficiency in the UK'* (2019). Available at: https://www.green-alliance.org.uk/resources/reinventing_retrofit.pdf

decreased by around 55%.[15] This was attributed in significant part to the rapid decrease in the cost of PV. It is possible that a similar transformation could occur if, for instance, heat pumps were to become widely adopted.

A separate Viability Addendum has been provided which contains further information related to the costs and potential viability implications of the proposed policy options. This document is provided alongside this report.

3.1.1.6. Carbon Offset Fund

Depending on the type of development in question, it may not be feasible to deliver the requisite level of CO_2 emissions reduction onsite. In this instance, some jurisdictions allow developers to make a financial contribution towards a carbon offset fund via Section 106 payments. The money can then be used to pay for interventions off site that would result in an equivalent amount of CO_2 being avoided (e.g. through energy efficiency measures or LZC projects) or removed from the atmosphere (e.g. through afforestation).

For example, the Greater London Authority (GLA) requires all new domestic developments to achieve a CO_2 saving of 100% compared with the CO_2 emission standards set out in Part L (2013) of the Building Regulations. A minimum 35% saving must be achieved through onsite measures, while the remainder can be offset via a financial settlement known as a Carbon Offset Payment. Payments to the GLA are currently based on a carbon price of £60 per tonne of CO_2over thirty years. All payments need to be completed prior to occupancy. The fund itself must be ringfenced and can only be used for the purposes of funding carbon offset projects elsewhere in the respective borough. The GLA has produced a guidance document for Local Authorities that wish to establish offset funds which contains further information.[16]

To provide a rough indication of the scale of carbon offset fund that could be generated annually via developer payments, please see Table 3.3 on the following page.

Key assumptions are as follows:

- It is assumed that all Local Authorities will set a target of Net Zero regulated emissions for new developments, recognising that most Councils have voted to declare a Climate Emergency.
- The annual, regulated CO_2 emissions for a new home built to Part L 2013 standards are assumed to be 1.57 tCO_2 per year per dwelling, based on analysis of Energy Performance Certificate (EPC) data for all new buildings completed in the West Midlands since 2013.[17] In addition, to reflect potential future changes in Building Regulations, figures are provided for the improved standards outlined in the Future Homes Standard Consultation:
    - Option 1: 20% improvement on Part L 2013 → 1.26 t CO_2 per dwelling per year
    - Option 2: 31% improvement on Part L 2013 → 1.09 t CO_2 per dwelling per year
- The cost of carbon is set at £60/tCO_2, which is based on the carbon offsetting requirements of the Greater London Authority (GLA). (Whilst there are other examples where Local Authorities have set up a carbon offset fund, for example Milton Keynes Council, the one covering London is the most ambitious.) In practice, Local Authorities could choose to set a higher carbon price; for example, the new draft London Plan suggests a price of £95/tCO_2.
- The cost is calculated over a 30-year period, so the total cost paid by the developer is £1,800/tCO_2 (£60/tCO_2 p.a. x 30 years)
- The target number of new dwellings constructed per year is based on figures provided by each Staffordshire Local Authority, as described in the Baseline Report. Typically, these align with the figures provided in the adopted Local Plans.

[15] Element Energy, *'Costs of building to the Code for Sustainable Homes'* (2013). Available at: https://www.brighton-hove.gov.uk/sites/brighton-hove.gov.uk/files/EP059%20Costs%20of%20building%20to%20the%20Code%20for%20Sustainable%20Homes%20(Sept%202013)%20(draft).pdf

[16] GLA, *'Carbon Offset Funds: Guidance for London's Local Planning Authorities'* (2018). Available at: https://www.london.gov.uk/sites/default/files/carbon_offsett_funds_guidance_2018.pdf

[17] Ministry of Housing, Communities & Local Government, *'Live EPC statistics: Table NB3 - Floor Area, Size, Energy Use, Carbon Dioxide Emissions and Fuel Costs of New Dwellings'* (2020). Available at: https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates

Table 3.3. Estimated annual carbon offset fund that could be generated from a Net Zero regulated CO_2 emissions target (carbon price: £60/tCO_2)

Assumption	Units	Average Regulated CO_2 per dwelling (Part L 2013)	Average Regulated CO_2 per dwelling (Future Homes Standard Option 1)	Average Regulated CO_2 per dwelling (Future Homes Standard Option 2)
Typical CO_2 emissions	tCO_2 per dwelling p.a.	1.57	1.26	1.09
Cost of carbon	£/ tCO_2	£60	£60	£60
Number of years	years	30	30	30
CO_2 offset generated	£ per dwelling	£2,834	£2,267	£1,955

Local Authority	Annual number of new dwellings*	Total annual offset fund (Part L 2013)	Total annual offset fund (FHS Option 1)	Total annual offset fund (FHS Option 2)
Cannock Chase	277	£784,905	£627,924	£541,584
East Staffordshire	754	£2,136,528	£1,709,222	£1,474,204
Lichfield	536	£1,519,835	£1,215,868	£1,048,686
Newcastle-under-Lyme	586	£1,660,484	£1,328,388	£1,145,734
South Staffordshire	466	£1,319,111	£1,055,289	£910,187
Stafford Borough	494	£1,399,227	£1,119,382	£965,467
Staffordshire Moorlands	320	£906,749	£725,399	£625,657
Tamworth	177	£501,546	£401,237	£346,066
TOTAL	**3,610**	**£10,228,386**	**£8,182,709**	**£7,057,586**

**Note that all figures may be subject to change. For references, see the Baseline Report.*

Note that these payments into the carbon offset fund would be expected to occur in all years for which new development continues to be come forward as illustrated here.

For context, Table 3.4 below shows indicative costs for a range of energy efficiency measures and projects that could be carried out using carbon offsetting funds.[18] Note that costs and carbon savings vary considerably depending on the project in question, and carbon savings also vary over time depending on factors such as electricity grid decarbonisation, so these figures are provided for information only.

Table 3.4. Indicative costs of energy efficiency retrofitting measures and LZC installations

	Installation cost (£)	Annual carbon savings ($kgCO_2$)	Lifetime of installation (years)	Lifetime carbon savings (tCO_2)	Lifetime cost of carbon (£/tCO_2)	Ref.
Individual measures						
Cavity wall insulation	£595	577	42	24	£25	[a]
	£345-£610	335-1,150	-	-	-	[b]
Internal solid wall insulation	£5,300	1,187	36	43	£124	[a]
	£7,400	510-1,720	-	-	-	[b]
External solid wall insulation	£8,100	1,187	36	43	£190	[a]
	£13,000	510-1,720	-	-	-	[b]
Loft insulation	£300	108	42	5	£66	[a]
Loft insulation (add 270mm insulation to uninsulated loft)	£285-£395	550-1,030	-	-	-	[b]
Loft insulation (top up from 120mm to 270mm insulation)	£230-£290	50-95	-	-	-	[b]
Double glazing	£4,500	492	20	10	£457	[a]
Flat roof insulation	£1,050	594	20	12	£88	[a]
Floor insulation	£520-£1,300	120-310	-	-	-	[b]
Draughtproofing	£100	140	10	1	£71	[a]
	£200	-	-	-	-	[b]
Whole house refurbishment (see notes below)	£6,895-£14,400	1,215	30	36	£269	[a]
Whole house refurbishment (Energiesprong standard)	£35,000-£75,000	-	30	-	-	[c]
Whole house refurbishment (CCC, 2019)	£16,000-£25,000	-	30	-	-	[d]
Whole house refurbishment (EnerPHit case study)	Approx. £39,000	-	30	-	-	[e]
Renewable energy technologies						
1MW wind turbine	£1,000,000	317,355	25	7,934	£126	[f]
1MW ground-mounted PV	£600,000	117,283	25	2,932	£205	[f]
1MW roof-mounted PV	£1,000,000	117,283	25	2,932	£341	[g]
Domestic solar water heating (approx. 3kW)	£4,615	289	20	6	£798	[a]

References

[a] AECOM, *'London Carbon Offset Price'* (2017). Figures are based on the Green Deal impact assessment carried out by the Department of Energy and Climate Change in 2012. In this instance, 'Whole house refurbishment' includes wall, loft and floor insulation, new double glazing, doors and draughtproofing.

[b] Energy Saving Trust estimate 2020. Available at: https://energysavingtrust.org.uk/

[c] Green Alliance, *'Reinventing Retrofit: How to scale up home energy efficiency in the UK'* (2019)

[d] Committee on Climate Change, *'Costs and benefits of tighter standards for new buildings'* (2019)

[e] Based on a case study reported by Passivhaus Trust, *'UK's first pre-certified step-by-step EnerPHit'* (2018)

[f] AECOM estimate 2020

[g] BEIS, *'MCS Installation Database - Small scale solar PV cost data'* (2019)

[18] AECOM, *'London Carbon Offset Price'* (2017). Available at: https://www.london.gov.uk/sites/default/files/london_carbon_offset_price_-_aecom_.pdf

3.1.2. Holistic Interventions

This section of the report describes other types of sustainability interventions that can be made to reduce energy demand in the built environment and transportation in a holistic manner. Recognising that this is a broad topic area which has been the subject of significant previous research, we have sought to highlight key considerations at an urban planning level, as well as at a building level, with reference to published studies and industry guidance.

Appendix C describes what a 'Home of the Future' might look like after incorporating all of these measures.

3.1.2.1. Measures to Reduce Overheating

At a masterplanning level, incorporating areas of green and blue infrastructure into the urban landscape can help to reduce the urban heat island (UHI) effect, in addition to providing attractive routes for pedestrians and cyclists, habitats for a variety of species, and helping to control surface water run-off. (Note: Some of these measures, such as green roofs and walls, are discussed in more detail in Sections 3.1.2.4 and 5.4.2 recognising that there is significant overlap with climate adaptation measures.) Reducing energy use in buildings overall will also reduce the amount of waste heat that is generated and rejected to the local microclimate, which is particularly relevant to urban areas.[19]

At an individual building level, the priority should be to minimise unwanted heat gains before considering alternative cooling strategies.[20] The geometry, orientation and form of buildings can have a significant impact on overheating risk. For example, single aspect units are at higher risk of overheating than other buildings, due to the lack of natural cross-ventilation. It is also important to ensure that, if natural ventilation is to be used to cool a building, this will not compromise its indoor air quality, noise levels, or security. The transition to EVs will be useful in this regard, because EVs are less noisy and have a significantly lower impact on air quality than traditional fuel vehicles, which means people may feel more comfortable opening windows.

In addition to building orientation, glazing area, and glazing specification, external shading devices are among the most effective means of reducing overheating risk.[21] This could also potentially be achieved through the use of balconies, external walkways or corridors and / or locating deciduous trees along the south, east or west facades of buildings. In the public realm, structures that provide shade (such as canopies and bus shelters) can be integrated with solar PV to generate renewable energy, thus serving a dual purpose. Materials that are lighter in colour have higher albedo (sun reflecting properties) and can therefore help to reduce heat gains.[22]

There are some sustainable design measures that can potentially conflict with measures aimed at reducing overheating and therefore must be given careful consideration. For example:

- Over the course of a year, there is a trade-off that will occur between reducing solar gains in summer (to minimise overheating) while also maximising solar gains in winter (to minimise heating demand).

- Although materials with a high thermal mass such as concrete, brick or stone can help to reduce fluctuations in temperature, some of these products – concrete in particular – have a high embodied energy and carbon content. This can be minimised, for instance through the use of cement replacements such as ground granulated blast furnace slag (GGBS).

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[19] Although it is difficult to determine the impact this would have on local temperatures in Staffordshire, research indicates that switching to Net Zero energy use buildings would reduce the average summer UHI magnitude in London by around 15%. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7604/2185850.pdf

[20] For example, the GLA London Plan (Policy 5.9) includes the following 'Cooling Hierarchy':

1 minimise internal heat generation through energy efficient design
2 reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
3 manage the heat within the building through exposed internal thermal mass and high ceilings
4 passive ventilation
5 mechanical ventilation
6 active cooling systems (ensuring they are the lowest carbon options).

For more information, see https://www.london.gov.uk/sites/default/files/energy_assessment_guidance_2018.pdf

[21] Report produced by AECOM on behalf of the Department for Communities and Local Government, *'Investigation into Overheating in Homes: Literature Review'* (2012). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7604/2185850.pdf

[22] More information can be found in the following publications:

- CIBSE *'TM60: Good practice in the design of homes'* (2018)
- CIBSE *'TM52: Limits of thermal comfort – Avoiding overheating in European buildings'* (2013)
- CIBSE *'TM54: Evaluating operational energy performance of buildings at the design stage'* (2013)

3.1.2.2. Promoting Sustainable Modes of Travel

The location and overall layout of the development should ensure that a mix of amenities are within easy walking or cycling distance of peoples' homes, to minimise the amount of travel required. In addition, wherever possible, developments should provide access to a range of public transport options such as bus and rail services.[23]

The streetscape should provide safe and attractive pedestrian routes that link destinations both within, and between, neighbourhoods or developments. To this effect, it is also important to provide dedicated cycle lanes and bus routes, and consider limiting access for private vehicles in town or city centres. These measures improve safety for cyclists and pedestrians, in addition to offering air quality benefits.

It is acknowledged that although design measures play a role in facilitating behaviour change, there are also questions of public perception / attitudes, consumer behaviour, and so on which can have a significant impact. This is particularly true in light of the COVID-19 pandemic. It is expected that the Local Authorities will need to undertake further research to understand how to capitalise on some of the positive changes that have taken place (e.g. less commuting and travel in general) and ensure that this is sustained as part of a longer term 'green recovery'. However, such an assessment is out of the scope of the present study.

As discussed in Section 3.2.3, the shift to electric vehicles will rely on a significant increase in the availability of charging infrastructure, and will put additional pressure on electrical power networks. Therefore, integrating PV technologies into transport infrastructure (for instance, installing solar canopies above car parks) will help to maximise the use of renewable energy for such vehicles. The same principle applies to domestic buildings: new homes should offer the provision for EV charging, which could be linked with rooftop PV and (vehicle-to-grid) battery systems.

There are also emergent technologies, such as Pro Teq star paths (a luminescent coating which absorbs UV rays during the day and produces a blue glow during the night and which can be applied to pathways) and bioluminescent plants, that could be used to provide public realm lighting solutions. However, at the time of writing, these are likely to be less cost effective than established options such as solar street lamps.

Changes in technology can contribute to reducing transport CO_2 emissions via measures that range from facilitating ridesharing and working from home, to smart logistics and traffic management. It is likely that intelligent traffic management systems will increasingly be used to optimise transport flow in ways that could reduce the need for parking spaces and multi-lane roads, although it is difficult to provide a quantitative estimate of the impacts these measures would have.[24]

3.1.2.3. Futureproofing to Facilitate Retrofitting LZC Technologies

[Note: Measures to ensure that developments are 'climate change adaptable' are discussed in Section 5.4; the current section focuses on ways to facilitate the installation, maintenance and performance of LZC technologies.]

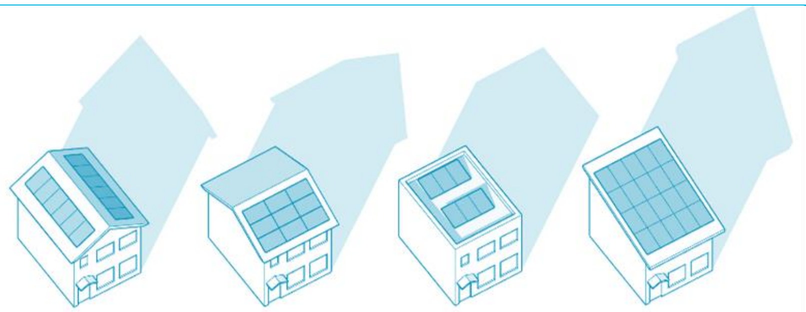
As will be discussed further in Section 4.1, in order to reach Net Zero emissions, there must be a major increase in the deployment of LZC technologies across the UK. Although this is an issue that is likely to be addressed in part through future changes in UK Building Regulations (see Section 3.1.1), in the interim period, it is important to ensure that new developments, along with extensions or refurbishment schemes, maximise opportunities to install such technologies – if not at the outset, then at a future date.

Although some technologies that are not yet widely available could become widespread in future (e.g. hydrogen gas and fuel cells), at the time of writing key opportunities are likely to include:

- **Maximising opportunities for renewable energy generation** – The amount of electricity generated by PV depends on multiple factors, including annual solar irradiation, panel orientation, tilt and efficiency. Therefore, the design and geometry of a building, and the overall layout of the development, are important factors that determine how much PV can be installed.

  To illustrate this point, the diagram below shows the difference in the amount of PV that could potentially be retrofitted onto buildings with the same footprint, but different roof geometries. The aim is not simply to compare the output of arrays with different orientations, but to highlight how multiple factors including array size, tilt and orientation have a combined impact on how much renewable electricity is generated, thus emphasising the need for sustainable design measures to be considered holistically.

[23] Campaign for Better Transport, *'Getting there: How sustainable transport can support new development'* (2015)
[24] Department for Transport, *'The Road to Zero: Next steps towards cleaner road transport'* (2018). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf



	House 1	House 2	House 3	House 4
Description	Dual pitch	Dual pitch	Flat roof + parapet	Monopitch
Orientation	East/West	South	South	South
Electricity (kWh p.a.)	2,190	1,910	1,150	4,080

Figure 3-4. Comparison of the electricity generation from PV on houses with different roof shapes

In this example, House 4, which has a south-facing monopitch roof, would be expected to generate roughly three and a half times more electricity per year than House 3, where panels have been installed on a flat roof and arranged in order to avoid being overshadowed by the parapet or adjacent panels.[25]

- **Use of low temperature heating systems that can be more easily replaced with ASHPs** – As stated in the Baseline Report, in the future, the most carbon efficient form of heating is likely to involve heat pumps, which operate most efficiently when used with low-temperature heating systems. Installing radiators and pipework that are compatible with low-temperature heating systems can both reduce the cost of retrofitting a heat pump (because the pipework and radiators can be retained), and in the meantime can potentially improve the performance of a gas boiler (resulting in an increase in boiler efficiency of around 3%).[2] For example, this would likely involve underfloor heating or specifying larger radiators than would be typically used for a traditional gas boiler system.

- **Allowing space for LZC technologies and battery storage** – ASHPs must be placed in an accessible outdoor location adjacent to the property, ideally in the open air (i.e. not within a shed or similar structure). Similarly, the design of new buildings should include space to accommodate battery systems, inverters, and other associated hardware (although it is acknowledged that the spatial requirements are likely to change over time due to technological improvements). Note that the increasing use of electric heating systems, EVs, battery storage and onsite renewable electricity generation would place significant demands on existing power infrastructure which may require upstream reinforcements of the local grid (e.g. increasing the capacity of upstream substations and cabling). This is discussed further in Sections 4.1.3 and 4.1.4.

- **Allowing access for maintenance and replacement of heating / cooling systems and other building services** – This issue is more likely to arise in non-domestic buildings with designated plant rooms and ventilation systems. It is important to ensure that the design allows for easy access to all building services (e.g. door dimensions and lift facilities allowing access to plant rooms in the basement or on the roof). Designing to facilitate maintenance can also help to reduce the amount of material needed to maintain a building over its lifespan and facilitate deconstruction, aligning with Circular Economy design principles (see Section 3.1.2.6).

- **Ensuring that buildings meet a high standard of fabric efficiency, including insulation and airtightness** – Reaching Net Zero will rely on reducing energy demands and switching towards the use of technologies that are powered by renewable electricity, including heat pumps and heat recovery systems. A high standard of fabric efficiency is necessary to ensure that these technologies operate at maximum efficiency. Furthermore, given that electricity is a more expensive fuel than natural gas, demand reduction is necessary to ensure that this transition does not result in higher energy bills.

[25] Based on standard 250W / 1.6 m^2 panels with a maximum annual output of 850 kWh/kWp, shown with a minimum 300mm gap between the panel and roof edge.

3.1.2.4. Green and Blue Infrastructure Design

Guidance from Natural England states[26] that a holistic approach to green infrastructure design should produce *'a strategic and linked, multifunctional network of spaces with benefits for people and wildlife.'* An obvious example is to co-locate green corridors (including trees, parks, gardens, and other areas of landscaping) with pedestrian and cycle routes, and to integrate these with sustainable drainage systems (SuDS) or other blue infrastructure such as canals, ponds and river networks.[27,28]

This approach offers multiple benefits, including but not limited to:

- **Recreation and amenity space** for people to enjoy, with associated positive health and social impacts, along with opportunities to provide outdoor education;
- **Habitats** for a range of wildlife, which can have a positive effect on biodiversity and ecosystems;
- **Reduction of the UHI effect** and, therefore, reduction in the risk of overheating and associated health impacts and cooling energy demands; and
- **Reducing surface water runoff** and providing flood attenuation / storage, which helps to alleviate pressure on drainage systems, reducing the risk of flooding and watercourse pollution.

Other forms of green infrastructure that should be integrated into new and existing built environments include:

- **Planting trees** that can (among other benefits) help to provide shade, thus offering comfortable outdoor space for amenity and recreation, reducing heat gains in buildings, and sequestering CO_2 from the atmosphere. Tree planting is discussed further in Section 4.1.3.3.
- **Green roofs and walls**, which can form part of a holistic SuDS strategy whilst offering beneficial outdoor space for building occupants. The design of these features should take into consideration the embodied carbon impacts of any additional structural support that they will need, along with the water use / irrigation requirements of any plant species.
- **Space for individual or communal food growing** such as allotments, orchards and edible gardens.[29]

The design of green and blue infrastructure must also consider:

- Proximity to buildings, infrastructure, or sources of disturbance such as noise or light pollution – these factors can have a significant impact on the actual ecosystem benefits that are realised.
- The water requirements of any plants – this would include selecting species that are drought resistant and can thrive with minimal or no supplementary irrigation.

Recognising that Staffordshire is already classified as an area with 'moderate' water stress,[30] and that this is likely to increase in future, design features that have an impact on water use or water management must consider opportunities to conserve this important resource.[31] For example:

- SuDS features (e.g. water gardens and reed ponds) could be integrated with greywater recycling systems.
- If irrigation is provided to green roofs or walls or other landscaping features, this must include rainwater harvesting to minimise the pressure on the public water supply.

One way of ensuring that these features are not constrained to narrow corridors, but are integrated within the wider landscaping scheme, would be to provide multi-function SuDS – for instance, spaces that are designed to flood under certain circumstances but otherwise offer natural play areas. (Areas that are designed to flood are not classed as 'developable' land but would count as open space which may also be publicly accessible, so there is a

[26] Natural England, *'Green Infrastructure Guidance'* (2009). Available at: http://publications.naturalengland.org.uk/file/94026
[27] CIRIA, *'C753: The SuDS Manual'* (2015)
[28] CIRIA, *'C768: Guidance on the Construction of SuDS'* (2018)
[29] A report that examined urban food growing in London noted that, *'Almost any site, irrespective of size, location or soil conditions can be used for food growing operations by making use of raised beds, skips and builders' bags filled with good quality soil.'* London Assembly, *'Cultivating the Capital'* (2010). Available at: https://www.london.gov.uk/
[30] Environment Agency, *'Areas of water stress: Final classification'* (2013). Available at: https://www.iow.gov.uk/azservices/documents/2782-FE1-Areas-of-Water-Stress.pdf
[31] CCC, *'Net Zero: The UK's Contribution to stopping global warming'* (2019). Available at: https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

trade-off in this regard.) A range of further guidance has been produced by the Construction Industry Research and Information Association (CIRIA).[32]

Finally, it is worth noting that there is a potential tension between the need to increase the amount of development in areas that are already served by transport links and other infrastructure – which will generally be in more urban areas – and the need to ensure that those same areas have a high level of green and blue infrastructure provision.

3.1.2.5. Sustainable, Locally Sourced Materials

Although there is no set definition of what constitutes 'sustainable sourcing' of materials, the term is commonly used to refer to a process that takes into account issues such as material traceability, health and safety, and environmental management through all stages of the supply chain. This could include consideration of energy, resource and water use, greenhouse gas emissions, and ecotoxicity. Local Authorities should support developments that seek to use materials that are sustainably sourced.

There are a variety of established standards and certification schemes that can be used to demonstrate responsible sourcing, some of which are recognised within the BREEAM or HQM environmental assessment standards (see Section 3.1.1.3). In the UK, the Building Research Establishment (BRE) has developed a *'Framework for Responsible Sourcing'* (BES 6001) which *'provides manufacturers with a means by which their products can be independently assessed and certified as being responsibly sourced'* through appropriate governance and supply chain management.[33] More broadly, organisations can implement environmental management systems (EMS) in line with ISO 14001 standards to demonstrate that they have taken steps to reduce their environmental impacts.

Other certification schemes exist for specific construction products or materials, including timber, aluminium, structural steel, and concrete.[34] For example, with regards to timber products, certification schemes are run by the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC).[35,36]

A range of potential benefits can be obtained by using materials and construction products that are produced near to the construction site. In particular, this can help to provide benefits to the local economy, providing jobs and skills training opportunities. It can also help to reduce the embodied carbon emissions of the development, for example if the material is transported a shorter distance – although distance is only one of many factors affecting the embodied carbon.

An obvious example of sustainable, local sourcing would be to utilise construction materials that have been reclaimed or recycled from existing buildings on or near the proposed development site, provided that these can be processed locally with minimal environmental impact. There are also examples of local reuse organisations that can provide furniture, appliances, and IT equipment. However, in many cases, the most sustainable method of meeting the demand for construction materials will be to avoid the need for them in the first place. This requires a design approach that maximises the retention and reuse of existing buildings, infrastructure, and other products. (i.e. a 'circular economy' approach – see below).

3.1.2.6. Lean Design and Circular Economy Measures

Designing for flexibility and adaptability, and following 'circular economy' principles, can contribute towards reducing the lifecycle energy demands and CO_2 emissions of buildings, while offering a range of co-benefits for sustainability and human health. According to the Ellen MacArthur Foundation:[37]

> *'A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration […] and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models.'*

A 'circular economy' therefore stands in contrast to the current 'linear' system of extracting materials, using them, and then throwing them away – which is inherently unsustainable when considering finite natural resources.

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[32] For example, the CIRIA *'Suds Manual'* (2015) or *'Water Sensitive Urban Design in the UK: Ideas for Built Environment Practitioners'* (2013). Available at: https://www.susdrain.org/files/resources/ciria_guidance/wsud_ideas_book.pdf
[33] https://www.greenbooklive.com/search/scheme.jsp?id=153
[34] For a list of schemes eligible for BREEAM and HQM credits, see BREEAM, *'Guidance note GN18: Recognised Responsible Sourcing Certification Schemes'* (2020). Available at: https://files.bregroup.com/breeam/GN18_BREEAM-NC_Guidance-Note.pdf
[35] https://www.fsc-uk.org/en-uk/about-fsc
[36] https://www.pefc.org/what-we-do/our-approach/what-is-certification
[37] Ellen MacArthur Foundation, *'Towards the Circular Economy: Volume 1'* (2013). Available at: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

By reducing the material demands up front ('lean design') and implementing waste reduction measures during construction, it is possible to reduce the embodied carbon and broader environmental impacts of new development. Designers should also consider ways to minimise the additional material demands and waste produced over the course of a building's lifecycle, by ensuring that buildings are easy to adapt, repurpose, and deconstruct. In addition to the environmental benefits, this can result in social benefits (e.g. making it easier for families to reconfigure their living spaces over time, or making it easier for changes in use of commercial properties) and associated cost savings.[38]

3.1.3. Policy Recommendations

3.1.3.1. Introduce CO_2 Emissions Standards that go Beyond UK Building Regulations

It is strongly recommended that Local Authorities should implement the highest CO_2 reduction targets for new buildings that can practically and viably be achieved. Recognising the Councils' commitments to achieving Net Zero, this should go above and beyond current Building Regulations, which only address a sub-set of total CO_2 emissions based on modelled estimates of regulated energy demands.

Options include:

- 19% improvement on Part L 2013 – This is equivalent to the energy performance requirements in Code for Sustainable Homes Level 4 and can be delivered entirely through energy efficiency measures. Note: At the time of writing, Local Authorities can require new domestic buildings to achieve up to a 19% improvement in CO_2 emissions compared with Part L 2013, and there is no limit on the standards they can set for non-domestic buildings. This may be revised in the near future following the Future Homes Standard consultation.

- Net Zero regulated emissions – This is the approach currently proposed in the adopted South Staffordshire Core Strategy (2012) although it is acknowledged that the policy was written prior to the withdrawal of the Zero Carbon Homes policy.

- Net Zero regulated and unregulated emissions. This would require applicants to predict operational energy demands using a modelling methodology (e.g. CIBSE TM54) or monitored data from comparable buildings.

- Encourage developers to obtain Passivhaus certification (for domestic buildings) and / or achieve a BREEAM 'Excellent' or 'Outstanding' rating (for non-domestic buildings), potentially setting minimum targets for BREEAM credits in Ene01.

- Require developers to monitor and report on operational energy use and / or CO_2 emissions, in order to confirm that the required level of improvement has been achieved, and to provide important information that will help designers to close the 'performance gap'.

- Require developers to undertake Lifecycle Carbon Assessments and minimise embodied carbon. (This would tend to favour retrofitting and repurposing existing buildings rather than demolishing and rebuilding, and would ensure that operational energy use is not the sole factor when considering carbon emissions.)

- Include targets for operational energy use and / or CO_2 emissions in addition to targets for the buildings 'as designed'. This would need to be combined with some form of monitoring post-completion. A Net Zero operational target would represent a significant challenge but would represent a progressive move that aligns with current global momentum to respond to the climate emergency.

Ideally, such a policy would apply to all types of development. Alternatively, Local Authorities could differentiate between different types/sizes of development, or developments in certain locations, e.g. setting higher standards for industrial sites, which may provide opportunities for waste heat recovery or have roofs with geometries that are particularly suitable for PV installations. It could also include greenfield sites where there are relatively fewer design constraints, and also a greater need to mitigate CO_2 emissions from changes in land use. In the long term, it will be necessary for all buildings to achieve Net Zero regulated and unregulated emissions, so if this is not set as the target initially, the Councils should consider how this target can be progressed in future. This will need to respect proposed changes to national policy and future building regulations. For example, policy wording could include a statement that the Council reserves the right to amend this target if and when there are changes to Part L of the Building Regulations or the approved calculation methodology.

[38] David Cheshire, *'Building Revolutions: Applying the Circular Economy in the Built Environment'* (RIBA Publishing, 2016)

A target for CO_2 reduction could be combined with the establishment of a Carbon Offset Fund (see Section 3.1.1.6) that could be used to deliver additional energy efficiency improvements in existing buildings, large-scale LZCs, carbon sequestration projects, etc.

We note that some of the adopted Local Plan policies in Staffordshire already include requirements for higher CO_2 emission standards or energy efficiency performance, although we recognise that some of these targets and associated timescales may have been set in line with the now-withdrawn Zero Carbon Homes Policy. For example:

- The 'Lichfield District Council Local Plan Strategy' (2015) includes a requirement in Policy SC1 for all new buildings to be Net Zero Carbon. The 'Lichfield District Local Plan Review – Preferred Options' (2018) Strategic Policy OSC3 requires all non-domestic buildings over 1,000 m^2 to achieve a BREEAM 'Excellent' rating where viable and for all buildings to achieve high energy efficiency standards.

- The 'Plan for Stafford Borough' (2014) Policy N2 also requires zero carbon standards for new residential development, and a BREEAM 'Very Good' rating for non-domestic developments. This policy also requires 'a proportion' of energy to be generated from on-site renewables. The burden is on applicants to prove that such a standard would make the scheme unviable.

- The Tamworth Borough Council Local Plan Policy SU3 states, *'Where appropriate, proposals for new development will be expected to demonstrate how they will address the causes of climate change and limit greenhouse gas emissions with an aspiration of achieving zero carbon development.'*

Some examples of policy wording from other Local Authorities are provided below. For more information and potential policy options related to this topic, see the Policy Playbook produced by UK-GBC.[39]

Example policy wording: <u>Milton Keynes Plan:MK (2019) Policy SC1: Sustainable Construction – Energy and Climate</u>

For residential developments of 11 or more dwellings and non-residential developments with a floor space of 1000 sqm or more –

i. *Achieve a 19% carbon reduction improvement upon the requirements within Building Regulations Approved Document Part L 2013 or achieve any higher standard that this that is required under new national planning policy or Building Regulations*
ii. *Provide on-site renewable energy generation, or connection to a renewable or low carbon community energy scheme, that contributes to a further 20% reduction in the residual carbon emissions subsequent to a) above*
iii. *Make financial contributions to the Council's carbon offset fund to enable the residual carbon emissions subsequent to the a) and b) above to be offset by other local initiatives*

Example policy wording: <u>South Downs Local Plan (2019) Strategic Policy SD48: Climate Change & Sustainable Use of Resources</u>

Residential – energy efficiency: 19% carbon dioxide reduction improvement against Part L (2013) through the energy efficiency of the building

Non-residential – major: BREEAM Excellent

[39] UK-GBC, *'The Policy Playbook – Driving sustainability in new homes – A resource for Local Authorities'* (2020). Available at: https://www.ukgbc.org/wp-content/uploads/2020/03/The-Policy-Playbook-v.1.5-March-2020.pdf

Example policy wording: <u>Stockton-on-Tees Local Plan (2019) Policy ENV 1: Energy Efficiency</u>

All residential developments of ten dwellings or more, or of 1,000 sq m and above of gross floor space, will be required to:

a) *Submit an energy statement identifying the predicted energy consumption and associated CO_2 emissions of the development and demonstrating how the energy hierarchy has been applied to make the fullest contribution to greenhouse gas emissions reduction; and*

b) *Achieve a 10% reduction in CO_2 emissions over and above current building regulations. Where this is not achieved, development will be required to provide at least 10% of the total predicted energy requirements of the development from renewable energy sources, either on site or in the locality of the development.*

All new non-residential developments up to and including 499 sq m of gross floor space will be completed to a Building Research Establishment Environmental Assessment Method (BREEAM) minimum rating of 'very good' (or any future national equivalent).

All new non-residential developments of 500 sq m and above of gross floor space will be required to:

a) *Submit an energy statement demonstrating how the energy hierarchy has been applied to make the fullest contribution to CO_2 reduction; and*

b) *Be completed to a Building Research Establishment Environmental Assessment Method (BREEAM) minimum rating of 'very good' (or any future national equivalent).*

Example policy wording: <u>Intend to Publish Greater London Authority Draft London Plan (2019) Policy SI2: Minimising greenhouse gas emissions</u>

A. *Major development should be net zero-carbon. This means reducing greenhouse gas emissions from construction and operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:*

   1. *Be lean: use less energy and manage demand during operation.*
   2. *Be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly.*
   3. *Be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site.*
   4. *Be seen: Monitor, verify and report on energy performance.*

B. *Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.*

C. *A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either:*

   1. *through a cash in lieu contribution to the borough's carbon offset fund, or*
   2. *off-site provided that an alternative proposal is identified and delivery is certain.*

D. *Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported on annually.*

E. *Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated emissions.*

F. *Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.*

3.1.3.2. Set a Minimum Target for Fabric and Energy Efficiency Performance

All development should be required to meet a minimum level of fabric and energy efficiency in addition to reducing CO_2 emissions. This is necessary in order to reduce energy demands, which in turn reduces the demands on power infrastructure. For example, policy wording could include:

Example policy wording:

To ensure a high standard of fabric and energy efficiency performance, all new development will be expected to exceed the carbon emission targets set by UK Building Regulations through fabric and energy efficiency measures alone.

[Optional if seeking further improvement:]

The 19% CO_2 improvement target should then be achieved through further fabric and energy efficiency and/or the use of decentralised, low and zero carbon energy technologies.

The viability of this policy is supported by the viability assessments associated with Building Regulations Part L (2013). The targets set in Part L are devised in a way that it is possible to deliver compliance through reasonable fabric and energy efficiency measures alone, with no additional requirement to provide additional carbon saving technologies such as solar PV. Similarly, the Government has indicated that the Future Homes Standard Option 1 (20% uplift) would likely be achieved through increased fabric efficiency measures alone.

In the case of residential buildings, the technical appendix for SAP (the approved calculation methodology), sets out a detailed recipe for delivering compliance, referred to as the 'Reference Values'. Similarly, in the case of non-domestic buildings the notional building performance provides a guide to the specification required to achieve compliance.

3.1.3.3. Introduce an 'Energy and Heat Hierarchy'

Decarbonising heat is a critical component of the Government's plan to reach Net Zero emissions. This is likely to be one of the hardest challenges and therefore the need to use policy and regulations on new buildings to drive the uptake of low carbon heating systems will be essential. It is recommended that an Energy and Heat Hierarchy should apply directly to all new development, both domestic and non-domestic, so that all proposals follow a similar approach in achieving energy and CO_2 reductions.

Example policy wording:

Development proposals should seek to reduce energy demand and CO_2 emissions as far as possible in line with the following Energy and Heat Hierarchy:

1. *Minimise energy demand through energy efficiency measures such as fabric performance and passive design*
2. *Supply energy efficiently and exploit local energy resources such as secondary and waste heat resources and district energy networks. Preference must be given to technologies with greater efficiencies, and fuels with lower carbon emissions, to achieve the highest total lifecycle carbon emission savings, following the hierarchy set out below:*
    a. *Electrically-driven ground or water source heat pumps or use of waste heat sources*
    b. *Electrically-driven air source heat pumps*
    c. *Direct electric heating*
    d. *Gas-fired boilers*
3. *Utilise on-site renewable energy generation and storage.*

Note: For all the systems listed above the use of solar thermal systems to provide a proportion of the annual heat demands may also provide additional carbon and cost savings so should be considered if suitable and viable.

Major developments will be required to consider including a heat network and / or incorporate the necessary infrastructure to enable future connection, where feasible.

[Note: Additional policy recommendations on LZC energy technologies are provided in Section 4.1.5.]

Applicants should demonstrate compliance with the relevant policies by completing an Energy Statement. This would require applicants to provide details of the low and zero carbon energy technologies installed and the estimated reduction in CO_2 emissions these will deliver.

If the proposed development does not utilise low carbon heating systems, then the system should at least be designed for compatibility / future connection. This would include the use of 'electricity ready' boilers (that could potentially be integrated with renewable electricity installations), use of underfloor heating or radiators that are sized to be compatible with low temperature systems, etc.

Note that the use of smart, energy efficient appliances may or may not be covered by Building Regulations depending on the energy end use, but it is assumed these could be used to meet or exceed the standards for hot water, cooking, lighting, fans and other fixed services.

3.1.3.4. Require High Standards for Water Efficiency and Conservation

Staffordshire – like much of the region – is classified as an area with 'moderate' water stress. It is important to conserve water, partly due to the CO_2 emissions associated with its treatment and supply (discussed in the Baseline Report) but also because climate change is expected to affect water availability.[31]

Example policy wording:

All development proposals should seek to reduce the use of mains water through adoption of water saving measures (e.g. smart meters), fittings and appliances. Refurbishment schemes will be expected to retrofit such measures.

- *Domestic developments should be designed to achieve a maximum of 105 litres per person per day, in line with the Optional Standard of Building Regulations Part G.*
- *Non-domestic developments should be designed to achieve the maximum available credits under BREEAM Wat 01 or an equivalent best practice standard.*

All proposals are required to incorporate rainwater harvesting systems, and should consider utilising alternative sources of water, such as greywater recycling, and (where relevant) water efficient methods of irrigation methods and land use practices.

Where such measures are proposed, the Design and Access Statement should set out how they will be integrated with broader measures such as landscaping designs, SuDS, and the provision of green / blue infrastructure, to reduce demands on the public water supply.

BREEAM (Wat 01) guidance[40] sets out the following requirements that could also be adopted:

> *'Any greywater systems must be specified and installed in compliance with BS8525-1:2010 Greywater Systems - Part 1 Code of Practice. Any rainwater systems must be specified and installed in compliance with BS8515:2009 Rainwater Harvesting Systems - Code of practice.'*

3.1.3.5. Promote Holistic Sustainable Design Measures

Note: Due to the cross-cutting, interdisciplinary nature of sustainable design, some of the intervention options discussed in Section 3.1.2 are explored further in other sections of the report, and policy recommendations are presented in the following sections:

- *Measures to Reduce Overheating – see Section 5.4.2*
- *Promoting Sustainable Modes of Travel – see Section 3.2.3.3*
- *Futureproofing to Facilitate Retrofitting LZC Technologies – see Section 3.1.4.1*
- *Green and Blue Infrastructure Design – see Section 5.4.2*

In order to ensure that sustainability measures are considered as part of a broad-ranging, holistic design strategy, potential policy responses include:

[40] https://www.breeam.com/BREEAM2011SchemeDocument/Content/08_Water/wat01.htm

- **Requiring developments to undertake a BREEAM or HQM assessment** – This could include a target overall rating and / or a requirement to achieve certain credits within particular sub-sections of either assessment scheme (e.g. sustainable materials). The requirement could be applied to all developments, or could focus on those of a certain scale (e.g. major developments only) or those in certain locations (e.g. on greenfield sites, where there may be fewer existing physical constraints and a greater risk of creating net reductions in biodiversity etc.).

The BRE has produced a set of guidance documents to support policymakers in understanding how BREEAM and HQM can be incorporated into planning policy, along with sample policy wording and guidance on the different target ratings and schemes typically applied to various development types.[41] Local Authorities would need to decide what target rating to set. For context, according to the BRE:[42]

'All ratings are better than the regulatory minimum and the final rating achievable will depend on the socio-economic context and localised, project specific conditions […] As a general benchmark though the most common targets set by policy makers are those comparatives to an Excellent/4 star, Very Good/3 star and Good/2 star whilst the most common rating achieved against the 2014 New construction scheme has, to date, been a Very Good (nearly 70% of certified projects).'

- **Requiring applicants to submit a Sustainability Strategy** as part of the planning application (either as a standalone document or within the Design and Access Statement) that sets out the overarching approach to sustainability. This should be accompanied by supporting text, a 'Sustainability Checklist' or other supplementary guidance that lays out topics for consideration.

3.1.3.6. Promote Adoption of Circular Economy Principles

It is recommended that Councils should introduce new policy wording or guidance relating to Circular Economy measures. Because circular economy principles encompass a wide range of topics, there are no universal benchmarks or metrics that can be used to assess *all* types of development and construction projects; opportunities will be highly site- and project-specific. At the time of writing, there is no formal assessment scheme that considers whole-building circular economy measures, but some key principles are reflected in BREEAM criteria, as follows:

- Design for disassembly and adaptability (Wst 06)
- Using products with lower life cycle impacts (Mat 01)
- Responsible sourcing criteria (Mat 03)
- Materials efficiency (Mat 06) – optimise use of materials
- Construction waste management (WST 01), recycled aggregates (Wst 02)
- Health and Wellbeing (Hea 02)

For schemes that are proposing to undertake a BREEAM assessment, Councils could consider requiring developers to achieve a certain number of BREEAM credits under one or more of the categories listed above.[43] More broadly, Councils could require applicants to demonstrate how the proposals incorporate circular economy principles. This information could be incorporated into the Design and Access Statement or Sustainability Statement, but would also affect proposals laid out in documents such as the following (where applicable):

- Sustainability Statement / Strategy
- Site Waste / Resource Management Plans
- Sustainable Procurement Plans
- Municipal / Operational Waste Management Plans

[41] Building Research Establishment, *'BREEAM, Home Quality Mark and CEEQUAL Practitioner Guidance for Planning Professionals'* (2019). Available at: https://www.bregroup.com/wp-content/uploads/sites/3/2019/03/1.-BREEAM_Practitioner-Guidance-for-Planning-Professionals_v1-March-2019.pdf and for more information, see https://www.breeam.com/engage/research-and-development/consultation-engagement/local-government/

[42] BREEAM, 'Top 10 Questions from the Planning Sector' (2019). Available at: https://www.breeam.com/wp-content/uploads/sites/3/2019/03/The-Top-10-Questions-from-the-Planning-Sector_v1-March-2019.pdf

[43] UK-GBC, *'Circular Economy Guidance for Construction Clients'* (2019). Available at: https://www.ukgbc.org/wp-content/uploads/2019/04/Circular-Economy-Report.pdf

Example policy wording:

[Note: Text is from the draft GLA 'New London Plan' Policy SI7 (2020) and is for reference only.]

"Referable applications should promote circular economy outcomes and aim to be net zero-waste. A Circular Economy Statement should be submitted, to demonstrate:

1) how all materials arising from demolition and remediation works will be re-used and/or recycled
2) how the proposal's design and construction will reduce material demands and enable building materials, components and products to be disassembled and re-used at the end of their useful life
3) opportunities for managing as much waste as possible on site
4) adequate and easily accessible storage space and collection systems to support recycling and re-use
5) how much waste the proposal is expected to generate, and how and where the waste will be managed in accordance with the waste hierarchy
6) how performance will be monitored and reported."

Councils could also consider producing their own supplementary guidance on the types of circular economy design features or metrics that are most applicable to specific types of development, reflecting local context. For example, the Greater London Authority has recently introduced a draft planning policy and associated guidance for applicants on how to incorporate circular economy measures into proposals.[44]

3.1.4. Other Intervention Options

3.1.4.1. Promote Energy Efficiency Retrofitting Measures and LZC Installations in Existing Buildings

As stated previously, although existing buildings account for around 58% of total emissions in Staffordshire, upgrading the existing stock is a major challenge. For buildings that are not Council-owned, Local Authorities have limited ability to influence the performance of existing buildings through the Local Plan process, except where planning permission is being sought e.g. for a major extension or refurbishment project.

Councils should therefore review opportunities to promote energy efficiency measures and LZC uptake in existing buildings, both to identify new opportunities, and ensure that any existing or planned initiatives / areas of influence are consistent with the Net Zero targets. This could consider topics such as:

- **Existing or planned initiatives aimed at reducing fuel poverty** – It is important that any advice given, or measures implemented, as part of these initiatives either directly contribute towards reducing energy demands and facilitating a switch towards the use of renewable fuels or, at least, are futureproofed to ensure that this can happen at a later date while avoiding unintended negative consequences. For example, this would mean providing funding for electric heating systems (especially heat pumps) and rooftop PV instead of new gas boilers.

- **Behaviour change and awareness programmes** – Opportunities to engage individuals on ways of saving energy via behaviour change, uptake of new technologies and correct use of existing technologies. In light of the COVID-19 pandemic it is expected that there will be significant interest in, and research about, changes in travel and (home) working patterns so the Councils should seek to ensure that this also considers the need for a 'green recovery'.

- **Existing or planned initiatives aimed at helping local organisations and businesses to reduce energy use** – For instance, if the Councils provide subsidised energy audits or other advice. Similar considerations apply as for fuel poverty initiatives (see previous bullet point).

- **Enforcement of the Minimum Energy Efficiency Standards** (MEES)[45] – Since 1st April 2018, any properties newly rented out in the private sector have been required to have a minimum Energy Performance Certificate (EPC) rating of E (some exceptions apply, for example in the case of Listed buildings). Owners of buildings with a lower EPC rating will be required to implement energy efficiency measures, though consideration will be given to financial viability, the anticipated payback time and impacts on property value. Over time, the Government intends to progressively increase the minimum EPC rating, meaning that buildings must become

[44] Greater London Authority, *'Circular Economy Statement Guidance – Consultation Draft'* (2020). Available at: https://www.london.gov.uk/sites/default/files/ggbd_circular_economy_statement_guidance_2020_web.pdf
[45] The *'Energy Efficiency (Private Rented Property) (England and Wales)'* Regulations 2015 introduced the Minimum Energy Efficiency Standard (MEES) for buildings across the UK. For further information, see https://www.gov.uk/government/publications/the-private-rented-property-minimum-standard-landlord-guidance-documents

more efficient in order to be sold or rented.[46] Local Authorities are responsible for enforcing MEES and fines can be issued for non-compliance.

- **Enforcement of Building Regulations Part L2B** – This regulation stipulates that, when undertaking certain types of work on existing non-domestic buildings over 1,000 m^2 in floor area, energy efficiency measures must be introduced to improve the performance of the building, known as a 'consequential improvements' policy.

The Government announced in July 2020 that £2 billion of grant funding would be made available to help improve the energy efficiency of existing homes (the 'Green Homes Initiative'). The Green Homes Grant would pay towards up to two-thirds of the cost of home improvement, to a maximum of £5,000 per home for most households, while lower income households would be able to receive grants of up to £10,000 covering 100% of costs. Local Authorities were offered the opportunity to bid for funding (minimum £500K) to provide energy efficiency improvements to low income households living in homes with an EPC rating of E, F or G. That particular opportunity closed on 1st September 2020, but it is anticipated that further rounds of bidding may be available in future years. Therefore, it is recommended that Local Authorities should keep abreast of developments in this area in order to take advantage of further rounds of funding if and when they become available.[47]

3.1.4.2. Demonstrate Leadership in Existing and New Council-Owned Properties

For buildings that are either owned and / or operated by Staffordshire Local Authorities, it is recommended that the Councils should take a leadership role in reducing CO_2 emissions through actions such as the following (if these have not already been adopted):

- Carrying out an assessment of the energy demands and CO_2 emissions from existing buildings, if this information is not already held, then developing an appropriate carbon management and reduction strategy.
- Reviewing leasing / tenancy arrangements to understand what interventions could be implemented in properties that are owned, but not operated, by the Council, and vice-versa.
- Based on the findings of those assessments, Councils should then adopt targets for existing buildings, any future developments and any refurbishment schemes, e.g. Net Zero operational CO_2 emissions, potentially as part of a Sustainable Design Code for Council assets.
- Initiate a dialogue with occupants of Council-owned buildings to build support for, and communicate the benefits of, energy and CO_2 saving measures that will require their engagement.
- Implement the energy and CO_2 saving measures across all Council-owned buildings, monitor the outcomes and publicise any lessons learned to help promote uptake of such measures across the wider stock.

[46] BEIS, *'The Non-Domestic Private Sector Minimum Energy Efficiency Standards: The Future Trajectory to 2030'* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/839362/future-trajectory-non-dom-prs-regulations-consultation.pdf
[47] For more information, see https://www.gov.uk/government/publications/green-homes-grant-local-authority-delivery-scheme-entering-a-bid

3.2. Ultra-Low Emissions Vehicles

According to the Department for Transport, ULEVs are currently defined as producing less than 75 gCO_2 from the tailpipe for every kilometre travelled. However, there are two main types of vehicle which qualify as ULEV. These include:

- **Battery Electric Vehicles** (BEV) – these run solely on electricity, and require recharging from a chargepoint; and

- **Plug-in Hybrid Electric Vehicles** (PHEV) – these have both an internal combustion engine in addition to an onboard electric battery and motor which can be recharged from a chargepoint.

In Q4 2019, the number of BEVs in Staffordshire totalled 1,065 and the number of PHEVs totalled 1,101[48].

There are three main types of chargepoints:

- **Rapid** – these deliver the fastest rate of charge. Most of these chargers are Direct Current (DC), and deliver 50 kW, 100 kW or up to 350 kW for Ultra-Rapid chargers. There are some Alternating Current (AC) rapid chargers, with 43 kW AC being the most common size.

- **Fast** – these are AC only and commonly deliver power at 7 kW to 22 kW, depending on the unit.

- **Slow** – these AC units deliver the slowest rate of charge and deliver power at 3 kW to 6 kW.

3.2.1. UK Government Policy

The UK Government has set a target that all new vehicles will be ULEVs by 2040. This means that new internal combustion engine vehicles (which use traditional fuels such as petrol and diesel) will not be permitted for sale beyond this date. This policy is supported by the Automated and Electric Vehicles Act 2018[49], which empowers the Government to require motorway services and large fuel retailers to install EV chargepoints that are 'smart' and practical for consumers. (In this context, the term 'smart' refers to the ability of charge facilities to be flexible in the rate of charge that can be delivered, in response to the real-time capacity in the incoming supply.)

Since the passage of the Act in July 2018, the Government has expressed support for bringing forward, from 2040 to 2035, the date from which the sale of traditionally-fuelled new vehicles will be banned. The Government is currently consulting[50] regarding this change, and the Government has indicated that it may support an even earlier date for the ban, with 2032 suggested by the Secretary of State for Transport[51]. The consultation is due to close on 31st July 2020.

The Government has set up the Office for Low Emission Vehicles[52] (OLEV) to help industry, local authorities, consumers and other stakeholders in their transition to ULEVs. Examples of the support and resources that the OLEV provides include grants for new vehicles, grants for new workplace charging equipment, and funding for ultra-low emission buses. Additionally, the OLEV provides guidance, latest news, and research and statistics.

3.2.2. Current Situation in Staffordshire

The Baseline Report summarised the estimated number of ULEVs that are currently registered in Staffordshire, and the number of public EV chargepoints in the County. Please see Section 5.2 of the Baseline Report for more details. In summary, the results showed that:

- ULEVs made up less than 0.4% of all registered vehicles across the County as a whole (Q3 2019)

- Public charging devices totalled 105 across the County (equating to 12 devices per 100,000 population), with rapid chargers numbering 42. At a Local Authority level, the total number of chargers ranged from 4 and 7 per 100,000 in Tamworth and Staffordshire Moorlands respectively, to 19 per 100,000 in Newcastle-under-Lyme and Stafford. (October 2019.)

[48] Department for Transport, *'VEH0132: Licensed ultra low emission vehicles by local authority'* (December 2019). Available at: https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01#licensed-vehicles
[49] https://services.parliament.uk/bills/2017-19/automatedandelectricvehicles.html
[50] https://www.gov.uk/government/consultations/consulting-on-ending-the-sale-of-new-petrol-diesel-and-hybrid-cars-and-vans
[51] https://inews.co.uk/news/politics/grant-shapps-ban-new-petrol-diesel-cars-12-years-1555687
[52] https://www.gov.uk/government/organisations/office-for-low-emission-vehicles

The national picture shows a big variation in the provision of chargepoints per head of population. On a regional basis, London (49), Scotland (32) and the (28) North East of England have the highest number of public chargepoints per 100,000 of population, while Yorkshire & the Humber (12), the West Midlands (14), East of England (15) and the East Midlands (15) having the lowest number per 100,00 of population[53].

Whilst there is no accepted or defined standard for the number of chargepoints which should be provided to support the EV market, these numbers indicate a significant variation across the country. Furthermore, a number of research papers[54,55] have indicated that the uptake of EVs is strongly linked to the availability and access to charging infrastructure. Harrison and Thiel (2017)[55] in particular, found that the market share of EVs increases as the ratio between the number of EVs to the number of chargepoints reduces.

Data published by DfT[53,56] indicate that the West Midlands has the highest ratio, at 42.9 BEV vehicles per chargepoint. Scotland, North East England, London and Wales all have ratios below 10, which indicate a relatively high number of chargepoints per vehicle. According to the statistics presented in Table 19 of the Baseline Report:

- Staffordshire as a whole has 20.8 EVs per chargepoint;
- Newcastle-under-Lyme and Stafford have the lowest ratios, at 10.3 and 14.8 EVs per chargepoint respectively; and
- Tamworth has the highest ratio, at 52.0 EVs per chargepoint.

These findings suggest that, despite the appetite that consumers are showing for EVs in the West Midlands, Staffordshire and in each of the Local Authorities, there is an under-provision of charging infrastructure in the region compared to other regions in the UK. This may be acting as a constraint to further and faster adoption of this technology. While there are a number of roads in Staffordshire that are administered by Highways England as part of the Strategic Road Network (e.g. the M6, M6Toll, A34, A38, A50), and which therefore are likely to be targeted by Highways England for enhancements in the provision of chargepoint infrastructure, much of the infrastructure required to facilitate and encourage a switchover to ULEV vehicles will need to be provided at a more local level. A key recommendation therefore will be to enhance the provision of EV chargepoints across each of the Local Authorities.

3.2.3. Opportunities & Constraints to Support the Adoption of ULEVs

3.2.3.1. Electric Vehicles

Traditionally-fuelled vehicles have relied on a well-established network of filling stations, which in 2019 numbered 8,385 across the UK[57]. This number is down from 13,107 in 2000, and there continues to be a year on year decline, albeit the pace of decline has slowed in recent years. By contrast, there are over 18,000 public chargepoints for EVs across the UK[56], despite the number of conventionally-fuelled vehicles outnumbering electric vehicles by more than 100:1. These numbers illustrate how the two vehicle technologies require different strategies for 'refilling'.

While there are often several fuel pumps at conventional filling stations, the throughput of vehicles for each pump is high; the time required to fill up with fuel, complete payment, and vacate the fuel pump can typically be as fast as five minutes or even less. The fuel taken on board can then last several hundred miles, depending on the vehicle. This means that the range achieved for the amount of time required to 'acquire' that range (i.e. to fill up with fuel), is very high. This is because of the very high energy density of fossil fuels, and the liquid nature of petroleum products, which allows it to be pumped at high volumetric flowrates. These characteristics, in addition to the need to store petroleum in a safe, centralised place where fuel can be delivered frequently, have led to the development of a highly consolidated network of enabling infrastructure.

By contrast, electric chargepoints require more time to recharge the vehicle battery; depending on the chargepoint type and the size of the battery, these can take upwards of an hour for rapid chargepoints, and twelve hours or

[53] Department for Transport, *Electric Vehicle Charging Device Statistics October 2019*, December 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850417/electric-vehicle-charging-device-statistics-october-2019.pdf
[54] Sierzchula, W., Bakker, S., Maat, K., & van Wee, B. (2014, May). *The influence of financial incentives and other socio-economic factors on electric vehicle adoption*. Energy Policy, 68, 183–194
[55] Harrison, G., & Thiel, C. (2017). *An exploratory policy analysis of electric vehicle sales competition and sensitivity to infrastructure in Europe*. Technological Forecasting and Social Change, 114, 165–178
[56] http://maps.dft.gov.uk/ev-charging-map/
[57] https://www.statista.com/statistics/312331/number-of-petrol-stations-in-the-united-kingdom-uk/

more for slow or trickle chargepoints. This means that owners' behaviours are changing the way that electric vehicles utilise chargepoints, compared to the way petrol/diesel cars are filled up traditionally.

The RAC Foundation has described[58] a future where EV charging infrastructure incorporates a range of charging facilities aimed at different charging needs and habits. It describes a public Chargepoint Network (CPN) which facilitates two types of charging behaviour:

- **Journey charging** – this is where the driver's primary purpose for being at the chargepoint is to charge the vehicle. Chargepoints therefore need to be able to deliver rapid bursts of charge in a short space of time to ensure that the vehicle's 'dwell time' is minimised – this is important in order to ensure that both the delivered charge is of a meaningful quantity, and the throughput of vehicles is maximised (thereby reducing the risks of unwanted queueing at the facility).

- **Grazing charging** – this is where the driver's reason for being at the chargepoint is primarily for a purpose other than for charging (e.g. at a supermarket, a gym, or restaurant). The use of chargepoints for this purpose will be driven by the driver's existing routine and the length of time the vehicle is parked for their primary purpose. Chargepoints for this type of behaviour do not need to be able to deliver rapid bursts of charge, since the 'dwell time' for these vehicles is longer and charging does not need to result in a full charge.

Charging infrastructure is also expected to be required at the home and at workplaces in order to ensure a smooth transition to electric vehicles. Chargers that deliver a slow trickle of charge are expected to dominate the home charger market due to the increased available plug-in time at home and reduced electrical infrastructure upgrade requirements for these types of chargers.

The above concept illustrates a highly decentralised approach to charging infrastructure for EVs. The constraints associated with providing these charge facilities are therefore different to those which have governed where conventional filling stations were located in the past. For home and workplace charging facilities, these will mostly be determined by the availability of space for charging units and associated parking spaces, in addition to the incoming electrical supply capacity.

For public facilities, additional constraints will need to be considered. For those facilities which are aimed at journey charging, they are likely to be sited in dedicated charge hubs, where rapid or ultra-rapid chargers deliver significant amounts of charge in a short space of time. They are therefore likely to experience a relatively fast throughput of customers, meaning that the sites' access and egress provisions, their location in relation to and connectedness with the wider road network, and their impact on existing urban traffic patterns and capacity, will be key considerations in determining suitable locations. They may also place significant additional loads on the local electrical distribution networks; for example, a hub of six ultra-rapid chargers, where each charger is capable of delivering 150 kW of charge, will result in an additional electrical load of nearly 1 MW on the surrounding grid, should all chargers be in use simultaneously. This is a significant additional load, which may require upstream reinforcements of the local grid infrastructure (e.g. increasing the capacity of upstream substations and cabling). This may result in significant extra capital costs associated with grid reinforcements which should be carefully considered when determining the location for chargepoint hubs. The Distribution Network Operator (DNO) in the region, Western Power Distribution (WPD) has developed an EV strategy which outlines how they aim to facilitate the uptake of EV charging infrastructure[59]. This document identifies the approximate connection cost and lead time associated with the connection of varying types of EV chargers.

Examples of where journey charging facilities are likely to be located include at major nodes of transport interchange, such as at train stations. These will likely see a consistent and high throughput of vehicles such as taxis, who require a short burst of charge in between picking up customers. They may also likely be installed at or near existing petrol/diesel filling stations.

In contrast, those facilities aimed at grazing charging behaviour are likely to be much more widely distributed. For example, supermarkets and other major retail outlets, to which a large proportion of customers typically drive, are expected to be prime locations for installing fast charging facilities. These destinations typically see customers' vehicles being parked for a significant length of time (an hour or more), and the substantial provision of such chargepoints would therefore encourage grazing charging behaviour. Leisure facilities, such as sports centres,

[58] RAC Foundation, *Development of the UK Public Chargepoint Network*, December 2018. Available at: https://www.racfoundation.org/wp-content/uploads/Development_of_the_UK_CPN_Harold_Dermott_December_2018.pdf
[59] WPD EV Strategy, March 2019: https://www.westernpower.co.uk/downloads-view/29293

cinemas, restaurants and museums, would also be suitable locations for the installation of fast chargepoints aimed at grazing charging.

For public-facing facilities which are aimed at journey or grazing charging, there are opportunities to integrate and pair charging facilities with renewable energy and/or battery systems. Solar canopy arrays at car parks for example (see Figure 3-5) represent a well-aligned opportunity to maximise the use of solar power for the purpose of charging EVs. The generation profile of the solar installation will likely match the demand profile (i.e. highest occupation during the day when solar generation is at its peak) which reduces the demand on the distribution system and increases the penetration of renewable energy in the system. Were large-scale battery systems to be deployed on the same site, they would enable the storage of any excess energy for which there is insufficient real-time demand for later use by EV chargepoints. They may also be used to manage the loading of the electrical supply system to maximise utilisation and reduce network infrastructure upgrade requirements. In their EV strategy document, WPD has a targeted commitment for 2020 to develop an infrastructure solution for public charging hub type installations.

Figure 3-5. Example of solar car park. Source: BRE, *'Solar Car Parks: A Guide for Owners and Developers'* (2016)

Smart chargers can facilitate an optimised investment in electricity supply infrastructure. They enable the rate of charge to be controlled such that the electrical infrastructure's utilisation is maximised and not overloaded. The implementation of chargers offering variable rates need to be carefully managed to align with the customer's expectations of what charge rate they will receive when they plug in. This could be managed by varying price-points for different charge rates or offering a range of rates when the customer opts to use the unit.

As WPD is actively participating in the transition to EVs, engagement with them is recommended to gain their support and learn from the trials and existing installations they have implemented. Engagement with WPD is also recommended in order to gain understanding of where capacity exists on the network, and what plans WPD have for expanding capacity in the future. Please see Section 4.1.3.3.

It is also recommended that the Authorities note the activities and emerging best practice, data, insight papers and guidance that is being developed by the EV Energy Taskforce. The Taskforce[60] comprises key stakeholders and actors in the UK EV industry, who have come together in anticipation of growth in the use of electric and plug-in vehicles. The Taskforce aims to *'bring together the energy and automotive industries to plan for the changes that will take place as a result of rising EV use'*.

[60] https://es.catapult.org.uk/impact/specialisms/ev-energy-taskforce/

Whilst the current focus for the EV industry is the transition to vehicles which require recharging at dedicated facilities, it is possible that other solutions may come to the fore in the future. These could potentially include the development of a network of battery 'swap shops', at which drivers would exchange their empty batteries for fully-charged ones, which would then be easily slotted into vehicles. While this would address many of the infrastructure-related challenges associated with providing a highly decentralised charging infrastructure network, there would be different and significant barriers which the industry would need to address were this approach to be adopted.

It is unknown whether and to what extent this, or any other EV design solutions, will be adopted in the future. However, it is recommended that the Authorities maintain dialogue with key market participants (e.g. WPD, and the Government's Office for Low Emission Vehicles) in order to ensure that policy and efforts to support this transition are aligned with market developments.

3.2.3.2. Hydrogen-Fuelled Vehicles

A potential alternative to EVs is the development of a hydrogen-fuelled vehicle industry. Hydrogen potentially has an important role to play in decarbonising the transportation sector, while it also assists with progress against other key priorities for Local Authorities, such as improving local air quality.

Hydrogen vehicles store hydrogen gas in pressurised storage containers, which feed the gas into a fuel cell unit. The fuel cell combines the hydrogen with oxygen from the air in a non-combustion electro-chemical reaction that produces electricity. This electricity is then used to drive an electric motor.

Hydrogen usually exists in a compound state with other elements, for example in water (H_2O). In order to attain hydrogen for use in a fuel cell, the hydrogen needs to be separated from other elements in order to produce a pure elemental gas (H_2). One way of producing hydrogen is by splitting water, using a technique known as electrolysis (where an electric current is passed through water), into its component elements: hydrogen (H) and oxygen (O). Hydrogen is considered a low carbon and renewable fuel if this electrolysis is powered by renewable and low carbon electricity.

While the EV market is expanding quickly and is considered further along its development than the hydrogen vehicle market, there are important advantages which hydrogen vehicles possess when compared to EVs. These include, most significantly, the ability to cover long distances with a 'tank' of fuel and refill the vehicle rapidly. The refilling infrastructure would also be comparable to that used at existing centralised gasoline refilling stations. However, there remain only a small handful of hydrogen refilling stations in the UK[61], and a very significant expansion of this infrastructure would be needed to support a hydrogen vehicle market.

Currently in the UK, there are hydrogen-fuelled vehicles being used in the London bus fleet (ten in total) and in Aberdeen (six)[62]. However, there are many more planned across the country. While it remains to be seen whether a hydrogen vehicle market will compete fully with the EV market, there may be a selective requirement for hydrogen vehicles in niche uses (potentially for heavy goods vehicles, haulage as well as buses). It is therefore recommended that the Authorities continue to note the hydrogen vehicle markets as they continue to develop.

3.2.3.3. Housing Infrastructure Fund

Many of the future technologies which will need to be adopted to facilitate a decarbonisation pathway will require substantial investments in new infrastructure. For example, electric vehicles will require large numbers of chargepoints (both public chargepoints and those in domestic settings) in order to facilitate their adoption at the scale required to decarbonise personal transportation. These chargepoints may also require upgrades in local grid capacity (e.g. new cabling, new/enhanced substations) in order to provide the capacity necessary to serve the new chargepoints. Similarly, district heating systems, which utilise low carbon sources of heat for distribution to customers, require significant investments in energy centres and insulated distribution pipework before customers can be served.

Some of the capital costs associated with the infrastructure required as a result of new housing development can be supported by the Housing Infrastructure Fund (HIF). This Central Government grant funding scheme is administered by Department for Communities and Local government, and is allocated to local authorities on a competitive basis to fund physical infrastructure such as roads, community facilities and utilities. The Fund is divided into two streams:

[61] https://www.drivingelectric.com/your-questions-answered/1363/where-can-i-buy-hydrogen-and-where-my-nearest-hydrogen-filling-station
[62] https://fuelcellbuses.eu/

- Marginal Viability Funding, which aims to provide the final or missing piece of funding to get additional sites allocated or existing sites unblocked quickly; and
- Forward Funding, which is aimed at a small number of strategic and high-impact infrastructure projects).[63]

To date, over 100 authorities have applied for Marginal Viability Funding, and c.30 authorities have made applications for Forward Funding.

3.2.4. Policy Recommendations

The UK Government has placed strong emphasis on supporting electric vehicle uptake and is channelling £400m into a Charging Infrastructure Investment Fund.[64] It is recommended that local policies should be adopted to support the provision of infrastructure for ULEVs. Adequate infrastructure must be in place for this growth to be realised. In addition to helping to reduce CO_2 emissions, this will improve local air quality, decrease noise pollution, and otherwise benefit the environment and human health.

Developers should be required to demonstrate that EV charging points will either be provided or that it is prohibitively costly to do so. Our research shows that the cost of retrofitting EV charging points is higher than installing during initial construction, so there is an opportunity cost if charging points are not installed.[65] (Per DfT, as of 2019 a domestic charging point would cost around £976 to be installed upfront compared with around £2,040 if retrofitted; for non-domestic charging points these prices were around £3,822 and £4,925 respectively.)

Future Local Plans should include policy wording that address the need to:

- Reduce reliance on private vehicles; and
- Support the provision of ULEV infrastructure, particularly within new developments, car parks and public realm facilities.

Some of the ways that this could be achieved might include introducing policy positions that require major new developments and regeneration areas to undertake a detailed appraisal of the anticipated future EV infrastructure needs as part of a planning application. These appraisals would need to consider both the number and type of appropriate charging infrastructure, in addition to considering its impact on the existing local electricity grid.

Authorities should also consider undertaking assessments of where public EV chargepoints would best be located, and what type of chargepoints would best be most appropriate (e.g. slow vs rapid chargers). In general, the suitability of chargepoint types depend on where they are located, and what activities the surrounding area supports (e.g. shopping centres may be more suited to slower chargepoint infrastructure that those located in short-stay carparks, since the 'residence time' of the vehicle owners is likely to be longer). These assessments should consider not just EV charging facilities on Council-owned assets (e.g. Council-owned car parks), but also on other principal locations, especially those under public sector ownership (e.g. rail stations, hospitals, and education facilities). Engagement with potential strategic partners should be encouraged, in order to realise the potential opportunities for EV charging infrastructure.

Authorities should also consider how best to shift usage patterns away from private transportation to more sustainable and community-orientated modes of transport. For example, developments should consider the role that adequate density and the provision of mixed uses and amenities in walking distance can help to reduce the need for travel overall. In addition, developments should demonstrate that they are linked to adequate existing or future bus routes, and pedestrian and cycle networks. This would need to be addressed through an overarching spatial strategy and Local Transport Plan. Providing lower levels of parking provision, dedicated 'car club' parking spots and a range of EV charging infrastructure are also recommended, along with establishing transport and delivery hubs.

In addition, Councils should seek to:

- Implement plans and/or new policy that promotes walking and cycling e.g. by establishing new cycle lanes, pedestrian routes, and public transport links within Staffordshire and beyond.

[63] https://www.gov.uk/government/publications/housing-infrastructure-fund
[64] https://www.gov.uk/government/publications/charging-infrastructure-investment-fund
[65] Department for Transport, *'Industrial Strategy: Electric Vehicle Charging in Residential and Non-Residential Buildings'* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/818810/electric-vehicle-charging-in-residential-and-non-residential-buildings.pdf
Also see Energy Saving Trust, *'Guide to chargepoint infrastructure for business users'* (2017). Available at: https://www.energysavingtrust.org.uk/sites/default/files/reports/6390%20EST%20A4%20Chargepoints%20guide_v10b.pdf

- When undertaking repairs or upgrades to road layouts, seek to improve and provide new cycle lanes and pedestrian facilities (e.g. ‘pedestrian priority’ at junctions).
- Ensure that any transport planning, or road network expansion is required to quantify and take steps to significantly reduce emissions. Recognising the legal requirements of the Climate Change Act, it is inevitable that these types of projects will become more controversial in the coming decades due to their environmental impacts.
- Consider how they can use their licensing authority and other powers to promote sustainable transport modes, for instance by introducing low / zero emission zones or congestion charges, workplace parking charges, differential charges for parking permits, or requiring all taxis and buses to be ultra low emission or EV.

4. Carbon Offsetting & Sequestering Emissions

This section considers strategic opportunities to deliver LZC energy technologies in Staffordshire, recognising that these will be crucial for achieving Staffordshire's CO_2 emissions reduction targets. It also discusses opportunities to increase carbon sequestration through nature based solutions such as tree planting and changes in land management.

4.1. Low Carbon and Renewable Technologies

4.1.1. Scope and Methodology

The Government acknowledges[66] that, *'there are no hard and fast rules about how suitable areas for renewable energy should be identified'* when developing an evidence base for local planning policies. Our assessment is therefore presented in two stages.

The first part of our assessment broadly follows the 'Renewable and Low-Carbon Energy Capacity Methodology' published in 2010 by the former Department of Energy and Climate Change (DECC),[67] which essentially seeks to address the question, '*How much LZC energy could be supplied in this geographic area, based on existing policy constraints?*' However, recognising the challenging decarbonisation targets that have been adopted at a national, regional, and local level, it is clear that a step change in LZC energy deployment will be necessary. Therefore, in the second part of our assessment, we will seek to address the question: '*How much LZC energy must be supplied to achieve Net Zero emissions in Staffordshire?*'

This two-pronged approach has been used to inform policy recommendations for delivering the scale of change that is required.

Our assessment considers the following technologies:

- Wind turbines
- Solar photovoltaics (PV) and solar hot water (SHW)
- Ground, air and water source heat pumps (GSHPs, ASHPs and WSHPs) – *Note that, although these do not generate renewable electricity or fuel, they can reduce CO_2 emissions by lowering primary energy demands and facilitating a switch towards less carbon-intensive fuels*
- Hydroelectric power
- Energy from waste (EfW)
- Landfill and sewage gas
- Biomass

Technologies that are not relevant to the geographic context of Staffordshire, such as tidal power, have been excluded from this analysis. Emerging technologies such as hydrogen fuel cells are also excluded due to uncertainty associated with their performance and limited information about practical constraints; however, both hydrogen and battery technologies are discussed from a qualitative perspective in Section 4.1.4.

Part I: Assessment based on existing constraints

DECC (2010) offers a standardised approach for estimating the maximum theoretical LZC energy potential on a regional basis. The methodology first estimates the total naturally available energy resource, which is narrowed down based on technical constraints, physical constraints, and planning or regulatory constraints, as illustrated in Figure 4-1 below. This provides a rough estimate of the 'potentially accessible' resource.

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[66] Department for Communities and Local Government, *'Planning practice guidance for renewable and low carbon energy'* (2013). Available at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/225689/Planning_Practice_Guidance_for_Renewable_and_Low_Carbon_Energy.pdf

[67] DECC, *'Renewable and low carbon energy capacity methodology'* (2010). Available at:
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf

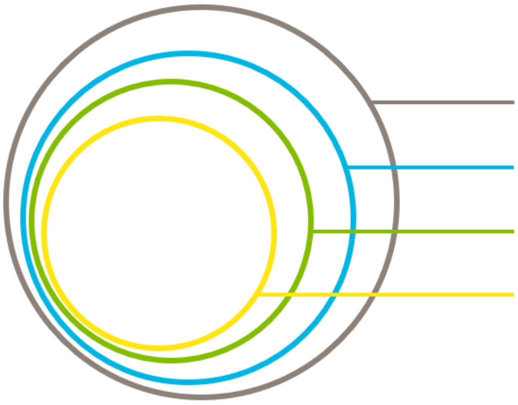

Figure 4-1. Sequential approach to assessing LZC opportunities, based on DECC (2010)

The DECC (2010) methodology offers a standardised method of assessing LZC energy opportunities, which facilitates comparison between different geographic areas. Although it was intended for use in developing regional (rather than local) energy studies, in this report, results are disaggregated to Local Authority level.

This methodology has informed multiple studies undertaken in the past decade that have examined LZC energy opportunities in Staffordshire. In particular, the *'Renewable Energy Capacity Study for the West Midlands'* was carried out in 2011 by SQW, the same company that developed the DECC methodology. An analogous approach was used in the *'Staffordshire County-wide Renewable / Low Carbon Energy Study'* produced by Camco in 2010. Results of those studies were incorporated into the 2018 *'Stoke-on-Trent and Staffordshire LEP Energy Strategy'* produced by Encraft Ltd.[68]

In order to provide a comprehensive assessment of future LZC opportunities in Staffordshire, AECOM carried out a review and validation exercise of these previous studies. Results have been incorporated, updated or supplemented with new information where appropriate, to account for changes that have occurred since 2011.

It is important to understand that not all opportunities will be captured using an area-wide assessment technique. Also note that, even in locations where constraints are identified, it may be possible to remove or mitigate these through careful design and planning. Conversely, there may be practical barriers or other reasons why LZC development would be difficult even in areas that are identified as being 'less constrained'.

Part II: Assessment based on energy demands

The second portion of the assessment will draw from the analytical work related to existing fuel consumption, which was previously presented in the Baseline Report. We will consider the relevant constraints outlined by DECC (2010) and seek to understand the extent to which they may limit decarbonisation opportunities in Staffordshire by comparing the scale of energy demands against the scale of potential LZC energy supply.

GIS analysis is used to provide a rough indication of whether this is theoretically possible to deliver in Staffordshire based on existing land areas and land uses and, if so, whether there are any obvious opportunity areas.

This portion of the assessment will focus particularly on large-scale wind energy and PV, on the basis that these are both well-established technologies that currently represent the most cost-effective solutions for generating renewable electricity in the UK.[69]

[68] Encraft Ltd, *'Stoke-on-Trent and Staffordshire LEP Energy Strategy'* (2018). Available at: https://www.stokestaffslep.org.uk/app/uploads/2018/12/P3684-Stoke-and-Staffordshire-LEP-Energy-Strategy-r1.pdf
[69] International Renewable Energy Agency, *'Renewable Power Generation Costs in 2018'* (2018). Available at: https://www.irena.org/publications/2019/May/Renewable-power-generation-costs-in-2018

4.1.2. Assessment Based on Existing Constraints and Buildings

The table below summarises potential LZC opportunities in Staffordshire based on the DECC (2010) methodology. Unless otherwise stated, results are reported in units of megawatts (MW) of electrical power capacity. Where previous reports have provided different estimates, these have been noted. Results for each Local Authority are presented in the SQW (2011) report and shown in Appendix D. Appendix E contains a description of the key variables impacting these estimates and discusses the extent to which these have changed since the previous studies were conducted.

Note that these estimates are based on the current technical performance of each technology and do not account for anticipated technological changes (e.g. efficiency improvements).

Table 4.1: Potential LZC opportunities in Staffordshire, based on the DECC (2010) methodology

Technology	Theoretical future capacity (MW)	Reference
Large-scale wind	50-60 MW 6,565 MW	Based on existing policies and site allocations SQW (2011) Further discussion is provided in Section 4.1.3
Small-scale wind	209 MW	SQW (2011)
Building-mounted PV*	219 MW - existing buildings	SQW (2011)
Solar hot water*	179 MW - existing buildings	SQW (2011)
Large-scale PV	Not quantified	Further discussion is provided in Section 4.1.3
ASHPs	1,381 MW - existing buildings	SQW (2011)
GSHPs	345 MW - existing buildings	SQW (2011)
WSHPs	Not quantified	Refer to Section 4.1.2.6
Hydro power	8.0 MW 1.5 MW	SQW (2011) Camco (2010)
The following technologies were assessed by SQW (2011) in line with DECC (2010) methodology. However, they are no longer expected to form a significant part of Staffordshire's future additional LZC energy mix. ***Results are shown for information only.***		
Energy from Waste (EfW)	29 MW municipal solid waste 21 MW industrial / commercial	SQW (2011)
Sewage Gas	No further resource identified	SQW (2011)
Landfill Gas	No further resource identified	SQW (2011)
Biomass:	*[electricity] or [thermal energy]*	SQW (2011)
Managed woodland	7 MWe or 9 MWth	
Energy crops	45 MWe or 259 MWth	
Waste wood	5 MWe or 4 MWth	
Agricultural arisings	7 MWe	
Wet organic waste	51 MWe	
Poultry litter	1 MWe	

** Note that PV and SHW compete for roof space and therefore the maximum amount of both technologies cannot be installed at the same time.*

Further details about the assumptions used to develop these estimates are provided below.

4.1.2.1. Large-Scale Wind

The technical potential for large-scale onshore wind energy depends primarily on wind speed at the turbine's hub height and land use constraints. The DECC (2010) method for assessing wind energy opportunities at a regional scale is to assess the average annual wind speed at 45m above ground level; as a rule of thumb,[70] locations with average annual wind speeds of at least 5-6 m/s are more likely to be financially viable. The NOABL database, which provides modelled estimates of wind speed across the UK, indicates that most areas in Staffordshire meet

[70] DECC (2010) suggests a threshold of 5 m/s at 45m above ground level whereas Camco (2010) used 6 m/s.

this threshold.[71] However, the model does not account for local surface roughness (e.g. the presence of tall trees or obstacles) and in practice site-specific assessments would need to be carried out to determine suitability.

DECC (2010) lists the following additional factors to consider when evaluating a potential site:

- Proximity to residential properties;
- Flood zones;
- Exclusion areas around airports, airfields and MOD sites (to be determined in consultation with the relevant bodies depending on the nature of the project);
- Proximity to infrastructure e.g. roads, railways, powerlines, and gas pipelines;
- Practical considerations e.g. grid connections, access and site spacing;
- Areas that have been designated for their ecological or historic interest, such as:
    - Ancient woodland;
    - International and national nature conservation designations (including National Nature Reserve, RAMSAR site, Special Area of Consideration, Special Protection Area, and Site of Special Scientific Interest); and
    - Sites of historic interest (including Listed Buildings, Scheduled Ancient Monuments, Registered Parks and Gardens and Registered Historic Battlefields).

In addition to technical and practical constraints, in line with DECC (2010) it is also important to consider the current policy context. The Written Ministerial Statement on Wind (HCWS42, 2015) states that, when determining planning applications for wind energy development, planning authorities should only grant permission if:

- the development site is in an area identified as suitable for wind energy development in a Local or Neighbourhood plan; and

- following consultation, it can be demonstrated that the planning impacts identified by affected local communities have been fully addressed and therefore the proposal has their backing.[72]

The statement goes on to explain:

> *'In applying these new considerations, suitable areas for wind energy development will need to have been allocated clearly in a Local or Neighbourhood Plan. Maps showing the wind resource as favourable to wind turbines, or similar, will not be sufficient.'*

Although it is anticipated[73] that the Government will relax its position in future, for the time being the requirements of the Ministerial Statement significantly limit opportunities for onshore wind energy development.

At the time of writing (May 2020), most Staffordshire Local Authorities have not specifically designated any sites for wind energy development in their adopted or proposed local development plans. Per HCWS42, this means that unless sites are identified within Neighbourhood Plans, large-scale wind would not be permitted in any of these districts. However, Lichfield, South Staffordshire and Newcastle-under-Lyme do identify suitable areas for wind energy development, based on GIS constraint mapping that was undertaken as part of the Camco (2010) study. Lichfield and South Staffordshire also set limits on the number of turbines that will be permitted through the year 2020 (six and four, respectively) although both Local Plans are under review.

Therefore, based on currently adopted local and national policies, which were informed by Camco (2010), opportunities for wind energy are capped at around 50-60 MW for Staffordshire as a whole.[74] By contrast, SQW (2011) estimated that the potentially accessible wind resource for Staffordshire County was more than 6,500 MW.

The Camco (2010) study largely conforms to the DECC methodology, but there are some key differences which have a large impact on the estimates. In particular:

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[71] The map can be viewed online at: https://www.rensmart.com/Maps#NOABL

[72] https://www.parliament.uk/documents/commons-vote-office/June%202015/18%20June/1-DCLG-Planning.pdf

[73] In March 2020, BEIS announced that onshore wind farms would be eligible to join the Contracts for Difference (CfD) scheme, reversing an earlier prohibition on subsidies for onshore wind, but as of June 2020, no changes have been announced that would lift the planning policy restrictions set by HCWS42. See BEIS, *'Contracts for Difference for Low Carbon Electricity Generation'* (2020). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/885248/cfd-ar4-proposed-amendments-consultation.pdf

[74] Based on 4 x 2.5 MW turbines in South Staffordshire, 6 x 2.5 MW turbines in Lichfield, 1 x 1 MW turbine at Keele University, and 4 additional sites in Newcastle-under-Lyme each assumed to be capable of accommodating 3 x 2.5 MW turbines.

1. The mapping outputs of the Camco study that are referenced in some Authorities' Local Plans only show sites capable of accommodating three or more large-scale turbines.

2. Whereas DECC (2010) recommends applying a 600m buffer zone / exclusion area around settlement boundaries, in the Camco study this buffer was applied to all residential address points. There is no technical reason for this; the stated rationale was that, in principle, any household could submit an objection to a proposed wind energy development.

However, it is important to understand that the constraints mapping carried out for both of those studies was intended to highlight general areas that might be considered suitable for wind energy, not to identify specific sites. They apply broad-brush constraints that are useful for undertaking area-wide analysis, but do not account for local factors such as landscape sensitivity or even detailed topography.[75]

On this basis, a policy that only permits wind energy development on sites mapped by the Camco (2010) study risks excluding some LZC opportunities without any technical justification. Conversely, both studies run the risk of *including* sites that might not be suitable.

As discussed previously, there is an urgent need to decarbonise the UK energy supply in order to meet legally binding climate change commitments. In our view, therefore, it would be preferable to broaden the areas of search for large-scale LZC developments, while retaining other constraint criteria relevant to site suitability, similar to those that are already laid out in Staffordshire planning policies.

This is discussed in more detail in Section 4.1.3, which considers the level of large-scale LZC development that would be needed for Staffordshire to meet its Net Zero commitments.

4.1.2.2. Small-Scale Wind

DECC (2010) assumes that small scale turbines can in principle be located at any address point where the wind speed meets or exceeds 4.5 m/s at 10 m above ground. In practice, site specific constraints vary considerably and include building height, roof shape, neighbouring buildings and other physical obstacles. These have a significant impact on viability because the power output varies cubically (x^3) with relation to wind speed (i.e. increasing the windspeed by a factor of 2 [doubling it] results in an 8-fold increase in power output [$2^3 = 8$]). Therefore, it is usually assumed that small-scale wind will be more suitable in rural locations where there are fewer obstacles and wind speeds are higher and more consistent.

The SQW (2011) report analysed potentially suitable properties and concluded that a total of around 209 MW of small-scale wind could be delivered across the County. In this report, we have assumed that there has been no significant change in either the amount of small-scale wind that could be delivered or the advice regarding its suitability since the time of the SQW (2011) report, on the basis that the density of any major new developments would likely render their locations unsuitable for small-scale turbines.

The Government has issued guidance for onshore wind turbines which clarifies that small- or domestic-scale installations are not subject to HCWS42 and in some instance are still considered permitted development.[76]

4.1.2.3. Small-Scale PV and Solar Water Heating

Both building mounted solar PV and solar water heating (SWH) depend largely on two site-specific factors: available roof space, and the solar exposure of the roof area (which relates to orientation, pitch, overshading, etc). SWH systems are typically sized to meet a certain proportion of annual hot water demand, since the heat is used on site.[77] PV can be sized more flexibly, subject to the amount of available roof space, since electricity can be stored or exported.

DECC (2010) methodology (Table 3-8) describes the percentage of different buildings assumed to be suitable for solar energy systems, along with average capacity of domestic systems (2kW) and non-domestic systems (5kW). These were used to generate the estimates in Table 4.1 above. In terms of policy constraints, the main

[75] For example, the NOABL data on average wind speeds – which was used in the Camco (2010) study and remains the best resource for assessing wind energy opportunities on an area-wide basis in the UK – is based on modelled estimates on a 1 km grid resolution. Other constraints are helpful as guidance, but do not represent a definitive barrier to wind energy development. For example, in regards to the buffer zone / exclusion area, DECC (2010) states that, *'There is no definitive guidance on this issue and therefore a rule of thumb has been used based on expert opinion (from wind farm noise specialists).'*
[76] HM Government, *'House of Commons Briefing Paper no. 04370: Planning for Onshore Wind'* (2016). Available at: https://commonslibrary.parliament.uk/research-briefings/sn04370/
[77] For context, in domestic properties a typical SHW system size would be 4-5 m^2 according to the Energy Saving Trust; the system would not be compatible with combi boilers if there is no hot water tank. See https://energysavingtrust.org.uk/renewable-energy/heat/solar-water-heating

consideration for roof-mounted technologies is visual impacts. Therefore, their use is often restricted in sensitive locations such as Conservation Areas and Areas of Outstanding Natural Beauty (AONBs).

Considering that Feed-in Tariff statistics currently indicate that there is around 70 MW of roof-mounted[78] PV installed in Staffordshire, installing this much additional roof-mounted PV would require a large increase in uptake. That said, it is noted that the cost of PV has plummeted in recent years[79] while uptake has risen sharply, despite uncertainty surrounding government incentive schemes. This suggests that the technology is viable in practice and it is commonly used by developers in order to meet carbon emissions reduction targets. Furthermore, the advance of battery storage technologies may help to further drive uptake by allowing users to store surplus power, helping to facilitate greater use of the generated energy on-site.

In general, greenfield and large new development sites may offer greater potential for solar energy generation; the relative lack of design constraints provides more opportunities to maximise sustainable design measures from the outset. Similarly, industrial sites may be more suited to solar technologies as they tend to have large roof areas.

4.1.2.4. Large-Scale PV

In principle, PV can be delivered anywhere where there is a suitable surface with adequate solar access (i.e. minimal overshading and favourable orientation and pitch). DECC (2010) does not set out criteria for large-scale ground-mounted PV farms, and therefore this resource was not quantified; however, it is discussed further in Section 4.1.3, since it is recognised to be a renewable resource of a strategic scale.

As with building-mounted PV, potential constraints on large-scale PV are likely to relate to the visual impact. Solar farms also have significant spatial requirements (empirical data suggests that c.0.8-1.0 MW of PV capacity can be accommodated per hectare of solar farm), which raises issues related to competing land uses. In the Written Ministerial Statement HCWS488, published in 2015, the Government emphasises the need to protect the natural environment while avoiding competition for use of the ‘best and most versatile agricultural land’. The Statement goes on to recommend that priority should be given to installations on brownfield sites and lower grade agricultural land – or, alternatively, that PV should be incorporated into the existing built environment (e.g. on the roofs of commercial and industrial buildings).[80]

4.1.2.5. Air and Ground Source Heat Pumps (ASHPs and GSHPs)

Air and ground source heat pumps can provide low carbon heat if they are powered with LZC electricity. In recent years, as discussed in the Baseline Report, the carbon intensity of UK grid electricity has decreased dramatically, a trend which is expected to continue.

DECC (2010) provides some rules of thumb for the proportion of existing buildings that might practically be retrofitted with a heat pump, along with the average capacity of domestic systems (5kW) and non-domestic systems (100kW). Using this approach, the SQW (2011) report found that there could be up to 1,381 MW of ASHPs and 345 MW of GSHPs installed in existing buildings across Staffordshire.

In principle, heat pumps could be retrofitted into most properties, but this would likely require complementary energy efficiency upgrades to be undertaken at the same time (e.g. insulation, high-performance glazing and draughtproofing) and replacement of, or changes to, the existing heating system (e.g. heat emitters and pipework). For both new and existing properties, it is also important to ensure that there is adequate space to locate the heat pump, and sufficient grid capacity to accommodate the increase in electricity demands (this is of particular concern in a large number of properties in a small area are converted to heat pumps, since it would result in potential issues regarding grid capacity constraints).

From a planning perspective, the main constraint on ASHP deployment may be associated with concerns related to visual impacts – particularly in, on or around Conservation Areas, Listed Buildings and other heritage assets. This is because ASHPs need to be positioned externally to the dwelling unit; for apartment blocks, this means that they would typically be fixed to the external wall or on the balcony. However, the use of ASHP units in these areas should not be automatically excluded from consideration as there is no technical reason to do so. Similarly, ASHPs

[78] Estimate based on comparing BEIS figures for total PV capacity per Local Authority (see the Baseline Report) with the Feed-in Tariff database and the Renewable Energy Planning Database. It is assumed that all FiT installations are roof-mounted and all REPD installations are ground-mounted, unless otherwise stated in the relevant database.
[79] International Renewable Energy Agency IRENA, ‘*Renewable Power Generation Costs in 2019*’ (2020). Available at: https://irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019#:~:text=Electricity%20costs%20from%20utility%2Dscale,respectively%2C%20for%20newly%20commissioned%20projects.
[80] https://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2015-03-25/HCWS488/

create some noise due to the use of fans which could be an issue, particularly when considered on a cumulative basis. Visual and noise impacts can be mitigated through careful design.

These issues are less of a concern for GSHPs, which do not use fans and can be located indoors, but there are additional technical factors to consider. To determine whether it is possible to install a GSHP on a specific site, a detailed analysis must be undertaken, which is beyond the scope of this report. Different constraints apply depending on the specific technology in question, i.e. whether the GSHP is horizontal or vertical, open or closed loop). In broad terms, however, the most important considerations relate to excavations, drilling and ground conditions rather than visual impact.

According to the Environment Agency's *'Environmental good practice guide for ground source heating and cooling'* (2011), in order to determine whether a proposed GSHP is in a 'sensitive location', an Environmental Impact Assessment (EIA) should assess whether the site is:

- Within a defined groundwater source protection zone 1;
- Within 50m from a well, spring or borehole used for potable water supply;
- On land affected by contamination e.g. historic landfill sites[81];
- Close to a designated wetland site;
- Within 10m of a watercourse;
- Close to other GSHP schemes[82]; or
- Adjacent to a septic tank or cesspit.

Additional considerations include:

- Location of buried infrastructure e.g. gas pipelines, sewers, cables; and
- Other site designations e.g. Archaeological Notification areas, Regionally Important Geological Sites, Sites of Special Scientific Interest, etc.

4.1.2.6. Water Source Heat Pumps (WSHPs)

There are relatively few examples of water source heat pumps (WSHPs) in the UK and our assessment has not confirmed whether there are any currently in Staffordshire. Detailed feasibility studies would be required to assess the potential for WSHPs on a given site, which would also require consultation with the Environment Agency; therefore, this report will not provide a quantitative estimate of the WSHP potential in Staffordshire. However, a report[83] published by DECC in 2015 provided a high-level assessment of river heat capacity for all of England, and relevant findings are presented below.

The DECC (2015) study found that the River Trent, which passes through Staffordshire, has one of the highest heat capacities of any river in the UK, as illustrated in Figure 4-2 below. (Note: This image is extracted from the DECC 2015 report; a higher resolution copy was not available.) In particular, it lists Burton-on-Trent as being one of the urban areas in the UK with the highest technical potential for WSHPs on this basis.

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[81] Maps available at https://data.gov.uk/dataset/contaminated-land
[82] Close proximity to open-loop GSHPs could result in thermal interference and diminish the performance of the GSHP.
[83] For more information, see DECC, *'National Heat Map: Water Source Heat Layer'* (2015). Available at: *https://www.gov.uk/government/publications/water-source-heat-map-layer*

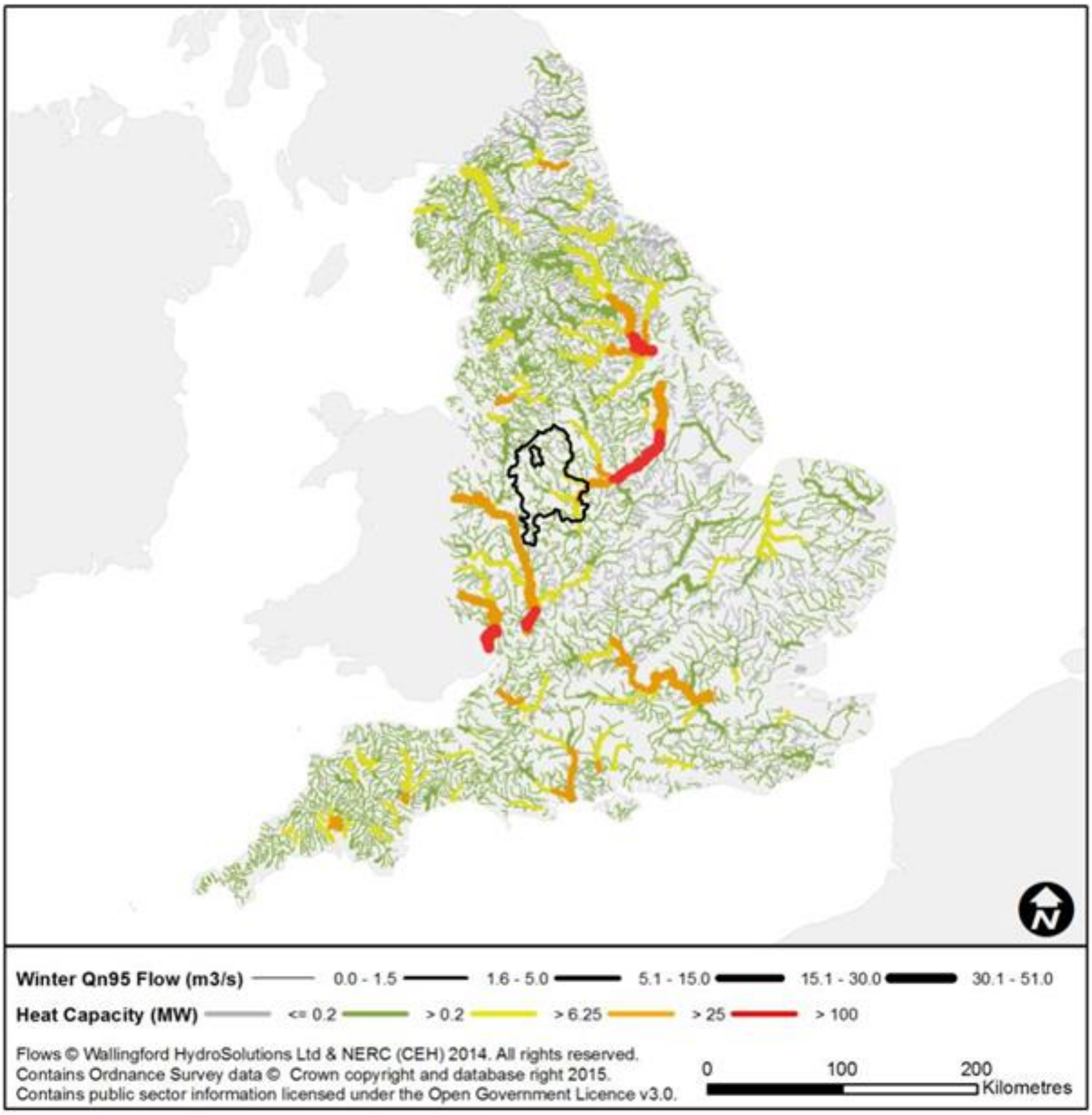

Figure 4-2. River heat capacity. Source: DECC (2015)

WSHPs are more likely to be suitable for sites with a heat demand that exceeds 5-10 kWh/m^2 per year, according to DECC (2015). This could include, for example, dense urban areas, hospitals, prisons, and certain industrial facilities.

Figure 4-3 below (also extracted from the DECC 2015 report) highlights urban areas that are adjacent to potential sources of river heat, colour coded based on the estimated capacity. Key findings in relation to Staffordshire include:

- 0-50MW capacity: Stafford, Cannock, Lichfield, Leek, Stone, and areas around Stoke-on-Trent
- 50-100MW capacity: Tamworth, Rugeley, and Uttoxeter
- 200MW capacity: Burton-on-Trent

Not all of this river heat capacity will be technically or practically accessible. It is also not appropriate to sum these figures because the cumulative impacts on a finite resource of installing multiple WSHPs would need to be taken into account. Nonetheless, this information can provide a starting point for further detailed study in the future. For context, as an indication of the potential size of WSHPs that have been installed elsewhere in the UK, there is a 2.3 MW river source heat pump in operation at Kingston-Upon-Thames which provides heating and hot water to around 140 homes, a large hotel and conference facilities.[84]

[84] https://les.mitsubishielectric.co.uk/assets/FileDownloads/e87311a1ec/Kingston-Case-Study.pdf

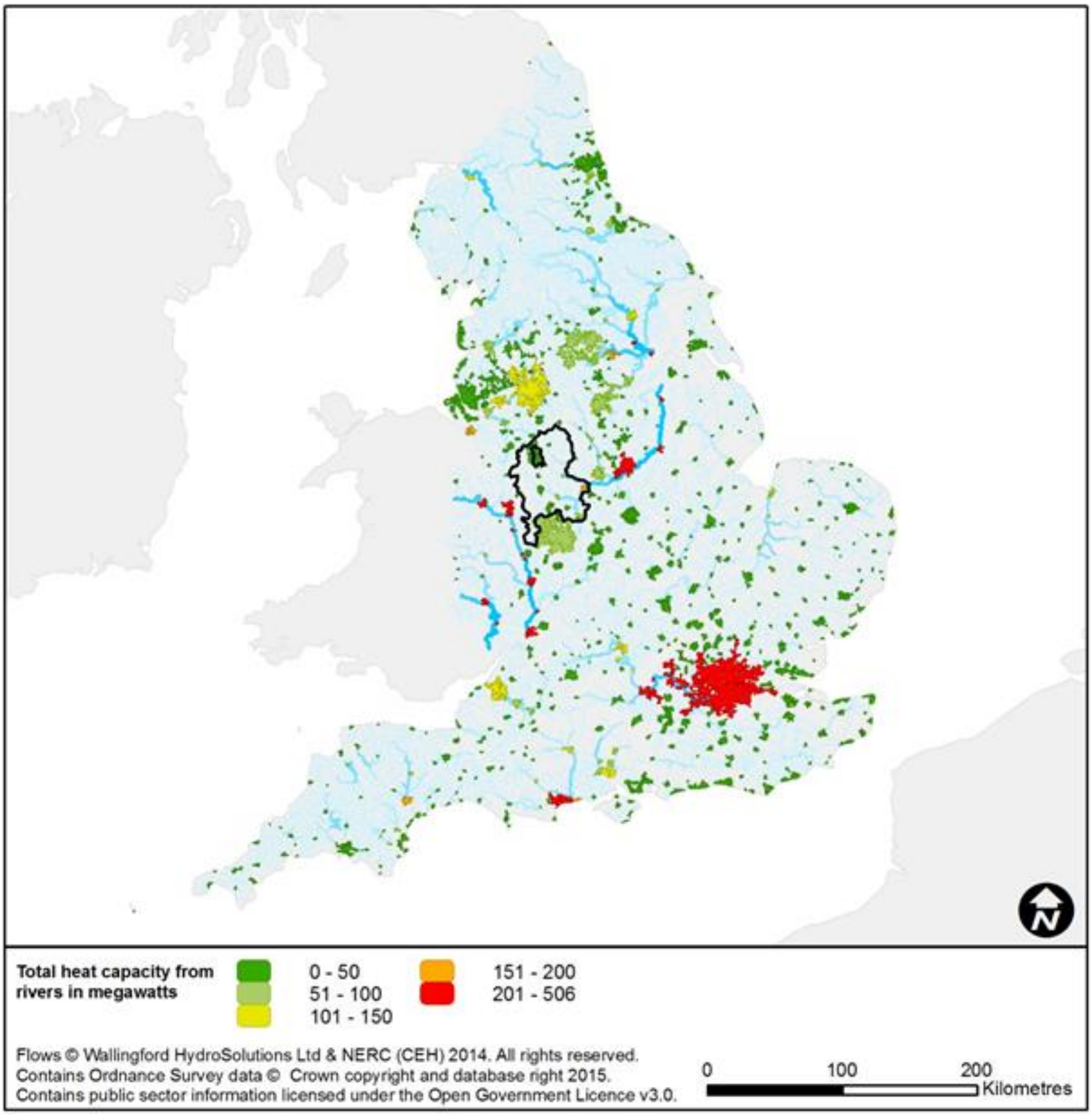

Figure 4-3. Total heat capacity from rivers in megawatts for urban areas. Source: DECC (2015)

Environmental designations that could potentially act as constraints on the use of WSHPs include:

- Sites of Special Scientific Interest
- Special Protection Areas
- Special Areas of Conservation
- RAMSAR sites
- CAMS water resource status
- Freshwater fisheries status
- Water Framework Directive Waterbodies

The above has highlighted the potential to utilise river courses as a source of heat for WSHPs. However, it may also be possible to deploy WSHPs in other resources. For example, wastewater treatment works (WWTWs) represent a large and renewable source of heat which could be used to power a WSHP. There are several WWTWs around Staffordshire, and they have the added benefit of typically being located near to major urban areas. No attempt has been made to quantify the potential capacity of WSHPs that source their heat from WWTWs, as this is beyond the scope of the current study, and the use of WWTWs for this purpose is still in its infancy. However, it is recommended that this is investigated in the future, particularly where there are large masterplan developments planned within the County, as it represents a key sustainable option for delivering low carbon heating to developments.

There is also the potential to utilise legacy assets from the mining tradition that used to operate across Staffordshire. Whilst the associated mine shafts are typically abandoned and flooded, research and pilot projects have been undertaken to determine the viability and efficiency of their use to power WSHPs, which in turn supply low carbon heating to customers via a district heat network[85,86]. No attempt has been made to quantify the potential capacity from this source of heat, as this is beyond the scope of the current study, and the technology is still in an experimental stage. However, given the legacy mining assets in the area, it may be possible that there are significant opportunities for this technology in the future. It is recommended therefore that the potential to utilise legacy mining assets be investigated at a strategic level in relevant Authorities.

4.1.2.7. Hydroelectric Power

Hydro power is generated by water flow through a turbine and depends on the volumetric flow rate and available head (i.e. the vertical distance of the water surface above the turbine). DECC (2010) recommends using the Environmental Agency's *'Mapping Hydropower Opportunities in England and Wales'* (2009) to identify potential regional sources of hydropower, and on this basis SQW (2011) estimated that there was around 8 MW of hydroelectric capacity potential in Staffordshire.[87] Earlier analysis carried out by Camco (2010) considered specific sites within Staffordshire and concluded that the potential was closer to 1.5 MW.[88]

This study has identified that there are six existing hydro power schemes within the County (see the Baseline Report) but details of their size and location are not publicly available. It is assumed that the Environment Agency would be averse to any additional barriers being created which would limit the availability of new sites. Considering the relatively high cost of the technology, and the need to carry out more detailed environmental assessment work compared with other types of LZCs, in practice it is likely that future uptake will be limited.

4.1.2.8. Energy from Waste (EfW)

'Waste' covers municipal solid waste (MSW) and commercial and industrial (C&I) waste. Both can be diverted from landfill to EfW facilities and used to derive power via combustion, pyrolysis, gasification or anaerobic digestion. In line with waste reduction principles, it is considered preferable for this resource to diminish rather than increase. There are additional concerns related to air quality impacts if waste streams are disposed of through combustion. Therefore, this technology is not recommended for widespread adoption in Staffordshire.

4.1.2.9. Biogas (Sewage and Landfill Gas)

DECC (2010) provides a method for estimating the potential availability of both sewage and landfill gas, which can be used to generate either electricity or heat. Sites that could theoretically provide potential opportunities for biogas include:

- Material recovery facilities
- Landfill sites
- Waste transfer stations
- Sewage systems

The SQW report estimated the potential sewage gas resource for Staffordshire to be around 4 MW, based on sewage gas installations in operation at that time. As described in our Baseline Report, this has not changed since 2010. This report has not estimated the potential additional sewage gas resource that could be utilised in future. DECC (2010) states:

> *'It is generally thought in the literature that the potential for expanding this resource is limited, as much of the resource is already captured and utilised. New resource will be highly dependent on projections for the expansion of water treatment as a result of population growth.'*

Landfill gas naturally diminishes over time as the organic portion of the waste biodegrades. DECC (2010) states:

> *'Current landfill sites have a limited useful lifetime as sources of bio-gas and will be exhausted by around 2020. There is unlikely to be much new landfill gas resource due to the EU Landfill Directive which caps landfill, especially post-2014, and due to policies to promote other waste management processes such as*

[85] Banks D et al, '*Water from abandoned mines as a heat source: practical experiences of open- and closed-loop strategies, United Kingdom*', (2017). Available at: https://link.springer.com/article/10.1007/s40899-017-0094-7

[86] Euroheat.org, '*District heat from an abandoned coal mine*', (2020). Available at: https://www.euroheat.org/news/district-heat-abandoned-coal-mine/

[87] http://www.british-hydro.org/UK%20Hydro%20Resource/England%20and%20Wales%20Resource%20Study%20Oct%202010.pdf

[88] https://www.gov.uk/government/publications/hydropower-resource-assessment-england-and-wales

> *anaerobic digestion, composting and recycling, which will reduce significantly the biodegradable fraction of landfill waste.'*

Therefore, landfill gas is not expected to form a significant part of Staffordshire's renewable energy mix.

4.1.2.10. Biomass

Biomass covers a diverse range of fuels derived from plants, animals or human activity. Biomass is usually converted to energy via combustion, pyrolysis, gasification or anaerobic digestion. The Camco and SQW studies both found that there was significant potential for biomass energy in Staffordshire, particularly energy crops.[89] Our review of those studies suggests that the key variables affecting those estimates are unlikely to have changed significantly in the last decade – for instance, recognising that the utilisation rate of agricultural land has remained stable since 2000.

However, although DECC (2010) provides a methodology for estimating the quantity of available feedstocks, it is difficult to quantify the overall environmental benefits of biomass energy using a broad-brush approach, in part because of questions about how the biomass is produced and whether there is a more suitable end use for the material. A 2018 report by the Committee on Climate Change considered the role of biomass in supporting the UK's decarbonisation targets, and found that:[90]

> *'Biomass can be produced and used in ways that are both low-carbon and sustainable. However, improved governance will be essential to ensure this happens in practice. If this is achieved, biomass can make a significant contribution to tackling climate change. If this is not achieved, there are risks that biomass production and use could in some circumstances be worse for the climate than using fossil fuels.'*

The same report found that, to provide the greatest reduction in GHG emissions, *'the greatest levels of GHG abatement from biomass currently occur when wood is used as a construction material in buildings to both store carbon and displace high carbon cement, brick and steel.*' If and when carbon capture and storage technologies become widely available, these could be used in conjunction with bioenergy to provide further benefits (via bioenergy carbon capture and storage (BECCS)). The CCC found that, as a final option, *'the remaining [biomass] resource would be best used to displace residual fossil fuel emissions where other low-carbon alternatives do not exist (e.g. in aviation).'* In other words, based on the present state of technologies, biomass energy is not a preferred option for heat or electricity generation for most applications.

There are additional issues related to air quality impacts. Direct combustion (burning) to produce electricity or heat is often the most viable approach to energy conversion from a technical and economic standpoint. However, biomass burning emits particulate matter (PMx) and therefore DEFRA's position is to not encourage this practice in or near urban areas or Air Quality Management Areas (AQMAs) due to air quality concerns.[91] A report[92] by the European Environment Agency found that, *'Particulate matter (PM) directly released into the air and emissions of volatile organic compounds (VOCs) increased because of the growth in biomass burning since 2005. $PM_{2.5}$ increased by 11 %, PM_{10} by 7 % and VOCs by 4 %'* which the authors characterised as a 'strong increase' although it is acknowledged that modern combustion technologies meet stricter standards for air quality than traditional solid fuel burners,

With this in mind, biomass combustion technologies are not recommended for widespread adoption in Staffordshire; instead, as noted by the CCC, the best opportunity from a carbon reduction perspective may be to use biomass in construction as a carbon sink. The most appropriate use of biomass as fuel is likely to be where there is an existing source of waste biomass – provided that waste reduction measures are also in place. This could include, for example, anaerobic digestion plants that are co-located with agricultural facilities that have a high energy demand. However, as these processes become more efficient and incentives for their uptake (such as through emerging agricultural policy discussed more in Section 4.2.4) increase, the opportunities around biomass for Staffordshire may change.

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[89] Realistically, it is not likely that the use of energy crops will increase without significant Government incentives. We note that the Energy Crops Scheme, which was aimed at increasing energy crop production, was cancelled in 2013 following low uptake.

[90] Committee on Climate Change, *'Biomass in a Low Carbon Economy'* (2018). Available at: https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf

[91] DEFRA, '*The Potential Air Quality Impacts from Biomass Combustion*' (July 2017). Available at: https://uk-air.defra.gov.uk/library/reports?report_id=935

[92] European Environment Agency, *'Renewable energy in Europe 2019 - Recent growth and knock-on effects'* (2019). Available at: https://www.eionet.europa.eu/etcs/etc-cme/products/etc-cme-reports/renewable-energy-in-europe-2019-recent-growth-and-knock-on-effects

Case Study: Eccleshall Biomass, Raleigh Hall Industrial Estate

The Eccleshall Biomass plant has been in operation at Raleigh Hall Industrial Estate since 2007. According to the Eccleshall Biomass website, this provides around 20,000 MWh of electricity each year from a 2 MW generator that runs on fuels such as miscanthus and wood chips which are *'principally sourced from […] within 25 miles of the power plant.'* As stated above, sourcing biomass from the nearby area represents good practice that should be adopted as standard for any installations.

Image source: https://www.eccleshallbiomass.co.uk/

4.1.3. Assessment Based on Energy Demands

4.1.3.1. The Scale of the Challenge

To reach Net Zero emissions, it will be necessary to switch away from the use of fossil fuels such as natural gas, coal and petrol, and instead utilise 100% renewable electricity wherever possible. Although it is understood that some energy will continue to be imported and exported, this will inevitably require a step change in local LZC energy deployment. Given that the UK has made a legal commitment to reaching Net Zero by 2050, and recognising the proliferation of Climate Emergency declarations, Local Authorities should assume that this shift is inevitable, and this must be taken into account when developing LZC energy policies and / or targets.

To understand the scale of this challenge, consider the following: Annual electricity use in Staffordshire was 3,722 GWh in 2018. LZC technologies in Staffordshire currently generate around 366 GWh of renewable electricity annually, equivalent to just under 10% of electricity demand. Based on typical outputs for PV and onshore wind turbines,[93] meeting 100% of electricity demands using local renewable energy would require roughly:

3,900 MW of PV, equivalent to solar farms totalling around 4,874 hectares (49 km^2) – roughly 2% of the land area of Staffordshire;

OR

1,775 MW of large-scale onshore wind, which could be delivered using roughly 700 large turbines. Wind farms of this scale would require a land area of around 20,000 hectares (200 km^2), which is roughly 7% of the land area of Staffordshire, although they could be co-located with other agricultural uses. (For comparison, the SQW report found that there was over 6,500 MW of wind energy potential in the County, whereas current policy restrictions would cap this at around 50-60 MW in total.)

Realistically, these figures under-estimate the amount of renewable electricity that will be needed; demand will increase over time due to the uptake of electric vehicles and electric heating systems.

There is clearly a large discrepancy between the amount of operational LZC generation, the potential LZC generation that could be accommodated based on current policies, and the scale of deployment that would be

[93] BEIS, *'Digest of UK Energy Statistics (DUKES) 6.5: Load factors for renewable electricity generation'* (2019). Available at: https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes

required to meet Staffordshire's current electricity demands.[94] This discrepancy is illustrated in Figure 4-4 on the following page. This raises several important questions:

- Is it even theoretically feasible to deliver LZC energy technologies at this scale, based on existing land areas and policy constraints?
- Are there any obvious opportunity areas?
- And what can Local Authorities do to facilitate this transition?

[94] The current electricity demand is based on 2018 data, taken from the BEIS sub-national fuel consumption statistics, and the current renewable electricity generation is based on the BEIS Regional Renewables Statistics (RRS), both of which are presented in the Baseline Report. The RRS includes the total capacity and annual electricity generation (MWh) of installed LZC technologies in Staffordshire which have been used to calculate typical outputs for onshore wind and PV (MWh/MW). This is then multiplied by the potential additional capacity (MW) of each technology as presented in Table 4.1 (see page 11).

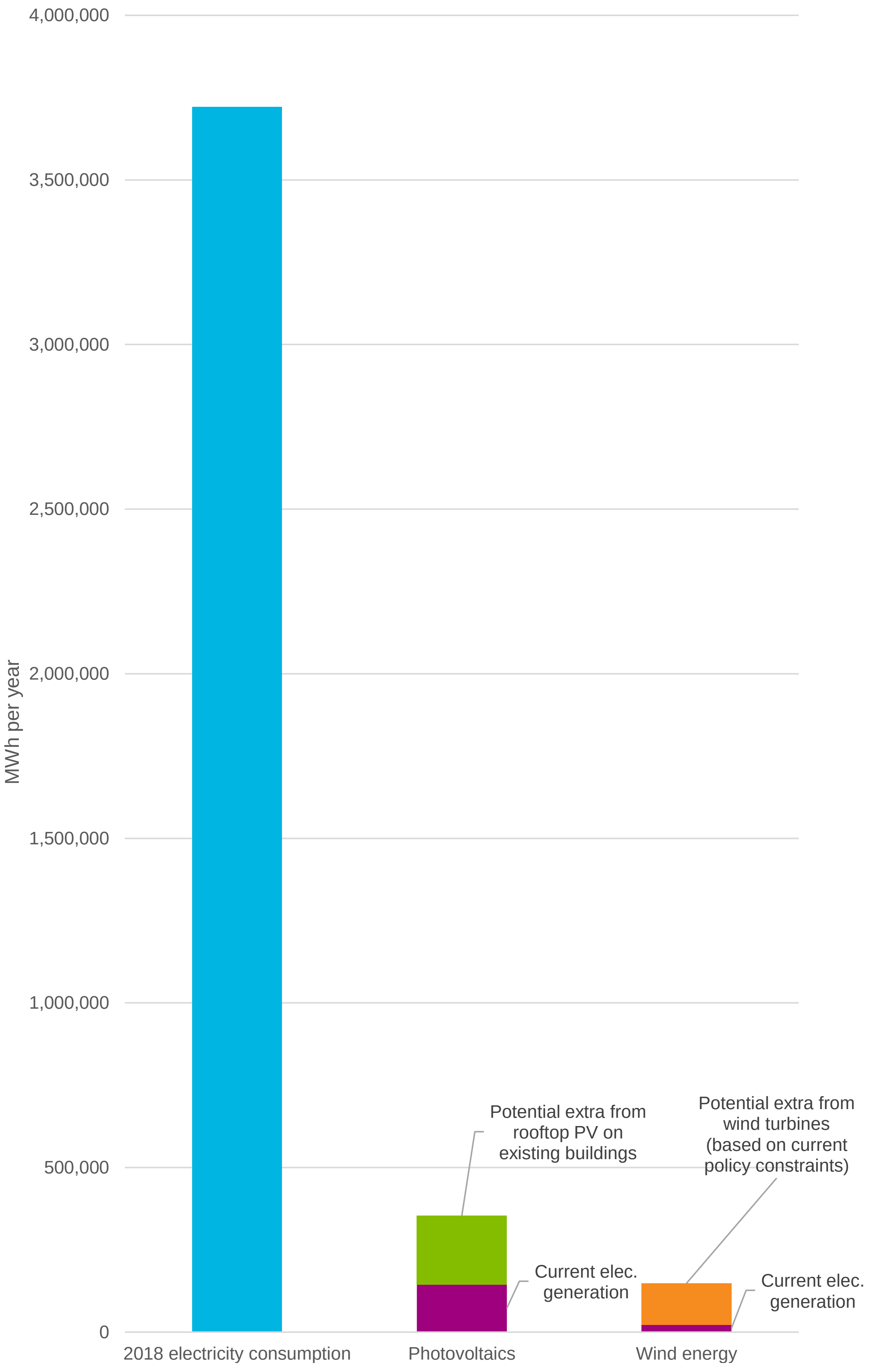


Figure 4-4. Comparison of the County-wide electricity demands (2018 data) versus the currently installed amount of PV and wind generation, illustrating the need for additional large-scale LZCs.

4.1.3.2. Opportunity Zones for Large-Scale LZCs

GIS analysis was used to gain a better understanding of the spatial implications of the scale of LZC development illustrated in Figure 4-4, compared with existing land uses in Staffordshire. Figure 4-5 on the following page therefore highlights areas that are subject to the fewest policy constraints, and so are more likely to be suitable for deploying large-scale wind or solar farms.

Areas shown in **white** are assumed to be unsuitable because they are classified as one or more of the following:

- Agricultural Land Grades 1 and 2 (i.e. the most productive);
- Conservation Areas;
- Urban areas and settlements;
- Woodland;
- SACs, SSSIs, SPAs, and Ramsar sites;
- National or Local Nature Reserves; or
- Parks and Gardens.

[Note that there are additional constraints on large-scale wind development due to safety and amenity concerns, which are not shown on this map because they are highly dependent on the design and size of the turbines used. These include, for instance, buffer zones around existing buildings, infrastructure and airports. For more information, refer to the DECC (2010) methodology guidance or SQW (2011) report.]

Areas shown in **light green** are 'more constrained' or potential opportunity areas that would likely be subject to stricter scrutiny, even though there is precedent in the UK for large-scale LZCs to be delivered in such areas. This includes agricultural land of Grades 3, 4 and 5 in areas that are classified as being also covered by one or more of the following designations:

- AONB;
- National Park or
- Green Belt land.

This does not constitute a recommendation that large-scale LZCs should necessarily be delivered in any of these areas. It is purely intended to reflect that there is UK precedent for such installations – for example, there is a wind farm on Green Belt Land in South Staffordshire, while in 2014, approval was granted for a PV farm within the Peak District National Park. These precedents suggest that negative impacts can potentially be mitigated through careful site selection, design, planning and community engagement.[95] This is in line with DECC (2010) guidance, which states that these areas should not be automatically excluded from consideration. It is also consistent with the Peak District National Park 'Climate Change and Sustainable Building SPD' which addresses LZC energy installations.[96]

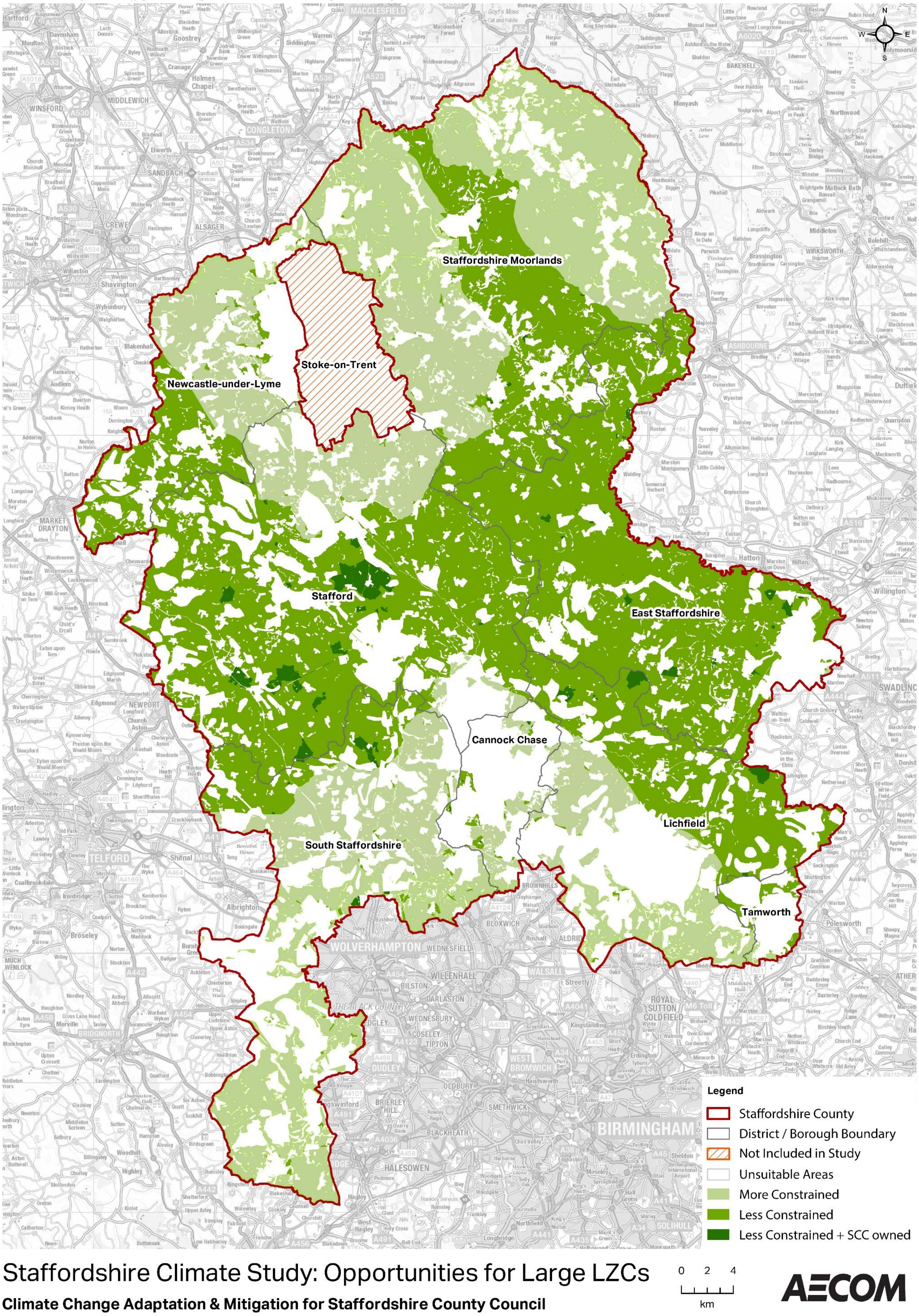
Areas shown in **medium green** are 'less constrained' from a policy standpoint, i.e. lower grade agricultural land (Grades 3, 4 and 5) that do not fall into any of the designations or categories listed above.

Finally, in order to highlight particular opportunity areas that might be easier for the County Council to develop, areas in **dark green** are 'less constrained' land that is also owned by SCC.

[95] https://www.peakdistrict.gov.uk/learning-about/news/archive/2014/news/landmark-decision-on-solar-panels-in-peak-district-national-park

[96] Peak District National Park, *'Climate Change and Sustainable Building SPD'* (2013). Available at: https://www.peakdistrict.gov.uk/__data/assets/pdf_file/0021/63507/3401-EF-Sustainable-Planning-Doc.pdf

Figure 4-5. Opportunities for large-scale LZC energy technologies

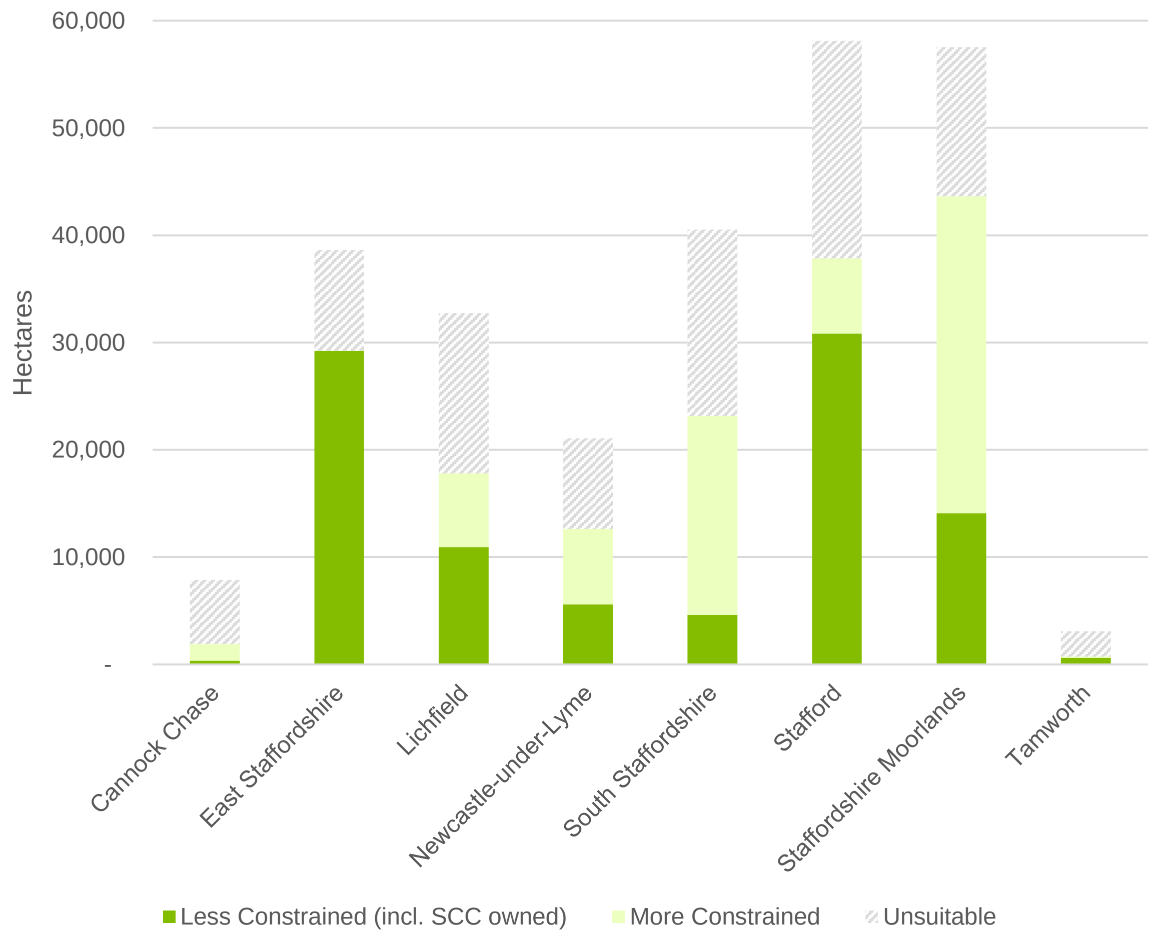


Numerical results are presented in Table 4.2 and illustrated in Figure 4-6 below.

Table 4.2. Estimated land areas subject to constraints relevant to large-scale LZCs

Local Authority	Total Area (hectares)	More Constrained / Potential Opportunity Areas (hectares)	Less Constrained / Opportunity Areas (hectares)	Less Constrained / Opportunity Areas Owned by SCC (hectares)
Description	*Total area of district*	*Areas in light green on the map*	*Areas in medium green on the map*	*Areas in dark green on the map*
Cannock Chase	7,888	1,539	355	22
East Staffordshire	38,999	28	29,226	370
Lichfield	33,129	6,865	10,942	397
Newcastle-under-Lyme	21,096	7,058	5,585	11
South Staffordshire	40,732	18,543	4,621	216
Stafford	59,817	7,008	30,829	1,701
Staffordshire Moorlands	57,585	29,534	14,090	52
Tamworth	3,085	130	608	0.2
Total	**259,585**	**70,704**	**96,256**	**2,768**

Figure 4-6. Estimated land areas subject to constraints relevant to large-scale LZCs



Overall, around 9,256 ha or 38% of the land area in the County is not subject to any of the policy or land use designations listed on page 63 (that is, areas in medium or dark green on the map in Figure 4-5 or on the chart in Figure 4-6). For context, using benchmarks for the typical spatial requirements and outputs of PV and wind farms[97] we can estimate that the 2018 electricity demand for all of Staffordshire could potentially be met if around 25% of this 'less constrained' land (i.e. the **medium green** or **dark green** shades on shown on the map) was used for wind farms or if around 7% was used for PV farms. This does not mean that it would be desirable, practical, or technically or financially viable to do so – only that there is enough physical and spatial resource in the County, ignoring all other constraints. It is understood that the amount of land that would actually be used to deliver wind or PV farms would depend on other local considerations (e.g. landscape sensitivity), therefore this report has not presented an estimate of the actual capacity (MW) that might be delivered in these areas.

This analysis suggests that a significant amount of renewable electricity could potentially be provided through local installations without necessarily infringing on Green Belt, AONB, National Park or other sensitive landscapes. There is an important trade-off, however, when one considers that the financial and technical viability might be better in areas such as Green Belt land that are closer to built-up areas and, therefore, closer to existing infrastructure; this is discussed more in Section 4.1.3.3 below.

Unsurprisingly, results differ by Local Authority, as shown in

Figure 4-6 (above). There is very limited land available in either Tamworth or Cannock Chase as these are small and comparatively built up areas. For these districts in particular, therefore it will be even more important to introduce policies and initiatives aimed at demand reduction, while promoting the uptake of other LZC technologies such as building-mounted PV and SHW, heat pumps, and communal / district heating and cooling networks that utilise sources of waste heat. This confirms the findings of the SQW and Camco studies which noted that some Local Authorities would struggle to deliver significant LZC capacity. In principle, this could be made up for by increased delivery in other Local Authorities, which emphasises the benefits of a strategic County-wide approach to policy and decision making.

We note that the Staffordshire Local Authorities own significant landholdings, and that SCC in particular owns around 2,770 ha (2.77 km^2) in areas that are considered 'less constrained' by the types of policy designations listed on page 63. Because these areas are within the Councils' direct control, in principle it may be easier to deliver some form of renewable electricity generation technology in these areas compared with elsewhere.

All Local Authorities should also undertake further detailed assessments of opportunities to incorporate PV arrays into existing built infrastructure, including industrial sites and car parks. In areas with greater land constraints, this is likely to represent the key opportunity for renewable electricity generation; however, the potential capacity has not been quantified in this report due to a lack of publicly available data on these types of buildings / structures.

Needless to say, there are many practical barriers to delivering this scale of additional LZC energy capacity. Setting aside the UK-wide restriction on onshore wind development, these include, but are by no means limited to:

- Competition with other land uses and priorities e.g. food production, biodiversity, amenity, etc.;
- Cumulative impacts of large-scale LZC development on issues such as landscape character;
- Legal challenges;
- Ensuring that there is a robust consultation process to obtain support from the local community, organisations, businesses and other stakeholders;
- Lack of financial or other incentives to promote uptake; and
- In general, a low level of Local Authority ability to influence the types of projects that are brought forward.

Nonetheless, there is no technical reason why more of the County could not be designated as being suitable for large-scale LZCs, and in order to meet their climate change commitments, Local Authorities will inevitably have to start finding ways to proactively facilitate this change. As a starting point, this should include a review of existing policy constraints, and potentially issuing a 'call for sites' capable of supporting such installations.

Finally, this analysis emphasises the scale of the challenge ahead, and the importance of reducing energy demands overall, to ensure that Staffordshire's energy needs can be met with 100% renewable energy in the future.

4.1.3.3. Transmission and Distribution Network Capacity

The viability of new LZC generation projects depends on the ability to be able to deliver the generated power to customers via new or existing Transmission and/or Distribution network infrastructure. The existing Distribution

[97] Assumptions on spatial requirements for PV farms are based on empirical data (0.8 MW/ha) and those for wind farms are based on DECC (2010) benchmarks (0.09 MW/ha). Annual electricity generation is based on the RRS (see Footnote 94).

Network in the Staffordshire region is owned and operated by WPD. WPD operates the network at voltages from 132 kV at sub-transmission, down to 400 V for domestic distribution.

The following table, developed by WPD, details the proposed connection voltage, depending on the size of the proposed renewable electricity installation. In general, the higher the connection voltage, the higher the cost of the connection infrastructure.

Table 4.3. Connection Sizes and Voltages

Size of Generation Installation	Location	Typical Connection Voltage
0-0.25 MW	Rural	400 V
0-0.5 MW	Urban	400 V
0.25-4.0 MW	Rural	11 000 V
0.5-7.0 MW	Urban	11 000 V
4.0-20.0 MW	Rural	33 000 V
7.0-20.0 MW	Urban	33 000 V
+ 20.0 MW	Urban + Rural	132 000 V

Domestic and small-scale commercial PV installations are commonly installed in developed areas where the distribution network already exists and is relatively suitably sized. Rural areas, in contrast, are usually identified for larger scale installations due to the increased availability of land. However, the network in these areas is often significantly undersized to accommodate large-scale generation installations. Therefore, when considering potential large-scale installations, it is prudent to consider the proximity of the proposed location to the existing network infrastructure. Minimising the required network expansion to connect the LZC generator will increase the viability of the development.

Figure 4-7 on the following page depicts the existing WPD infrastructure, overlaid on the LZC energy resource map shown in Figure 4-5. Each WPD substation is colour-coded to represent its capacity to accommodate additional generation (labelled as 'Substation Generation Headroom'); green indicates available capacity, amber indicates limited additional capacity, and red indicates no additional capacity, as advised by WPD.[98]

From a technical perspective, areas with a strong energy resource that are close to substations and associated distribution lines that are coloured green (i.e. which have available grid capacity to accommodate the connection of large-scale generation installations) are likely present suitable development options. As detailed in Table 4.3 above, the size of the generation installation will dictate the required connection voltage.

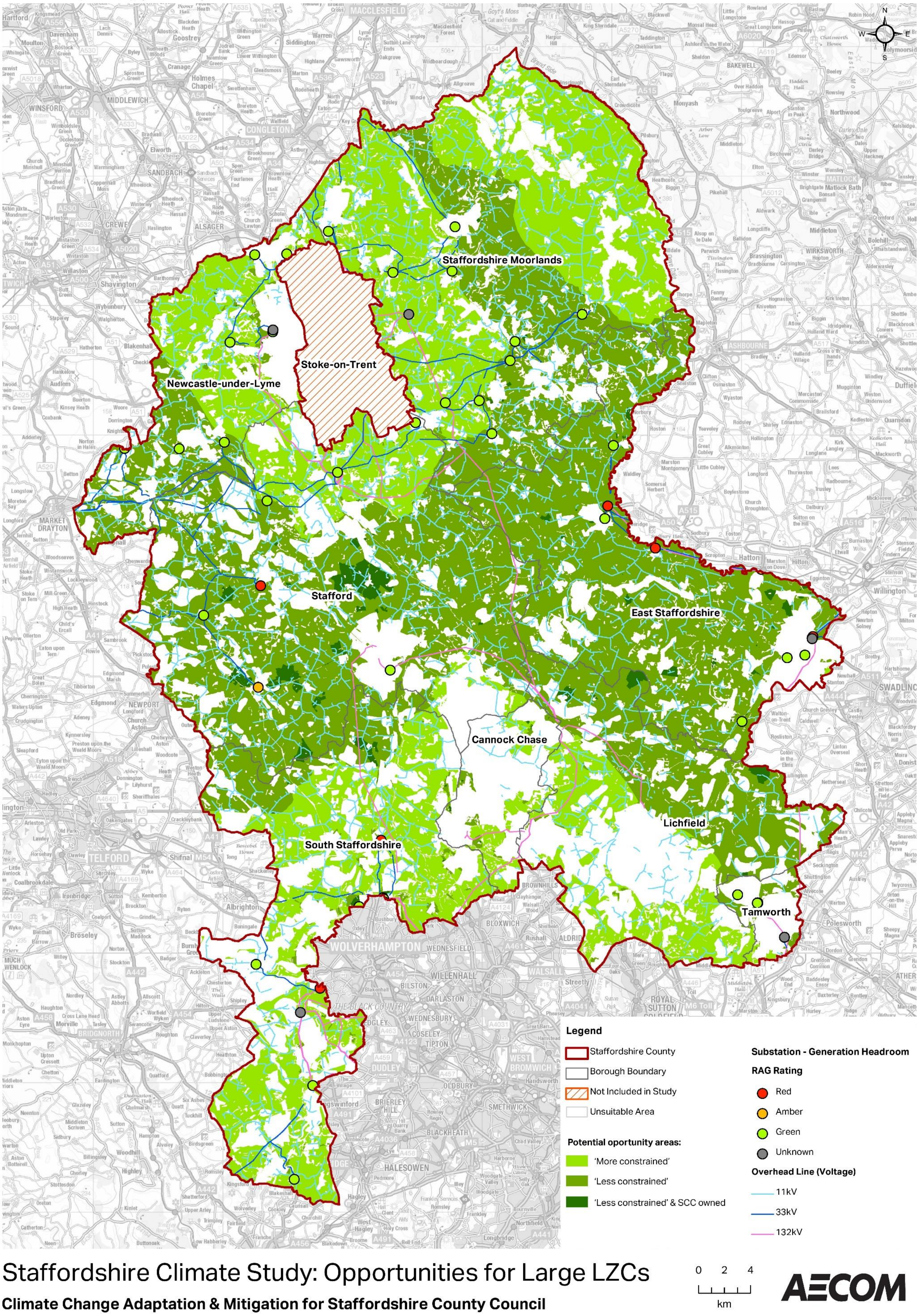
The map shows that, at present, there are a number of high voltage power lines and substations with additional capacity located around the edge of the Stoke-on-Trent Green Belt, in areas that are 'less constrained' from a policy perspective. These areas, located in Staffordshire Moorlands, Newcastle-under-Lyme and the northern part of Stafford Borough could be considered opportunity zones for new large-scale (5-20+ MW) installations. Whilst it is beyond the scope of this report to identify specific sites for large-scale LZCs, scheme are, in general, more likely to be viable where they are in close proximity to:

- Urban areas or large energy users; and
- Existing power infrastructure – larger sites would require higher voltage connections and sub-stations with greater capacity headrooms to accommodate additional generation.

The map shown in Figure 4-7 can be used as a starting point for considering potential areas of search for large-scale renewable energy installations. In particular, if SCC or any of the other Councils' own landholdings are in close proximity to existing infrastructure and lie within these opportunity areas, they could be considered potential candidates to deliver LZCs, thereby contributing towards the Councils' Net Zero ambitions. However, because the viability of large-scale renewable developments depends on site-specific factors (including scale, distance from substations and required grid capacity enhancements), it is not possible to give a general rule of thumb as to appropriate distances from these features.

[98] WPD Network Capacity Map Data https://www.westernpower.co.uk/our-network/network-capacity-map/

Figure 4-7. Existing substation capacity in Staffordshire (overlaid with LZC opportunities map)



Engagement with WPD is also recommended in order to build greater understanding of where capacity exists on the grid network, and what plans WPD are aware of from other parties to increase capacity in certain areas. Ofgem requires grid networks to be fully utilised, which means DNOs are obliged to target capacity growth in areas where the demand is expected to come from. Importantly, the capital cost of providing new capacity is usually borne by the party requesting the additional capacity. Whilst the 'Second Comer' rule can facilitate the recovery of some of the invested capital from third parties (should the third party require some of the additional capacity that was financed by the party who requested the additional capacity in the first place), this risk will need to be carried by applicants who require additional capacity to be provided by the DNO. (It may also be possible for the costs to be split between the party requesting the additional capacity and the DNO, should the works provide additional benefits to other parts of the network. This would be done through a 'Cost Apportionment Fund' mechanism.) The Authorities are encouraged to actively engage with the Local Authority Engagement Feedback Forms that WPD use to inform themselves of the plans and activities that authorities are engaged in and which might affect the grid requirements in the future.

4.1.4. Future Low Carbon Technologies

4.1.4.1. Hydrogen

As discussed earlier in relation to EVs, hydrogen is considered to potentially have a significant role to play in decarbonisation efforts in the UK. While hydrogen can be used as a fuel for transportation (see Section 3.2.3.2), there are also significant opportunities for utilising renewably-sourced and low carbon hydrogen as a replacement fuel in systems that currently rely on natural gas. (As noted in the Baseline Report, natural gas is primarily used for generating electricity in large gas-fired power stations or for use in domestic buildings, where it is used in central heating systems and for cooking. Other important uses for natural gas include supporting industrial processes.)

Whilst the expansion of renewable electricity capacity is expected to reduce the UK's reliance on natural gas as a means of producing electricity, and in doing so aid the decarbonisation of grid electricity, the displacement of natural gas from other uses is expected to be more challenging. Much of the gas is transported via the gas grid, with high pressure transmission pipelines feeding into medium and low pressure distribution networks. In principle, hydrogen can be injected into the gas grid, so that the gas received by customers is a blend of natural gas and hydrogen. (This principle also applies to the injection of biogases into the gas grid. These are synthetic hydrocarbon gases produced in facilities such as anaerobic digesters, and which, because of the short carbon cycle associated with their production, help to reduce net carbon emissions to the atmosphere.) Since hydrogen was a major component in 'town gas' (which was created from coal and used extensively throughout the UK before the discovery of natural gas and oil reserves in the North Sea in the 1960s), it is considered technically feasible for hydrogen to become a major component in the gas network in the future.

Customers' appliances can, in many cases, run on blends of gas with a high hydrogen content, and the Government is working with the heating industry to trial the rollout of hydrogen in the gas network. For example, Keele University in Staffordshire is testing the viability of using a blended gas of 20% hydrogen : 80% natural gas in a project called HyDeploy.[99] At this blend ratio, no changes are expected to be required to the majority of boilers in the UK. The potential to run a 100% hydrogen network is being explored in a project called Hy4Heat, where positive results have been achieved to date.[100] Boiler manufacturers would need to ensure that boilers can operate safely with 100% hydrogen, though the major manufacturers are working on prototypes which can be switched to hydrogen-only fuels relatively simply.

The main challenges associated with delivering a hydrogen gas grid will be upscaling commercially viable hydrogen production capacity, and the upgrading of the gas distribution infrastructure. Current hydrogen production capacity in the UK is low, and is considered uneconomic in the current environment. This is mainly due to the relatively high cost of the electricity needed to produce hydrogen via electrolysis. This process, which is referred to as 'green' hydrogen if the electricity is renewable, is expected to become more commercially viable once the capacity of renewable electricity generation is expanded to a point where there are large surpluses in grid generation for significant periods of time. Surplus generation results in very low real-time wholesale power prices, which potentially can be used to power the production of large quantities of commercially-viable green hydrogen. This has the added benefit of ensuring demand for renewable electricity during periods when generation exceeds demand.

The gas distribution network is likely to require significant investment before hydrogen can be distributed in large volumes. New hydrogen meters and sensors would need to be fitted for each customer, which is likely to require significant administrative and organisational resources to deliver. The network itself may require some upgrades

[99] https://hydeploy.co.uk/
[100] https://www.hy4heat.info/

to reduce the incidence of leakage from and the failure of pipework. Any upgrades of the network would likely need to be led by Cadent.

It is recommended that the Authorities note the development of trials aimed at establishing the feasibility of hydrogen networks, particularly the HyDeploy trials underway at Keele University.

4.1.4.2. Batteries

Batteries are expected to play a key role in the transition to a grid which is dominated in the future by renewable sources of electricity generation. By their nature, most renewable energy sources (particularly those which are most relevant to Staffordshire, i.e. PV and wind) are intermittent, due to their being dominated by local weather conditions. This means that, with evermore renewable capacity coming online, the real-time generation of electricity may at times dip below the real-time demand. This could lead to brown-outs, where certain loads need to be dropped (i.e. the supply needs to be cut to loads which are deemed less critical) in order to preserve supply capacity for the most critical loads (e.g. hospitals and residential customers). In severe cases, black-outs may occur, where the supply is significantly below demand, causing the whole local network to shut down.

Large 'grid-scale' or 'utility-scale' batteries (MW+), and other forms of energy storage, enable a surplus of supply to be stored during periods when generation exceeds demand. This surplus energy is released onto the grid when demand exceeds real-time generation. Hydroelectric generators have provided this kind of 'grid balancing' service for many years, and there are new concepts coming forward for innovative storage facilities, such as deploying weights within abandoned mine shafts that rise and fall when grid conditions result in oversupply or excess demand on the grid respectively. However, with the increasing penetration of renewables onto the grid, and the reduction in fossil fuel-based generation capacity (which are able to act as modulating generation in order to 'top up' the supply in response to demand levels), storage assets are expected to become an essential part of the energy balance in the future.

Applications for large batteries are increasingly coming forward, as the market and the regulatory environment matures. Recent years have seen significant growth, with the UK now reaching c.1GW of operational battery storage capacity in 2020, with a further c.13.5 GW under development at the planning stage.[101] Furthermore, the UK government recently announced the removal of planning barriers to building energy storage projects over 50 MW in England, and this is expected to drive more and larger battery facilities coming forward for approval.[102] In Staffordshire, the Renewable Energy Planning Database (REPD) shows that there is a 20 MW battery located at Noriker Power in Chesterton, Newcastle-under-Lyme that has been operational since 2017. The REPD also indicates that there are three stand-alone battery storage facilities that have been granted planning permission and are listed as 'awaiting construction':

- 50 MW at the former Rugeley Power Station Site (permission granted 2017);
- 40 MW in Turner Crescent, Newcastle-under-Lyme (permission granted 2017); and
- 50 MW on land near West Wolverhampton (permission granted 2016).

There are precedents for local authorities to develop large grid-scale battery facilities. Of particular interest is the recent completion of a 30 MW system owned by South Somerset District Council in Taunton, where Western Power Distribution is the local District Network Operator.[103] The Solar Trade Association has compiled a range of other case studies in its report *'Leading Lights'* (2017).[104]

Costs for large scale battery facilities are coming down as the market size increases, with costs typically in the region of £200,000-400,000 per MWh of capacity, depending on scale and battery technology. Units typically come in self-contained 'modular units', which means that capacity can be increased with relative east, with additional units being delivered and integrated into existing facilities if required. Each MW unit is approximately the size of a shipping container. The capacity of upstream grid infrastructure (e.g. substations, incoming cables, etc.) needs to be assessed and potentially upgraded in order to facilitate connection.

It is recommended that the Authorities note the development of large-scale battery systems, and engage with Western Power Distribution regarding applications for new batteries in Staffordshire.

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[101] www.solarpowerportal.co.uk/blogs/uk_battery_storage_market_reaches_1gw_landmark_as_new_applications_continue
[102] https://www.gov.uk/government/news/battery-storage-boost-to-power-greener-electricity-grid
[103] https://www.solarpowerportal.co.uk/news/uks_largest_council_owned_battery_storage_site_further_expanded_to_30mw
[104] Solar Trade Association, 'Leading Lights: How local authorities are making solar and energy storage work today ' (2017). Available at: https://www.solar-trade.org.uk/wp-content/uploads/2018/04/local-authority-solar-guide-WEB.pdf

4.1.5. Policy Recommendations

4.1.5.1. Require All New Developments to Maximise Opportunities for Renewable Energy

A key step in being able to achieve Net Zero emissions across Staffordshire will be its ability to satisfy its heating, cooling and electricity needs through the use of renewable energy. In order to do this, it will be critical to increase the amount of decentralised and renewable energy technologies (such as those listed in Section 4.1) within the County. Providing on-site and decentralised energy systems can help to improve the resilience of the energy network and decrease pressures on grid infrastructure.

The design and layout of new developments, and in particular the geometry and orientation of a building, can have a significant impact on the potential amount of renewable energy that can be generated on development sites. Furthermore, existing developments are often subject to structural constraints which limit the potential for the building to accommodate additional structural loadings, space for new plant rooms, and so on. New developments are less constrained than existing buildings in these regards, so it is important for developers to maximise opportunities to incorporate these technologies where possible.

Potential policy options include:

- Requiring all new developments to demonstrate how the layout, orientation and massing has been designed to maximise opportunities for on-site renewable and low carbon technologies, e.g. through an Energy Statement.
- Requiring all developments to include some form of onsite renewable electricity or heat generation and / or battery systems, but without setting a specific target for the provision of renewable electricity.
- Setting a minimum target for the proportion of energy demands that should be met with renewables. This is likely to depend on the type of development in question. If renewables cannot be accommodated onsite, developers should contribute towards a Carbon Offset Fund (see Section 3.1.1.6); however, in order to encourage developers to install renewables onsite, it is important to ensure that the cost of paying into such a fund is not cheaper than installing renewables onsite.

4.1.5.2. Increase Support for LZC Energy Developments that Meet Local Criteria for Acceptability, and Seek to Broaden those Criteria

The NPPF states that, in order to help increase the use and supply of renewable and low carbon energy, local planning authorities should, amongst other topics, *'consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources.'* Evidence from this study, along with previous renewable energy studies for Staffordshire and the West Midlands (see Section 4.1.1), should be used to update local policies, including those that relate to wind energy and biomass.

Local Authorities should review existing policies that encourage the use of biomass and consider adding clarity regarding the impacts that this can have on issues such as air quality impacts and sustainable sourcing. Future policy wording should emphasise the preference for use of efficient heating technologies powered by renewable electricity.

In order to support large scale wind energy development, while giving due consideration to local conditions and the requirements of HCWS42, Local Authorities have several options:

1. Designate the entire area as being 'strategically suitable' for wind energy;
2. As above, but create exceptions for specific areas or sites;
3. Designate specific sites for wind energy development;
4. Do not designate specific sites, leaving this to the Neighbourhood Planning process; or
5. Do not designate specific sites and clarify that wind is not suitable.

Recognising the need to deliver a step change in large-scale LZC deployment, the recommended approach would be to select Option 1 while also providing local criteria for acceptability.

Example policy wording:

<u>Wyre Local Plan (2019) Policy EP12: Renewable Energy</u>

The Wyre Local Plan indicates that the entire area is strategically suitable for wind energy development.

> *The development of renewable or sustainable energy schemes, including, but not limited to, district heating, biomass, hydroelectricity, solar, ground source heat, will be supported subject to the Core Development Management Policies, taking into account the cumulative impact of the proposed development along with other planned, committed or completed development.*
>
> *The Council will support in principle the development of a tidal energy scheme across the River Wyre at Fleetwood subject to the Core Development Management Policies.*
>
> *<u>In relation to wind proposals, the whole Borough is designated as an area of search suitable for wind energy development.</u>* [Emphasis added]

The supporting text in paragraph 8.12.2 states:

> *Policy EP12 supports in principle renewable energy schemes and sets out the criteria for considering wind and solar energy proposals. Evidence shows that there is no differentiation within the Borough on the suitability for wind energy and thus Policy EP12 designates the whole of the Borough as an area of search.*

4.1.5.3. Encourage the Development of Heat Networks where Appropriate

The delivery and expansion of heat networks relies upon the connectivity of potential heat loads. A previous study identified several potential opportunity areas in the GBS LEP region[105] but in general, suitable developments will be those of mixed usage types and those with a sufficiently high density of heat demand.[106] New development can facilitate the creation of heat networks if buildings are designed to connect to an existing network or with the ability to connect to it in the future.

Example policy wording:

Major developments will be required to consider including a heat network or incorporate the necessary infrastructure to enable future connection, where feasible.

[Note: 'Major development' is understood to be defined in line with the Town and Country Planning (Development Management Procedure) (England) Order 2015 which includes residential developments of 10 or more dwellings, non-residential developments with floorspace of 1,000 m^2 and above and sites with an area of 1 hectare or more.]

For commercial buildings, the costs associated with ensuring designs can facilitate their connection to a heat network in the future should be no greater than the alternative approach. Design considerations are likely to include the location of the plant room, the provision of space within the plant room for a heat exchanger, provision of capped off connections to the flow and return pipework, lower temperature heating systems and the choice of control systems. For residential buildings, there could be additional costs associated with the communal heating network within blocks of flats if compared to individual heating systems.

4.1.5.4. Seek to Ensure a Collective, Flexible Policy Approach

As discussed in Section 4.1.3, due to the unique geographies and resources within each Local Authority, decreasing CO_2 emissions by supplying local renewable energy will be easier for some Authorities than for others. Although in practice it is likely that different types and sizes of LZC installations would be delivered in each Borough/District, in order to deliver the scale of change that is required, it would be beneficial if adjacent Local Authorities were to set similar criteria for acceptability where possible. When planning for additional large-scale renewables, Local

[105] Includes Cannock Chase, Lichfield, East Staffordshire, and Tamworth.
[106] A common rule of thumb is that Combined Heat and Power (CHP) DHN schemes are likely to be economically feasible for developments above 50 dwellings per hectare. See, for example, Energy Saving Trust (2014) *CE299: The applicability of district heating for new dwellings.*

Authorities should consider the need to meet energy demands within their own Borough/District as well as other neighbouring Boroughs/District.

4.1.6. Other Intervention Options

In addition to updating Local Plan policies related to LZC provision, there are several ways that Councils could facilitate LZC uptake. These include:

- Councils should review the Permitted Development rights regarding PV and other renewable technologies to assess whether restrictions can be loosened without compromising broader policy aims / requirements.
  - For smaller-scale or building-integrated installations, consider removing the need for a full planning application e.g. offering a self-certification route.
  - For larger-scale or standalone installations, consider issuing Local Development Orders (LDOs) that would extend permitted development rights for certain LZC technologies and / or certain sites, removing the need for a full planning application. This is the approach that has been taken by Swindon Borough Council (see case study below).[107]
- Work with community groups to deliver local energy projects e.g. on schools and public buildings.
- Partner with organisations to deliver awareness and training related to LZC technologies.
- Review any local fuel poverty initiatives or subsidy schemes, particularly those aimed at replacing gas boilers, to ensure that these offer solutions that are compatible with the Net Zero target.
- Issue a 'call for sites' for large-scale LZCs as for other development sites.
- Undertake surveys to better understand opportunities to incorporate LZCs within existing built infrastructure, such as PV or wind turbines on industrial sites and car parks.

Case Study: Local Development Orders in Swindon[108]

Swindon Borough Council has taken a leading approach in delivering large-scale PV and battery storage projects, including for example a 5 MW PV farm on a former landfill site. Commenting on the project, the Solar Trade Association states that,

'The project was aided by Swindon's use of a Local Development Order (LDO) which accelerated the planning process for solar farms. The LDO involved a call for all sites with the potential to host large scale solar installations in the Borough. Thus Swindon Council had a basis for assessing the impacts of development strategically, whilst enabling meaningful conversations with the local Distribution Network Operator (SSE) on wider grid capacity in Swindon.'

- Solar Trade Association, *'Leading Lights: How local authorities are making solar and energy storage work today' (2017).*

Image source: https://www.solarpowerportal.co.uk

[107] https://www.swindon.gov.uk/info/20113/local_plan_and_planning_policy/648/local_development_orders/2

[108] For more information, see https://www.solar-trade.org.uk/wp-content/uploads/2018/04/local-authority-solar-guide-WEB.pdf

4.2. Carbon Sequestration & Natural Capital

4.2.1. Carbon Benefits of Natural Capital for Achieving Net Zero

The UK's Natural Capital Committee defines natural capital as "those elements of the natural environment which provide valuable goods and services to people, such as the stock of forests, water, land, minerals and oceans".[109]

The natural environment is vital in facilitating climate change adaptation and mitigation and achieving net zero due to its capacity to take carbon out of the atmosphere through sequestration. Sequestration refers to removing CO_2 from the atmosphere by increasing biological uptake (vegetation pulls CO_2 from the atmosphere as it grows) or natural inorganic reactions. Healthy ecosystems (particularly forests, but also heathland, peatlands, wetlands and grasslands) sequester and store significant amounts of carbon in soils and vegetation, and are referred to as 'Natural Climate Solutions'. In fact, natural habitats represent the only 'negative emission' technology with a long track record of working at a large scale (Natural England, 2019). Enhancing, restoring and creating habitats to support the achievement of net zero ambitions is therefore recognised as a priority in the immediate term as it does not require new technology to implement, and there is a time lag between starting work (i.e. planting) and seeing carbon reduction (and other) benefits (Natural England, 2019).

However, in a report to Government, the Natural Capital Committee (2020) warns that a carbon / GHG-only 'siloed' approach risks trading off functioning ecosystems and habitats for carbon capture. For example, new forests can support biodiversity, provide opportunities for recreation and reduce flood risk, as well as supply timber or fuel. Natural habitats can deliver carbon sequestration while also achieving existing environmental objectives, such as assisting with nitrogen mitigation requirements for Special Areas of Conservation (SAC). Trees and other urban greening strategies can also help us to cope with the consequences of a warmer climate by providing shading in towns and cities and by reducing the amount of hard surfaces in urban settings, which can lead to urban heat island effects. Failure to recognise co-dependencies, benefits and costs in pursuit of a single objective may increase the likelihood of detrimental land use and agricultural policy (NCC, 2020).

Initiatives that aim to increase carbon sequestration therefore should not be untangled from the many environmental and social co-benefits they deliver. A large variety of environmental enhancement, restoration, creation, and conservation policies and activities will deliver increased sequestration and well-managed habitats, and high-quality habitats provide more ecosystem services (although management and quality are defined differently for different habitat types). To this end, we have summarised the link between common carbon-sequestration-centric nature-based actions, as identified for the UK Climate Change Committee (CCC) (Vivid Economics, 2020), and the wider ecosystem services and benefits they support. See Table 4.4 below.

Table 4.4: Actions to increase carbon sequestration and their associated ecosystem services/benefits

Action grouping	Carbon-based actions	Additional ecosystem services/benefits:
Forestry	New coniferous woodland planting New broadleaved woodland planting New management of existing broadleaved woodland	▪ Air quality regulation ▪ Biodiversity ▪ Climate regulation (local temperature) ▪ Fibre/timber ▪ Health and wellbeing ▪ Recreation
Peatlands	Restoration of upland peatland Restoration of lowland peatland Restoration of woodland to bog	▪ Biodiversity ▪ Climate regulation (local temperature) ▪ Flood control ▪ Health and wellbeing ▪ Recreation ▪ Water supply ▪ Water quality
Bioenergy	Miscanthus Short rotation coppice Short rotation forestry	▪ Biodiversity ▪ Disease and pest regulation ▪ Energy ▪ Fibre/timber ▪ Food ▪ Erosion control ▪ Soil regulation
Agroforestry	Silvoarable agroforestry	

[109] Natural Capital Committee, *'Economic valuation and its applications in natural capital management and the Government's 25 Year Environment Plan'* (2019). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/608850/ncc-natural-capital-valuation.pdf

	Silvopastoral agroforestry	▪ Air quality regulation ▪ Biodiversity ▪ Fibre ▪ Food ▪ Pollution control ▪ Soil regulation
	Hedgerow expansion	
Agricultural practices and technology (AP&T)	Controlled release fertilisers	▪Biodiversity ▪Disease and pest regulation ▪Fibre ▪Food ▪Pollution control ▪Soil regulation
	Measures to improve livestock health	
	Anaerobic digestion	

Note: Adapted from Vivid Economics (2020). Ecosystem services and benefits based on UKNEA classifications[110].

Note that this table is not exhaustive in describing all types of habitats present or actions appropriate within Staffordshire; further investigation of potential measures aimed at enhancing ecosystem services / benefits in Staffordshire is encouraged.

Of the action groups shown in Table 4.4, the following have been identified as the most relevant regarding carbon sequestration opportunities for Staffordshire:

- Forestry,
- Peatland (see Box 1), and
- Agroforestry.

Bioenergy is not assumed to form a key part of the sustainable energy strategy for Staffordshire going forward (as discussed in Section 4.1), and agricultural practices and technology actions have been excluded as they focus more on emissions reduction rather than sequestration. It should be noted however that small changes to agricultural practices can result in large reductions in avoided CO_2 emissions when applied over large areas. For example, small changes in the timing of manure applications may result in avoiding 0.25 tCO_2e emissions per hectare (CCC, 2015), and when spread across many hundreds of thousands of hectares of agricultural land, such as in Staffordshire, this can equate to many tens of thousands of tonnes avoided.

Box 1: Staffordshire peatland habitat

Staffordshire County has a substantial area of moorland habitat which includes a wide range of upland habitats such as peat-based blanket bogs, dwarf shrub heath on peaty or mineral soils, acid grassland, rush pastures and wet flushes. As such, it includes large areas of peatland, which are among the world's most carbon-rich ecosystems.

Peatlands provide a range of climate adaptation and mitigation services. In a natural condition, peatlands have a net cooling effect on climate, reduce flood risk, and support biodiversity. Healthy peatlands can reduce flood risk by slowing the flow of water from the uplands, and by providing floodplain storage in the lowlands. They also provide important nesting and feeding grounds for many wading birds, as well as important habitats for rare insects and plants.

Unfortunately, many peatland areas are in poor condition in England and are releasing carbon to the atmosphere (i.e. they are carbon sources). SCC therefore has a particular opportunity working to restore peatlands directly on the sites they own and manage, and can also advise other landowners on how to protect these vital habitats. Restored and healthy peatlands can then act as carbon sinks.

Image: Wikimedia Commons

This review has identified three broad options for increased carbon sequestration to support Staffordshire's decarbonisation targets, as follows:

[110] For more information see: http://uknea.unep-wcmc.org/EcosystemAssessmentConcepts...

- **Increasing carbon sequestration on Council-owned land** – This land could be managed to offset carbon (e.g. through tree planting, soil carbon management), and can include: areas of greenspace including parks and gardens; linear parcels and green infrastructure such as verges and green spaces alongside roads; and the 'greening' of grey infrastructure in urban settings. It is noted that the County Council own significant quantities of land.

- **Secure carbon sequestration through tree planting via accredited UK offset schemes** – Working through a partnership with schemes such as those run by the Woodland Carbon Code (WCC) and the Woodland Trust. The Councils could work to deliver planting through this scheme within the Staffordshire area, and therefore ensure that local residents could benefit from the wider ecosystem services and environmental benefits delivered.

- **Large-scale sequestration across public and private landholdings –** Local Authorities are well placed to drive and influence increased sequestration in their wider areas through the services they deliver, their role as community leaders and major employers, and their regulatory and strategic functions.[111] The development of emerging environmental policy within the UK also provides new opportunities for funding and large-scale landscape management cooperation between sectors, actors and beneficiaries.

The remainder of this section aims to assess the opportunities and potential magnitude of carbon sequestration associated with these broad options. First, a high-level view of the current delivery of carbon sequestration across Staffordshire is assessed, before focusing on estimating the potential to increase sequestration around each of these three broad opportunities, and finally summarising policy recommendations.

4.2.2. Current Carbon Sequestration by Natural Capital

In 2014, the value of existing carbon storage provided by Staffordshire's woodlands was estimated at around £1.5 billion and around £600 million for wetlands (Hölzinger and Everand, 2014). While this does not represent the amount sequestered per year, the maintenance of biocarbon stocks held within natural assets such as soils has been recognised as just as, if not more, important than creating new stocks of biocarbon (Natural Capital Committee, 2020). It is therefore important to consider the impacts on both.

Carbon sequestration opportunities are likely to differ based on the relative breakdown of existing habitats and land types. Local Authorities comprising of mostly urban areas will have a different set of options for sequestering carbon, for example through enhancing urban greenspaces or undertaking street tree planting, compared with largely agricultural or rural areas, which might have larger or more varied habitat creation options available. This is discussed in more detail in the following subsections.

In order to provide a better understanding of the existing habitats and high-level view of current sequestration across each Local Authority, the University of Exeter's Natural Environment Valuation Online (NEVO) Tool[112] was used. Land was classified into the following types: agricultural land; semi-natural grassland; urban; water; and woodland.

As shown in Figure 4-8 below, the relative breakdown of each habitat differs in each Local Authority, however agricultural and urban areas comprise the largest relative areas by percentage.

[111] Centre for Sustainable Energy (2019). West of England Carbon Reduction Requirement Study - Carbon Offsetting in the West of England, report to West of England Authorities. Available at: https://www.bristol.gov.uk/documents/...
[112] Natural Environment Valuation Online (NEVO) tool is a web-based GIS tool backed by Defra. The tool comprises over 60 different mapping layers which hold information about accessible natural spaces within England and Wales. This tool can be used to estimate the different types of habitat within each Local Authority. Available at: www.leep.exeter.ac.uk/nevo

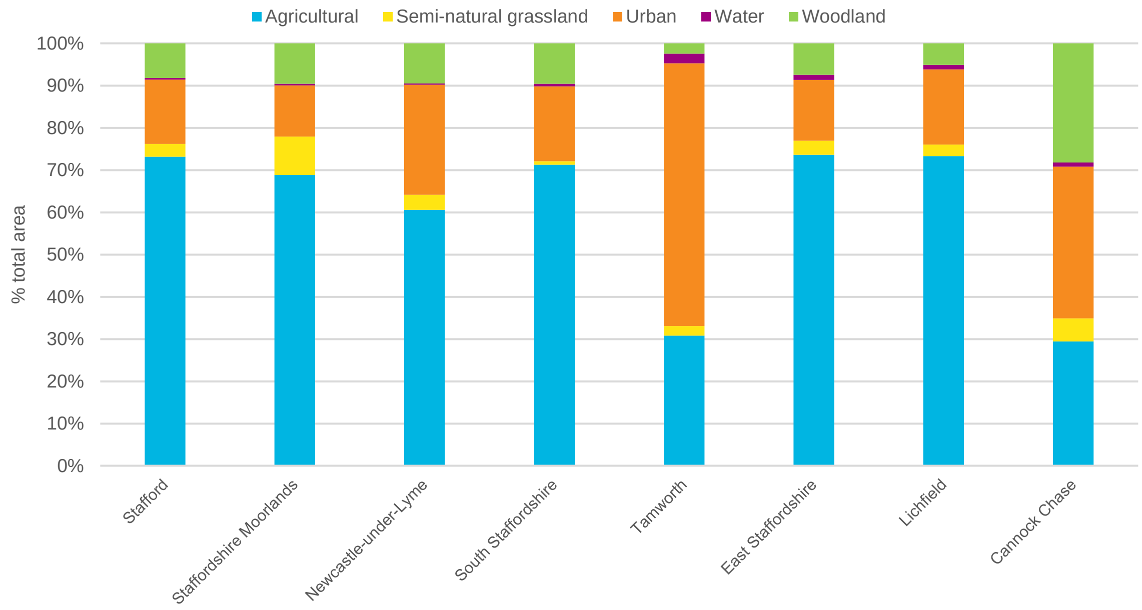


Figure 4-8: Habitat types by area, as a proportion of total area by Local Authority

Applying sequestration rates from literature to the area of each habitat, presented in Table 4.5 below, we are able to explore the potential volume of carbon sequestered in tonnes of CO_2 equivalent per year by habitat type. Note that these quantities are annual rates of sequestration, not the total carbon store, which is the cumulative effect of sequestration over many years. Note also that these figures do not align with the BEIS CO_2 statistics presented in the Baseline Report, since the BEIS figures do not include a Land use and Land Use Change & Forestry (LULUCF) category.

There are a number of assumptions and caveats that should be noted in undertaking this exercise. As shown in Table 4.5, due in large part to detailed spatial habitat data, these broad habitats do not encompass the full range of habitats across Staffordshire that contribute to carbon sequestration. For example, wetland and heathland can also sequester significant amounts of carbon, however data for these habitat breakdowns was limited. In addition, the rate at which different habitats sequester or emit carbon can differ greatly, while sequestration rates of different vegetation species within different broad habitats can also differ (for example different tree species of different ages can sequester more or less than others, and location and management regimes can also influence sequestration). Using one sequestration rate across broad habitats necessitates averaging across each of these factors, and estimates should be taken as indicative. Undertaking this high-level assessment can however provide useful insights into the potential magnitude of sequestration that is currently taking place, and can highlight important geographic areas and opportunities.

Table 4.5: CO_2 sequestration (-) and emissions (-) by habitat type

Broad habitat	tCO_2e/ha p.a.	Source
Agricultural	0.11	Thompson (2008) as referenced in Natural England (2012) - general arable land.
Semi-natural grassland	-0.40	Christie et al. 2010
Urban	-	n/a
Water	-	n/a
Woodland	-6.57	Woodland Carbon Code (2020) - averaged across all species, spacing, yield classes, 100 years.

The results of this assessment, showing the current rate of sequestration that is occurring across each Local Authority, are presented in Figure 4-9 below. Note that negative values represent carbon being sequestered (taken out of the atmosphere) and positive value represent carbon being emitted (released into the atmosphere). As expected, woodland habitats are responsible for the majority of sequestration. Interestingly, orders of magnitude start to emerge – woodlands across Staffordshire Moorlands and Stafford are estimated to sequester over 30,000 tonnes of carbon equivalent per year. This estimate confirms that the quantum of CO_2 that can be sequestered each year is significantly less than the net annual emissions (see Section 2).

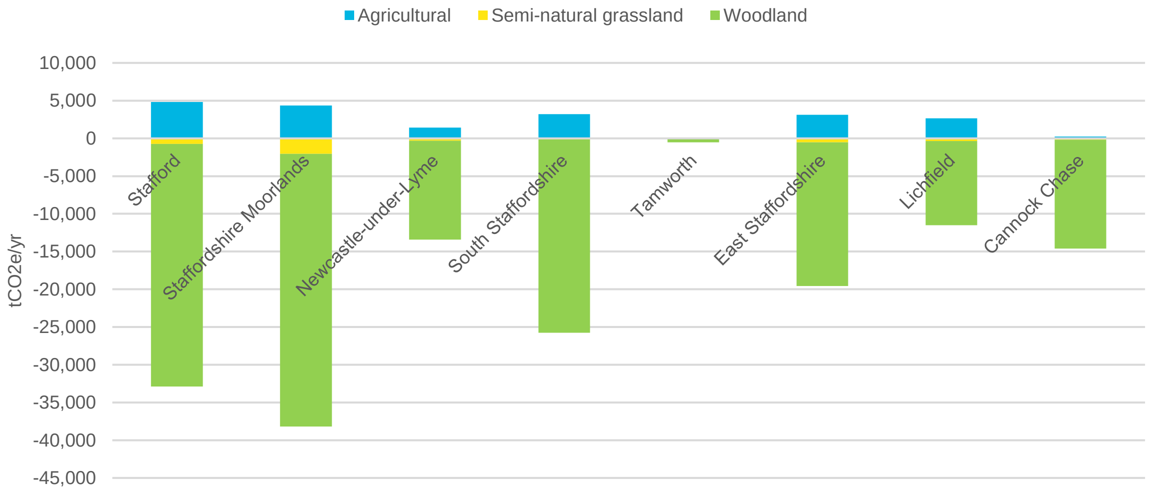


Figure 4-9: Total estimated CO_2 sequestration (-) and emissions (-) by habitat type, current land use

We have also estimated the current annual CO_2 sequestration potential of SCC landholdings, again by applying appropriate habitat specific carbon sequestration factors. The habitat area breakdown of the sites was estimated using National Forest Inventory and Agricultural Land Classification spatial GIS data (shown in Figure 4-10 below) and the carbon sequestration factors were then multiplied by the total area of each habitat. It should be noted that it was only possible to identify habitats on around 70% of SCC landholdings.

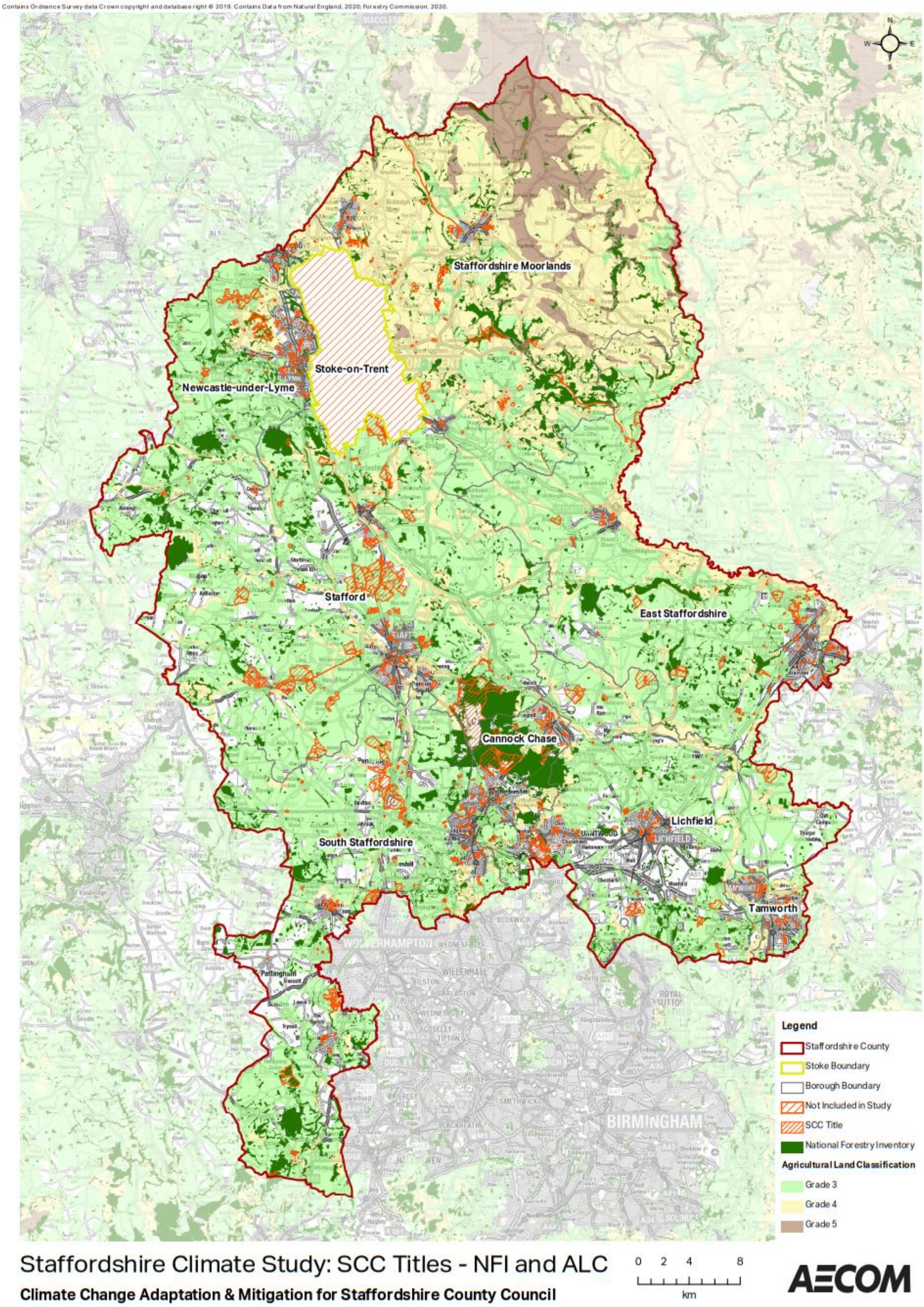


Figure 4-10. SCC landholdings overlapped with the National Forest Inventory and Agricultural Land Class

The total rate of carbon sequestration per year by SCC-owned land was estimated to be c.9,365 tCO_2e (i.e. this amount of CO_2 is removed from the atmosphere each year). As discussed previously, it should be noted that applying an average sequestration rate to large areas of woodland does not allow for differences in the sequestration rate that can be achieved by specific species, woodland management regimes or woodland age. For example, mature woodland sequesters carbon at slower rates compared to new growth woodland, which might be a particularly important consideration for some areas more than others. This approach does however give us useful insights for exploring sequestration potential in more detail. See Table 4.6 for a breakdown of carbon sequestration by Local Authority and land use.

Table 4.6: Estimated CO_2 sequestered (-) or emitted (+) by SCC landholdings from current land use

Local Authority	Area of SCC sites (Ha)	Estimated sequestration (tCO_{2e}/yr)
Cannock Chase	**503**	**-2,554**
Grade 3	63	7
Grade 4	32	4
Grassland	18	-7
Woodland	389	-2,557
East Staffordshire	**486**	**-163**
Grade 3	412	45
Grade 4	41	5
Woodland	32	-213
Lichfield	**634**	**-220**
Grade 3	563	62
Grade 4	27	3
Woodland	43	-285
Newcastle-under-Lyme	**543**	**-699**
Bare area	6	0
Grade 3	234	26
Grade 4	188	21
Grassland	1	0
Woodland	113	-745
South Staffordshire	**1,179**	**-1,234**
Bare area	2	0
Grade 3	875	96
Grade 4	98	11
Woodland	204	-1,341
Stafford	**2,916**	**-3,242**
Bare area	2	0
Grade 3	2,189	241
Grade 4	122	13
Grade 5	38	4
Grassland	35	-14
Woodland	531	-3,486
Staffordshire Moorlands	**722**	**-1,252**
Grade 3	70	8
Grade 4	412	45
Grade 5	39	4
Grassland	2	-1
Woodland	199	-1,309
Tamworth	**8**	**-1**
Grade 3	5	1
Grade 4	3	0
Woodland	0	-2
Grand Total	**6,990**	**-9,365**

4.2.3. Natural Capital Carbon Sequestration Opportunities

This section provides more detail on the three broad options identified in Section 4.2.1 for increasing the rate of carbon sequestration in Staffordshire to support the achievement of Net Zero emissions.

4.2.3.1. Increasing Carbon Sequestration on SCC's Landholdings

In order to explore the particular opportunities which might exist within the Local Authorities, we have assessed SCC's current landholdings in more detail. (The focus here is on SCC landholdings because data was available regarding all of its landholdings; however, the broader insights and recommendations are relevant to other Councils, should they also have significant landholdings across similar usage types.) This includes a high-level analysis of SCC land parcels, their current land use or habitat type, and their potential capacity for increasing carbon sequestration for example through increased tree planting and habitat restoration. This exercise is intended to provide useful insights into the magnitude of sequestration that might be achievable, and the scale of land use changes that would be needed to make a meaningful impact on CO_2 emissions.

Actions to look at the opportunities across the SCC's own holdings would not only improve the subregion's carbon impact but would also demonstrate leadership and commitment to achieving Net Zero. Securing carbon sequestration improvements across the areas where SCC and Local Authorities have significant influence could bolster the wider leadership role of Local Authorities in addressing climate change.

An analysis was undertaken to assess the potential increase in carbon sequestration that could be achieved if varying amounts of agricultural land classes (ALC) Grade 3, 4, and 5 that are under SCC ownership were to be replaced with woodland. Please see Table 4.7 overleaf. As shown, the net average annual increase in sequestration ranges from around 7 to 29 $ktCO_2e$ p.a. across SCC's landholdings in Staffordshire. While this is a relatively low value compared to annual baseline emissions (5,407 $ktCO_2e$ for Scopes 1, 2), it is comparable to some of the estimated CO_2 emissions identified by sectors and fuel types in the baseline study – for example petrol and diesel emissions from the rail sector contribute around 27 $ktCO_2e$ p.a. Furthermore, the impacts of this increased sequestration over 100 years is significant – between 700 and 3,000 $ktCO_2e$.

The analysis highlights the limited opportunities on SCC's estate in certain Boroughs and Districts. For example, there is very few opportunities for sequestration on SCC-landownership in Tamworth. Although there are expected to be further opportunities on land that is under different ownership, this does highlight the challenges associated with sequestering carbon in highly urban landscapes (such as those in Tamworth). It is recommended that further investigations are undertaken to assess the full extent of sequestration opportunities in all Boroughs/Districts, and that these analyses consider the opportunities and constraints relevant to the local environment.

It is important to note that although this analysis explores the potential impact that widespread woodland creation can have on SCC holdings, there are wider opportunities available to Local Authorities to increase sequestration on their land. This can be achieved by simple measures such as reducing grass-cutting frequency, or planting hedgerows. Where Local Authorities own designated sites (e.g. SSSIs, SACs) these could be managed to improve their carbon sequestration, biodiversity quality and nature conservation through changes in management.

Agroforestry (or the integration of trees and/or shrubs on cropland and grassland) could also be promoted on agricultural land rented by Local Authorities. Benefits of agroforestry include the enhanced capacity to sequester carbon, as well as improving water quality (by reducing the amount of nitrate that leaches into water courses), improving soil structure and fertility from litter fall, and by enhancing biodiversity. However, a report by the CCC (2018) found that the take-up of agroforestry in the UK has been extremely low with incentives lacking, particularly in England. There are no official estimates of the amount of land used for agroforestry practices in the UK, but the report does go on to estimate that agroforestry may account for around only 1% of UK agricultural land.

Although governments in England and Scotland are now looking to encourage farmers to plant more trees (as set out in their respective reports, the Clean Growth Strategy and the Climate Change Plan), there is no specific planting target for agroforestry. The CCC (2018) however identified that 5-10% of agricultural land area could be used for agroforestry by 2050. If we apply this proportion to the estimated 3,440 hectares (8,500 acres) of farmland that Staffordshire County Council own[113], between 172 and 344 hectares of agricultural land could be used for agroforestry practices. It is estimated that this could sequester around 1,100 – 2,200 tonnes of CO_2 per year while still allowing for agricultural production. If agroforestry increases within the same range across the County's 180,000

[113] As reported on Staffordshire County Council's website here: https://www.staffordshire.gov.uk/Business/Farms/farms-overview.aspx

hectares of agricultural land, this would increase tree cover by between 9,000 and 18,000 hectares, with the potential to sequester between 59 and 119 ktCO_2e per year. This is a substantial amount.

Local Authorities also have responsibilities for managing parks, public gardens and other green spaces. This includes SACs as designated under the Conservation of Habitats and Species Regulations 2017.[114] The objective of the Habitats Directive is to protect biodiversity through the conservation of natural habitats and species of wild fauna and flora. It defines the rules for the protection, management and exploitation of such habitats and species.

According to the Joint Nature Conservation Committee[115] (JNCC), in Staffordshire most SACs include moorland, heathland, bog, and grassland meadow habitat with a few including areas of ancient woodland. The continued enhancement of these areas can both enhance carbon sequestration while supporting the primary objective of SAC management to achieve the Favourable Conservation Status (FCS) of protected habitats and species. Local Authorities can use these existing functions to improve the carbon sequestration and ecological resilience of SACs and other green spaces they manage by restoring moorland and heathland habitats, planting trees and plants suitable to a changing climate. Local authorities also have the power to designate land in their ownership as Local Nature Reserves in recognition of their importance for wildlife and to local communities, helping to preserve, to some extent, sequestration and other benefits delivered by these areas.

[114] Available online: https://www.legislation.gov.uk/uksi/....
[115] JNCC (2019). UK Protected Area Datasets for Download.

Table 4.7: Assessing CO_2 sequestration potential of converting SCC landholdings to woodland

	Bare area + ALC Grade 3,4,5	% of area conversion to woodland				Carbon sequestration potential – conversion to woodland (net average annual tCO_{2e}/yr)				Carbon sequestration potential – conversion to woodland (net total tCO_{2e} over 100 years)			
Local Authority	**Area (Ha)**	**25%**	**50%**	**75%**	**100%**	**25%**	**50%**	**75%**	**100%**	**25%**	**50%**	**75%**	**100%**
Cannock Chase	95	24	48	71	95	125	250	375	500	12,499	24,998	37,498	49,997
East Staffordshire	454	113	227	340	454	595	1,191	1,786	2,382	59,545	119,090	178,635	238,180
Lichfield	590	148	295	443	590	775	1,549	2,324	3,099	77,469	154,937	232,406	309,874
Newcastle-under-Lyme	428	107	214	321	428	562	1,125	1,687	2,249	56,230	112,460	168,690	224,920
South Staffordshire	974	244	487	731	974	1,279	2,558	3,838	5,117	127,919	255,837	383,756	511,674
Stafford	2,350	588	1,175	1,763	2,350	3,085	6,170	9,256	12,341	308,518	617,035	925,553	1,234,070
Staffordshire Moorlands	521	130	260	391	521	684	1,367	2,051	2,735	68,366	136,732	205,097	273,463
Tamworth	8	2	4	6	8	11	21	32	42	1,055	2,111	3,166	4,222
Staffordshire	**5,673**	**1,378**	**2,756**	**4,135**	**5,513**	**7,237**	**14,473**	**21,710**	**28,947**	**723,673**	**1,447,346**	**2,171,019**	**2,894,692**

4.2.3.2. Secure Carbon Sequestration through Tree Planting via Accredited UK Offset

A commonly used and effective way for organisations to lessen the impact of GHGs emissions is through the purchase of carbon credits, a tradeable certificate that guarantees the sequestration of one tonne of carbon dioxide or other GHGs. Carbon credits can be purchased and traded on international markets or locally through voluntary schemes that align with local standards. Two schemes of note in the UK are the Woodland Carbon Code (WCC) and the Peatland Carbon Code.

The WCC is the UK Government's forestry carbon offset standard, which maintains the standard and verification of carbon credits available from projects that create, restore and maintain forests. The WCC is concerned with accounting for the net sequestration of carbon within a woodland site. It does not account for any avoided emissions that may result from any change in land use involved in creating the woodland, nor does it consider other possible co-benefits like biodiversity.

The Peatland Code, however, is primarily concerned with accounting for *avoided or reduced emissions from the previous land use*. It is also concerned with other possible ecosystem co-benefits deriving from restoration, such as water quality and biodiversity improvements. This difference essentially excludes peatland restoration as an option for increasing carbon sequestration opportunities, but moorland and peatland restoration should however remain an important component of a multi-pronged approach to Staffordshire's climate adaptation strategy. This is especially the case as once peatland is restored to pristine condition, it is likely to achieve net carbon sequestration.

Local Authorities could engage with the WCC by diverting developer funds to selected WCC projects, or by purchasing carbon credits through the WCC directly. There is also the potential for Authorities to set up their own WCC projects, although some work would be needed to ensure that it does not result in a conflict of interest (e.g. whereby a council is planting trees and purchasing their own credits) or do not result in the double-counting of carbon credit sales.

There are two WCC verified carbon offsetting schemes within the Staffordshire sub-region, located at Yoxall and Alrewas. Both of these are woodland restoration projects, and are run by Forest Carbon, and more detail is provided in Table 4.8 below. With both projects expect to produce 2,810 and 880 credits respectively over the projects' duration, for a total of 3,690 credits, purchasing all credits would cost around £38,000. The relatively small scale and low number of projects within Staffordshire highlights the necessity for any large-scale offsetting needed to be purchased elsewhere, as well as the need for incentivising the uptake of accredited schemes across Staffordshire.

Table 4.8: Summary of WCC verified carbon offset projects in Staffordshire County

Location	Project	Credits available	Price per credit
Yoxall	The woodland at Yoxall is on a National Forest owned site, at Woodmill, near Yoxall. The woodland, around 8 hectares in size, was established to offer public amenity, enhance the landscape and foster biodiversity. It is managed by thinning to achieve continuous cover. The woodland is an example of a Lowland Mixed Deciduous Woodland – one of the UK Post-2010 Biodiversity Framework Priority Habitats.	Estimated credits produced over project's duration: 2,810	£10.20
Alrewas	Montgomery Wood is a public access permanent native woodland situated between the A38 and the River Trent just north of Alrewas. The woodland, around 1.8 hectares in size, is the product of a partnership between Kier Living's Greener Living programme, Forest Carbon and The National Forest. The woodland has been planted for carbon capture, wildlife habitat and as part of the tow path walk from the nearby village.	Estimated credits produced over project's duration: 880	£10.20

Note: The price per credit can vary by project and the volume of credits purchased (i.e. discounts exist for large purchases).

4.2.3.3. Large-Scale Sequestration across Public and Private Land Holdings

Existing and emerging policy requirements which involve strategic, large-scale environmental planning and interventions for biodiversity and conservation can also help to support increasing carbon sequestration across the subregion. This is because, as discussed previously, carbon sequestration is a likely co-benefit of a large number of nature and conservation-based actions. For example, Local Nature Recovery mapping and planning, when used to address conditions of the National Planning Policy Framework 2019[116] to promote the conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species, can also be used to identify and highlight opportunities for securing measurable gains in carbon sequestration. It is noted that LNR mapping is being led by Staffordshire Wildlife Trust, and many Councils are taking this forward through their Local Plans.

The opportunities around existing and emerging policies that hold the most potential to increase sequestration through targeted, strategic restoration and enhancement activities, and implications for local policy development, are discussed below.

Carbon offset funds

As discussed in Section 3, carbon offset funds or carbon offset schemes, can be used to fund off-site carbon abatement where zero carbon development cannot be achieved on-site.

A recent literature review and survey by the Centre for Sustainable Energy (2019) details the potential for these funds to deliver social and environmental benefits and support the local economy, as well as deliver carbon reductions, and the potential of the fund to help deliver existing wider corporate priorities. The review found that carbon offsetting is possible within current planning legislation and guidance, has been used successfully elsewhere, can enable innovation and has been found to be feasible for a group of Local Authorities (West of England authorities) to implement.

The review also found that tree planting has been identified as a carbon offset measure in some of the existing carbon offset schemes identified. It finds that it would be possible to provide a route to secure carbon sequestration through tree planting via a WCC accredited UK offset scheme (such as those presented in Table 4.8), however it is not clear whether it would be possible to restrict planting through this scheme to within Staffordshire, and therefore ensure that local residents could benefit from the wider environmental benefits delivered. With further research and engagement with a specialist such as the Staffordshire Wildlife Trust (especially with regards to their Local Nature Recovery plans and existing networks across a wide range of landowners), Woodland Trust, the Tree Council, or Trees for Cities, it may be possible to address these issues. It may also be possible to identify carbon sequestration activities beyond tree planting (e.g. restoration of privately-owned peatlands) which could be included within approved carbon offset fund activities.

There could also be an overlap between the requirements to carry out tree planting to achieve carbon sequestration and landscaping required as an integral aspect of new development, so care should be taken to ensure 'additionality' and avoid double charging.[117] These issues might be resolved were tree planting to happen in a way that is clearly independent of and additional to the landscaping associated with a development, for instance in managed blocks and with an agreed management plan. Tree planting and other habitat creation/restoration measures could be considered for eligibility under Carbon Offset Funds by each Council according to their circumstances and views.

For context, Table 4.9 below shows indicative costs per tonne of CO_2 abated for a range of forestry options that could be carried out using carbon offsetting funds.[118] Note that costs and carbon savings vary considerably depending on the project in question, and costs also vary over time, with estimates highly sensitive to the carbon price and cost estimation methods used, so these figures are provided for information only.

Table 4.9: Estimated cost-effectiveness of woodland creation options

Woodland creation in England	Cost-effectiveness to 2200 (£/tCO_2e)
Short rotation forestry (SRF) for energy 15-year rotation	188 to 366
Short rotation forestry (SRF) for energy 25-year rotation	82 to 132
Farm woodland for mixed objectives	48 to 96
Broadleaf woodland for game and biodiversity	61 to 84

[116] See paragraphs 170 through 174 of National Planning Policy Framework (NPPF). Available at: https://assets.publishing.service.gov.uk/government/...
[117] Centre for Sustainable Energy (2019). West of England Carbon Reduction Requirement Study - Carbon Offsetting in the West of England, report to West of England Authorities. Available at: https://www.bristol.gov.uk/documents/...
[118] Adapted from *CJC Consulting (2014). Assessing the cost-effectiveness of woodlands in the abatement of carbon dioxide emissions* - as presented in Forestry Commission (2019). Comparing the costs-effectiveness of forestry options for climate change mitigation.

Broadleaf woodland for timber and carbon	140 to 245
Upland conifer for timber	27 to 33
Lowland conifer for timber	21 to 46
Continuous cover forestry for mixed objectives	50 to 88

Targeted, large-scale woodland creation can also be eligible for government funding, such as through the Woodland Carbon Fund[119], created to offer capital funding for the creation of new woodland for carbon sequestration, including forest roads and other recreational infrastructure. Because planned woodland is also green infrastructure, securing additional funding through new schemes can also allow SCC to bridge the large funding gap identified for its green infrastructure over the coming years.[120]

The future of Section 106 mechanisms which provide the foundation for existing carbon offset funds has however been called into question with the Government's recent publishing (6 August 2020) of their Planning White Paper[121]. This proposes an overhaul of the country's planning system with changes that would represent the most significant reform to housing policy in decades. (Please see Appendix A for further details on the potential impacts from the recent White Paper.) One of the significant changes proposed is that the current planning obligations under Section 106 should be consolidated under a reformed 'Infrastructure Levy'. In light of these proposed changes and uncertainty around what a future Infrastructure Levy would entail and how it would work as a potential mechanism for carbon adaptation and mitigation project funding, the viability of alternative funding mechanisms should be explored.

For example, one model that might be available is one based on the District Licensing Schemes such as the Great Crested Newt scheme which provides developers in the South Midlands an opportunity to speed up the planning application process and save money by choosing to pay into a great crested newt compensation fund, rather than going through the normal lengthy processes of newt surveys and mitigation. It shifts investment from site-based assessment and mitigation, into strategic habitat improvements, and is in the process of being expanded to Staffordshire and other counties. Further work could assess how a scheme based on this precedent could provide vital support and funding for energy efficiency, carbon adaptation and mitigation projects in absence of Section 106.

The Environment Bill – Biodiversity net gain and environmental net gain

Mandatory biodiversity net gain (BNG) and environmental net gain (ENG) as introduced in the Government's Environment Bill[122] provide enormous opportunity for large-scale funding for the creation and maintenance of habitats which can deliver increased carbon sequestration. Throughout this study, the documents reviewed highlighted the particular opportunities that achieving BNG and ENG will provide for Staffordshire in response to the planned works that will support the delivery of HS2.

Biodiversity encompasses the breadth of plant and animal species, the genetic diversity among those species and the different biomes and ecosystems that they are a part of. As such it is incredibly challenging to measure, and no single metric can fully summarise or quantify the many qualities, benefits and characteristics of biodiversity.

The concept of BNG can be summarised as "development that leaves biodiversity in a better state than before". Established BNG approaches use habitats as a proxy for biodiversity in a given area; this approach recognises that a mixture of connected high-quality habitats will support a wide range of plants, animals, fungi and microorganisms. By using habitats as a proxy measure, together with appropriate ecological advice, Local Planning Authorities and developers can more easily agree on the biodiversity losses or gains due to a development.

A key component of the BNG approach is the mitigation hierarchy (avoid, reduce, mitigate, compensate/offset) which ensures that a project seeks to first avoid losses in biodiversity, where possible. Development projects that adopt a BNG approach seek to minimize impacts on biodiversity and deliver improved biodiversity though habitat creation or enhancement.

[119] https://www.gov.uk/guidance/woodland-carbon-fund
[120] AECOM (2019). Staffordshire and Stoke-on-Trent Strategic Infrastructure Plan 2018-2038. Available at: http://moderngov.staffordshire.gov.uk/mgConvert2PDF.aspx?ID=130098
[121] MHCLG (2020). Planning for the future.
[122] https://deframedia.blog.gov.uk/2019/03/13/government-to-mandate-biodiversity-net-gain/

UK legislation requires public bodies to have regard to conserving biodiversity, and BNG is an established part of planning policy. The National Planning Policy Framework (NPPF) was revised in 2018 to make clear that planning should identify and pursue opportunities that secure measurable net gains for biodiversity. NPPF paragraph 170 states that planning policies and decisions should minimise impacts on and provide net gains for biodiversity; paragraph 174 requires plans to pursue opportunities for securing measurable net gains; paragraph 175 requires planning decisions to encourage biodiversity improvements in and around developments; and paragraph 118 states that the planning system should take opportunities to secure net environmental gains.

Defra undertook consultation in 2018 with respect to the concept of mandatory BNG within the planning system. Following this consultation, in the 2019 spring statement the Chancellor committed to making BNG mandatory as part of the forthcoming Environment Bill which is now set to be enacted in Autumn 2020. While the details of mandatory net gain policies are yet to be fully passed at the time of writing, legislation will require development to achieve a 10% net gain for biodiversity. Government will require net gain outcomes, through habitat creation or enhancement as part of delivering mandatory BNG, to be maintained for a minimum of 30 years, and will encourage longer term protection where this is acceptable to the landowner.

This legislation will contribute hugely to the growth of a vibrant and fluid market in habitat creation, and provide much needed funding for strategic habitat creation and maintenance across Staffordshire.

In addition, the Environment Bill introduces new duties to support better spatial planning for nature through the creation of Local Nature Recovery Strategies (LNRSs). The intention is that the whole of England will be covered by LNRSs with no gaps or overlaps. Each LNRS will include a statement of biodiversity priorities for the area and a local habitat map that identifies opportunities for recovering or enhancing biodiversity. National government will provide data, guidance and support but each LNRS will be produced locally, with a relevant public body appointed as the responsible authority by the Secretary of State.

The concept of ENG was first introduced within the Governments 25 Year Environment Plan, with reference to gains in natural capital assets. ENG builds on the concept of BNG, and is defined by Defra as ‘achieving environmental net gain means achieving biodiversity net gain first, and going further to achieve net increases in the capacity of affected natural capital to deliver ecosystem services’.

Net gains in biodiversity will result in wider natural capital or environmental net gains approach. Achieving BNG is therefore seen as a prerequisite first step to achieving ENG, which attempts to quantify the wider ecosystem services (such as carbon sequestration, flood alleviation, air quality improvement, and recreation) provided by habitats. Both approaches seek to ensure that a site is “left in a measurably better state” than it was pre-development. ENG incorporates social, economic, amenity, and biodiversity aspects, thereby capturing wider assets that contribute to the health and resilience of an ecosystem. Healthy ecological networks should be achieved using both approaches, but ENG is more closely linked to a natural capital approach than BNG.

With respect to achieving ENG within Staffordshire, there is no current tool to quantify net gains in ecosystem service provisions or natural capital. By the end of 2020, it is anticipated that Natural England will release the Eco-Metric tool, which incorporates natural capital assets and ecosystem services including carbon sequestration and storage, flood protection, water quality, air quality, erosion control, access to nature and pollination. This Eco-Metric tool will be a means to optimise the design of schemes, and test whether BNG delivers specific ecosystem services such as flood risk alleviation.

The Natural Capital Committee’s advice to government finds that the delivery of net zero will become incredibly difficult, if not impossible, without environmental net gain, as it is the only approach that considers the impact of development on ecosystems, including biocarbon stocks. Planning for infrastructure – including solar farms, wind turbines, buildings, railways and roads, all of which apply pressure on the natural environment and natural capital assets – should be fully joined up with any spatial planning for nature-based interventions. This will better ensure that natural capital is fully embedded in infrastructure decisions (Natural Capital Committee, 2020).

UK Government’s Environmental Land Management (ELM) Scheme

Staffordshire’s large area of agricultural land makes it particularly sensitive to changes in agricultural policy such as the large overhaul taking place as the UK leaves the European Union. Large-scale changes in agricultural practices therefore represent a key threat, both to carbon emissions as well as habitat and biodiversity loss, and opportunity for the subregion.

Agricultural land throughout Staffordshire represents an opportunity for implementing and driving land use change to support climate, as well as broader environmental, initiatives. While food and timber production are the key commercial outputs, the land management decisions made with respect to this area of land can have significant impacts on the natural environment and the provision of environmental public goods from which the whole country benefits.

Well considered land management decisions can support the provision of ecosystem services, such as thriving plants and wildlife; clean air; clean and plentiful water; protection from, and mitigation of, hazards such as flooding; a habitable climate; and beauty, heritage, and engagement with the natural environment. However, land management decisions can also pose significant threats to ecosystem service provisions, including greenhouse gas emissions and declining diversity of wild species.

Land management decisions undertaken in the agricultural sector are currently shaped by the incentives provided by the EU Common Agricultural Policy (CAP). Each year the UK receives around £3.3 billion in CAP funds – of which around 80% are distributed through Direct Payments to farmers under Pillar 1 of the CAP. The remaining 20% are spent on Pillar 2 programmes intended to support environmental outcomes, farm productivity, socio-economic objectives, and rural growth.

The Government is aiming to transform agricultural policy through enacting a new Agriculture Bill[123]. The cornerstone of the Bill is the Environmental Land Management (ELM) scheme which will provide public money to pay farmers and other land managers in England for the ecosystem services they deliver – providing a basis to achieve the goals set out in the 25 Year Environment Plan.

The aim of the new ELM scheme is to phase out Direct Payments (Pillar 1) and considerably expand and refine the mechanism underpinning Pillar 2 payments. If designed and implemented effectively, this scheme could provide an example for the rest of the world as to how improvements to natural capital can be delivered while supporting the agricultural sector and providing value for money to taxpayers. However, the transition will require a significant scaling-up of knowledge and resources across Government agencies, land managers, their advisors, and other stakeholders, and the implementation of the scheme could have significant impacts on a range of different stakeholders.

The 2020 Agriculture Bill designed by Defra confirms that actions to mitigate climate change will qualify for funding under the proposed ELM scheme. Payment rates (or funding) will be adjusted to incentivise activities that enhance the natural environment, rather than simply 'maintain' it (as per the CAP system), and weightings will be used to reflect local priorities. This would mean that farmers and agricultural land owners/managers would be paid for activities such as planting trees on agricultural land while maintaining their primary use ("agroforestry"), and restoring peat which would reduce peatland emissions, while allowing food production to continue on the most productive land.

Previously there was a lack of market incentives to individual landowners to implement climate adaptation and mitigation measures such as the creation of new woodland, the restoration of peatlands and the planting of bioenergy crops, even as a study commissioned by the UK CCC (Vivid Economics, 2020) found that these actions are most valuable to society, with social benefits far outweighing the costs of each hectare converted. The conversion of areas of the UK into woodlands requires substantial capital expenditure to buy land and plant trees. Peatlands also require significant upfront expenditure to undertake restoration activities. The substantial amount of public funding through ELMs can provide the financial support needed to deploy these options.

Aligning land use policy and financial support with the provision of valuable public goods is a significant opportunity to support livelihoods and improve the health and sustainability of land in the UK.

The ELM system aims to move away from 'payment for environmental actions', such as those under the Countryside Stewardship schemes, towards 'payment for environmental results' and could ultimately create a dynamic marketplace that can accommodate changes in the demand for and supply of ecosystem services and drive investment in the protection and enhancement of England's natural capital.

Defra's new ELMs scheme is currently in its 3-year piloting stage, however, AECOM's work helping to develop ELMs for Defra has found that, as it stands, there may be particular opportunities for SCC and Local Authorities to coordinate with land holders across the subregion around 'tier 3'[124]:

- **Tier 3:** focused on delivering landscape-scale land-use change projects, where such projects drive added value over and above what can be delivered through Tiers 1 and 2. This tier would coordinate projects that are critical in helping to meet environmental commitments such as net zero. It would be fully aligned

[123] https://services.parliament.uk/bills/2019-21/agriculture.html
[124] For more information, including details of all three Tiers, see: https://consult.defra.gov.uk/elm/elmpolicyconsultation/

with activity under the Government's Nature for Climate fund for afforestation and peatland restoration which Staffordshire could apply for once the fund is fully operational.

Supporting movement to the management of component land parcels as a network would provide opportunities for Local Authorities to drive the strategic delivery of a wide variety of environmental net gains, including carbon sequestration as well as linking to climate change pressures such as reducing flooding risks, improving air quality, regenerative agricultural practices, and health and wellbeing benefits for residents and visitors to the region.

Although Defra's ELM scheme is still in the pilot stage, AECOM's experience with both developing and trialling the new ELM scheme can provide support to navigate how best to strategise and capitalise on the opportunities that this new subsidy regime will provide for the sub-region.

4.2.4. Policy recommendations

A summary of key considerations for how local policies can be developed to increase carbon sequestration rates (specifically) across Staffordshire is provided overleaf. These have been broken down by Local Plan specific points and wider environmental policies / initiatives which Local Authorities can consider. They have been compiled based on the results of the analysis and from documents reviewed as part of this study, including the UK CCC's *Land Use Policies for a Net Zero UK* (2020) and Staffordshire Wildlife Trust's *State of Staffordshire's Nature* (2016) and other sources.

Local Plan	Wider environmental policies / initiatives
Increasing tree planting and afforestation rate – increasing forestry cover through the planting of broadleaf and conifer woodland each year, improving the yield class (productivity) of new trees, and increasing management of existing woodlands. The CCC Land Use Policies for Net Zero (2020) make a range of recommendations, including increasing UK forestry cover from 13% to at least 17% by 2050 by planting around 30,000 hectares of woodland each year. This follows a Government commitment in 2018 to plant 11 million trees by 2022 and an announcement of a Woodland Carbon Guarantee scheme in 2019, which aims to encourage tree planting and woodland creation.	**Better understanding and linking of environmental activities to carbon sequestration**, including accounting for changes in habitat extent (area) and condition, as well as measuring and monitoring the wider environmental benefits they deliver. For example, Appendix F provides detail on current actions outlined within green infrastructure and/or green space strategies for each Local Authority which also have the potential to improve and increase carbon sequestration. Making these links can help to outline opportunities to secure and protect carbon stocks whilst delivering wider environmental, social, and economic objectives.
Ensure ecological experts are involved in the writing of planning conditions relating to biodiversity and environmental net gain, habitat or protected species to ensure the conditions are appropriately worded. Where approved developments will involve the creation or management of habitats or species, regular monitoring must be carried out by developers. This requirement, and the submission of regular results to the Local Authority, should be written into planning conditions.	**Use opportunities through upcoming ELM schemes** and any targeting of the schemes to create and manage habitats.
Increasing agroforestry and extending the length of hedgerows with an aim to increase carbon sequestration by increasing the amount of permanent vegetation on agricultural land whilst maintaining agricultural production. Agroforestry can involve silvopastoral systems which integrate low density woodland with livestock grazing, or silvoarable systems which integrate narrow strips of economically valuable woodland within arable cropping.	**Use biodiversity net gain and environmental net gain opportunities** through planning to create new habitats. Biodiversity offsetting will be a major method of delivering new habitats once the Environment Bill is enacted.
	Developing creation and management plans for habitats that will explore how to maximise its benefits for people and wildlife through determining what species to plant and where planting should be targeted. Have a system in place to guide decisions around species, location and management. Well-managed habitats provide more ecosystem services, but 'well managed' is defined differently for different habitat types. In short, whilst the climate emergency serves to highlight the importance of habitat creation, and there is the potential for the Local Plan to support targeted afforestation and woodland creation through spatial strategy and site selection, there remains a need to balance competing objectives, and ultimately requires the provision of "the right habitat in the right place, for the right reasons".

Appendix G contains an overview of potential delivery and funding mechanisms that could be used to support the creation of new woodland.

5. Climate Risks

This section provides an overview of key climate risks impacting the existing built environment in Staffordshire, along with those that are relevant to proposed new development locations, with a particular focus on issues related to flooding and heat. The risks are first described (where possible, using GIS visualisation and quantitative analysis), with indicators then derived to help better outline the influence new development could have on climate risks and factors of vulnerability. Finally, a comprehensive set of interventions that can be used to inform potential policy measures are developed. This process builds on the information presented within the Baseline Report, which is summarised in Section 2.4 for reference.

In order to capture risks affecting the widest possible range of development typologies across Staffordshire, a three-step analysis has been undertaken to better understand climate risk and help inform potential interventions. These are:

- **Staffordshire-wide baseline (see Section 5.1)**: A regional and per local authority overview of current and future flood exposure (riverine and surface water), and current vulnerability to flooding and heat for Staffordshire as a whole.
- **Influencing Climate Risk (see Section 5.2):** A breakdown of future development sites into three typologies; Urban extension, Urban infill / replacement, New Settlement. This section provides a comparable template covering all anticipated site typologies within Staffordshire, demonstrating key climate risks and physical and environmental risk related indicators that future development opportunities may influence and be subject to.
- **Vulnerability Indicators (see Section 5.3):** An overview of socio-economic and physical and environmental indicators that could be considered in future development opportunities with regards to vulnerability to climate change.

5.1. Staffordshire-Wide Baseline

5.1.1. Flood Exposure

Flooding is the most frequent hazard (either fluvial or surface water) that is experienced in Staffordshire. In recognition of the importance and prevalence of this issue, potential measures aimed at mitigating flooding in Staffordshire have been investigated in a number of studies undertaken by different organisations. For example, the Staffordshire Wildlife Trust led an important national pilot project[125] that was funded by Defra and which aimed to understand how farming management practices can reduce flood risks downstream.

The exposure to flooding is therefore a key consideration in determining local government policy and more specifically the location of future development opportunities. This section summarises the findings of the flood exposure screening undertaken against the allocation areas provided by the following districts: East Staffordshire, Lichfield, Newcastle Under-Lyme, Stafford, Staffordshire Moorlands, South Staffordshire and Tamworth.[126] The names of shapefiles used in the analysis for each district are provided in Appendix H. This analysis will demonstrate the allocation areas that are currently, or will potentially be, exposed to surface and riverine flooding both currently and by 2100.

5.1.1.1. Approach

To identify the current and future extent to which local plan land allocations are exposed to fluvial, pluvial and surface water flooding, the following Environment Agency (EA) data was used:

[125] '*Farming Floodplains for the Future',* Staffordshire Wildlife Trust. Available at: https://www.staffs-wildlife.org.uk/sites/default/files/2018-12/Farming%20Floodplains%20for%20the%20Future%20Final%20Report.pdf
[126] The data analysed in the screening against flood exposure, is that which was available to and provided by the district councils for future development opportunities in shapefile format. This reflects the various stages of local plan review development across the district councils.

Table 5.1: Overview of data used for flood exposure analysis

Flood Zone	Definition
Flood Zone 3 (FZ3)[127]	This is the EA's best estimate of the areas of land at risk of flooding when the presence of flood defences are ignored and covers land with a 1 in 100 or greater (>1%) chance of flooding each year from Rivers; or with a 1 in 200 or greater (>0.5%) chance of flooding each year from the Sea. This includes an allowance for climate change.
Surface Water 1 in 100 (SW 1in100)[128]	This is the EA's best estimate of the areas of land at risk of surface water flooding with a 1% probability of a surface water flood occurring each year. This includes an allowance for climate change.
Flood Zone 2 (FZ2)[129]	This is the EA's best estimate of the areas of land at risk of flooding, when the presence of flood defences is ignored and covers land between Zone 3 and the extent of flooding from rivers or the sea with a 1 in 1000 (0.1%) chance of flooding each year. This includes an allowance for climate change.
Surface Water 1 in 1000 (SW1in1000)[130]	This is the EA's best estimate of the areas of land at risk of surface water flooding. 0.1% probability of a surface water flood occurring each year. This includes an allowance for climate change.

5.1.1.2. Findings

Flood Zones 2 & 3

The analysis shows that, of the 671 site allocations provided (covering 4,186 ha), 107 are located in FZ2, and 97 are located in FZ3. A total of 260 ha of future development land across Staffordshire is located in either Flood Zone 2 or Flood Zone 3. Table 5.2 shows the breakdown of sites by Council.

For all districts (with the exception of East Staffordshire), the area of the allocated sites that are in FZ3 is less than the area of allocated sites that are in FZ2.

Unless appropriate design considerations are adopted, development on these allocation sites across Staffordshire would expose a combined 109 ha of new development (across all Councils) to a 1% chance or greater of flooding in any given year and 155ha to a 0.1% of flooding in any given year.

Table 5.2: Total area of Allocations (ha), vs the area of allocation sites that is exposed to riverine flooding in both FZ2 and FZ3 for the districts, to some extent at any given time in any given year.

District Council	Number of Sites	Total Allocation Area (ha)	Area (ha) of allocation sites located in FZ2	Area (ha) of allocation sites located in to FZ3
East Staffordshire	21	694.16	15	19.09
Lichfield	6	330.36	5	3.78
Newcastle-Under Lyme	527	169.06	59.9	57.12
Stafford	25	528.76	31	8.07
Staffordshire Moorlands	41	163.07	1.04	0.96
Tamworth	31	154.61	36	14.56

[127] https://data.gov.uk/dataset/bed63fc1-dd26-4685-b143-2941088923b3/flood-map-for-planning-rivers-and-sea-flood-zone-3
[128] https://data.gov.uk/dataset/8b82987d-3616-4e46-8edb-2973e8b82ad7/risk-of-flooding-from-surface-water-extent-1-percent-annual-chance
[129] https://data.gov.uk/dataset/cf494c44-05cd-4060-a029-35937970c9c6/flood-map-for-planning-rivers-and-sea-flood-zone-2
[130] https://data.gov.uk/dataset/1f3d6e13-40f1-4d12-99de-77132bc19c47/risk-of-flooding-from-surface-water-extent-0-1-percent-annual-chance

Note: South Staffordshire is not presented in Table 5.2 as the shapefiles provided were dot points only and didn't provide area (ha), meaning the exposure analysis could not be undertaken.

Surface Water Flooding: 1 in 100 and 1 in 1000 year flood events

Surface water flooding has been analysed across two recurrence intervals; 1 in 100 year events and 1 in 1000 year events. Of the 4,186 ha of allocation land analysed for surface water, a total of 162 ha is seen to be exposed to the 1 in 100 recurrence interval, with 390 ha exposed to the 1 in 1000 recurrence interval. Table 5.3 shows the breakdown by Council.

Surface water flooding poses a significant risk to Staffordshire. It can affect individual homes and business, as well as infrastructure networks such as transport systems and utilities. Unlike fluvial flooding, surface water flooding occurs in less obvious locations, since it is not affected by the presence of an existing water body. It is therefore crucial that appropriate design measures aimed at helping to reduce the built environment's exposure to, and impact from, surface water flooding are adopted.

Table 5.3: Area (ha) of allocations sites exposed to 1 in 100 and 1 in 1000 surface water flood recurrence intervals across the districts in Staffordshire in any given year at any given time.

District Council	Number of Sites	Total Allocation Area (Ha)	Area of Allocation Sites exposed to 1 in 100	Area of allocation sites exposed to 1 in 1000
East Staffordshire	21	694.16	23.32	58.91
Lichfield	6	330.36	6.49	22.49
Newcastle-Under Lyme	527	169.06	4.38	10.43
Stafford	25	528.76	31.23	72.66
Staffordshire Moorlands	41	163.07	4.95	13.24
Tamworth	31	154.61	3.87	13.93

South Staffordshire is not presented in Table 5.3 as the shapefiles provided were dot points only and did not provide land areas (ha), meaning the exposure analysis could not be undertaken.

Maps which overlay Staffordshire's exposure to flooding and the sites allocated for potential development are provided in Appendix I.

5.1.2. Current Day Flood Vulnerability

5.1.2.1. Approach

The Neighbourhood Flood Vulnerability Index (NFVI), as developed by Sayers and Partners (2017) [131], provides insight into the social vulnerability of an area should it experience a flood event. The NFVI looks at the following characteristics of vulnerability:

- **Susceptibility -** the predisposition of an individual to experience a loss of well-being when exposed to a flood, based on age and health.
- **Ability to prepare** - the actions taken by an individual during normal conditions that are likely to reduce the harm they suffer when a future flood occurs, based on income, local knowledge and property tenure.
- **Ability to respond** - the underlying reasons why some individuals act more effectively in the run up to and during a flood, based on income, local knowledge, physical mobility and crime.

131 Sayers, P . B ., Horritt, M ., Penning Rowsell, E ., and Fieth, J . (2017). Present and future flood vulnerability, risk and disadvantage: A UK scale assessment. A report for the Joseph Rowntree Foundation published by Sayers and Partners LLP.

- **Ability to recover -** the degree to which an individual can aid their own recovery, based on income, and physical mobility.
- **Community support -** the availability and quality of services provided by health and emergency services as well as broader care and social services. This is based on housing characteristics, direct flood experience, service availability and social networks.

The NFVI index is broken down into seven scoring bands: Acute, Extremely high, Relatively high, Average, Relatively low, Extremely Low, and Slight.

5.1.2.2. Findings

According to the NFVI developed by Sayers and Partners (2017), the level of social vulnerability to flooding across Staffordshire as a whole is modest, with the majority of areas shown to have vulnerability scores either at a level consistent with the UK average, or at a Relatively Low level. The areas with a Relatively High to Acute vulnerability scores are predominantly focused in urban areas, including in Burton on Trent, Stafford, Newcastle-under-Lyme, Wimborne, Huntingdon, Lichfield and Tamworth. There are pockets of rural land however that demonstrate an Extremely Low level of vulnerability, such as those at Quarry Hill in Tamworth, Creswell Green in Lichfield, Hawks Green in Cannock Chase, Moreton in Stafford and Giggetty in South Staffordshire.

From a physical and environmental perspective, urban areas are more susceptible to flooding, as they contain areas of hard, impermeable surfaces which inhibit the natural drainage of surface water. The effect of this is to speed up the time it takes for rain water to form ponding on hardscape surface low-points or saturated softscape features, or to feed a water body such as a river or lake. The presence of green, natural surfaces and softscape features in an urban environment reduces this risk, by attenuating or slowing down the flow of rain water, as well as reducing the risk of ponding. The prevalence of hard impermeable surfaces therefore ultimately increases the risk of both surface water and fluvial flooding.

However, the NFVI predominantly focuses on the socio-economic drivers that affect vulnerability, and which therefore disproportionately enhance the impact of flooding on certain communities. For example, people in the lower income brackets are less able to recover from flood events, compared to those in the medium to high-income brackets. One of the reasons for this is that those in the lower-income brackets are more likely to be in a rental property or in a poor quality private home, with little influence or ability to fund the refurbishment required should any damage be incurred. They may also not be able to afford the appropriate insurance, or the cost of recovery and temporary shelter when required. Those areas that are subject to increased levels of vulnerability therefore reflect poorer, more isolated groups in society, which are more likely to be home to low-income workers, the elderly, the infirm and ethnic minority groups. By comparison, the areas that demonstrate a reduced level of social vulnerability to flooding are home to primarily middle to high-income, well-off, well-educated and connected communities.

It is important that the relationship between socio-economic vulnerability and the exposure to flood risk across different communities is well understood, and that this is taken into consideration when developing Local Plan policy and flood risk management approaches.

5.1.3. Heat Socio-Spatial Vulnerability Heat Socio-Spatial Vulnerability

5.1.3.1. Approach

The heat socio-spatial vulnerability index (HSVI), as developed by Lindley et al. (2011), refers to mapped social vulnerability with respect to heat-related hazards.[132] It shows how the personal, social and environmental factors, which help to explain uneven impacts on more vulnerable people and communities, come together in particular neighbourhoods. The HSVI reflects an equally weighted combination of neighbourhood-level scores for indicators within each of the five dimensions of vulnerability:

- **Sensitivity:** personal biophysical characteristics which affect the likelihood of negative impacts, calculated using a combination of population age and health.
- **Enhanced exposure** Physical environmental aspects that enhance exposure to heat hazards, such as green space and building characteristics.

[132] Lindley, S. J., O'Neill, J., Kandeh, J., Lawson, N., Christian, R. & O'Neill M. (2011) "Climate change, justice and vulnerability", Joseph Rowntree Foundation Report, York

- **Inability to prepare:** A community's ability to prepare for an event, based on income, tenure and language.
- **Inability to respond:** A community's ability to respond based on income, language, social networks, mobility, crime, accessibility and infrastructure.
- **Inability to recover:** A community's ability to recover, based on language, social networks, mobility and service access.

The HSVI is broken down into seven scoring boundaries: Slight, Extremely low, Relatively low, Average, Relatively high, Extremely high and Acute.

5.1.3.2. Findings

According to the HSVI, the majority of regions across Staffordshire demonstrate an Average or Relatively Low social vulnerability to heat-related hazards. These areas are generally rural in nature. The two main areas in Staffordshire with a reduced social vulnerability (Extremely Low to Slight) are Cannock Wood and the Northern areas of Staffordshire Moorlands.

From a physical and environmental perspective, the natural characteristics of rural areas reduce the propensity of those areas to suffer from the overheating effects that result from the urban heat island effect. Hard surfaces, which are widely used in urban areas, absorb solar radiation and release it as heat; by comparison, natural and green surfaces, which are predominantly found in rural areas, do not absorb solar radiation to the same extent and therefore do not suffer from excessive microclimate overheating.

From a socio-economic perspective, areas that are less vulnerable to the impacts of heat-related hazards are usually occupied by non-vulnerable population groups, such as those in higher-income brackets, who live in high-quality housing, with better connectivity to the local community and a supportive social network.

The areas that are more vulnerable to heat related hazards are predominantly located in urban centres, such as Cannock, Codsall, Newcastle Under-Lyme and Tamworth. These groups are more likely to include, for example, people in low-income brackets, those from ethnic minority groups, those with poor heath, or who occupy the lower quality building stock.

It is important that the relationship between socio-economic vulnerability and the exposure to heat-related risks across different communities is well understood, and that this is taken into consideration when developing Local Plan policy.

5.2. Influencing Climate Risk

This section of the report looks at the indicators that should be considered in regard to climate change risks when developing local plan policy and the associated site allocations. This analysis has been split into three different categories of site typologies within local plan allocations: urban extension, urban infill / replacement and new settlement. The site typologies utilise one to three case studies each, and are designed to highlight key issues affecting various allocation sites across Staffordshire and provide a baseline of understanding around the physical and environmental indicators that could influence climate risk.

5.2.1. Urban Extension

An "Urban Extension" can be defined as a typology that involves the planned expansion of a city or town.[133] The following two sites show examples of "Urban Extension" within Staffordshire:

Example Site 1: Coton House Farm Coton Lane

District: Tamworth

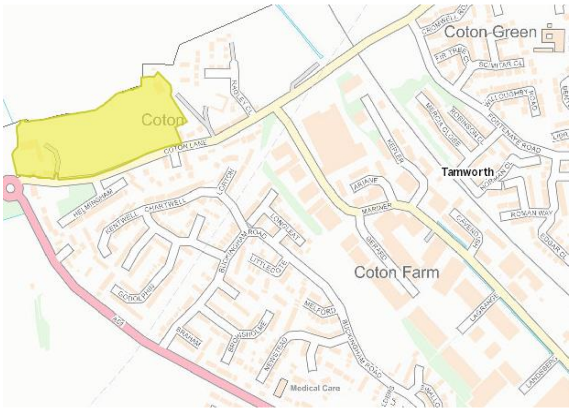
Site area: 4.87 ha

Use of site: Housing

Number of dwellings: 140

Greenbelt or brownfield site: Greenfield

Flood Exposure: 3.24 ha (67%) of the area of this site is located in FZ3, with 4.8 ha (96%) in FZ2. This site is not exposed to surface water flooding for 1 in 100, however it is exposed up to 0.60m for 1 in 1000.



NFVI: Relatively Low

HSVI: UK Average

Additional information: This site is on the edge of the Tamworth urban area, therefore has access to a variety of services. The site is currently part of the green space network.

Example Site 2: SDL West of Stafford. Site 4.

District: Stafford

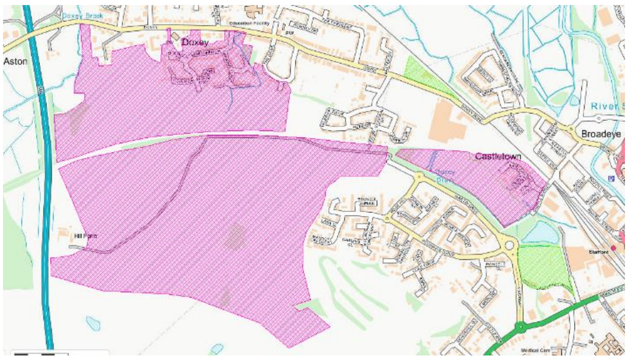
Site area: 110Ha

Use of site: Housing

Number of dwellings: 2,200

Greenbelt or brownfield site: Greenfield

Flood Exposure: 1.66 ha (6%) of the site is located in FZ3 and 12.4 ha in FZ2 (46%). Parts of the site are also exposed to <0.6 m of surface water flooding for 1 in 100 and <1.2m for 1 in 1000.



NFVI: UK average

HSVI: UK Average

Additional information: The site is located to the south west Stafford town centre and in close proximity to the Cannock Chase Special Area of Conservation.

[133] https://www.planningportal.co.uk/directory_record/565/urban_extension

Example Site 3: North of Lichfield

District: Lichfield

Site area: 193.67 ha

Use of site: Housing

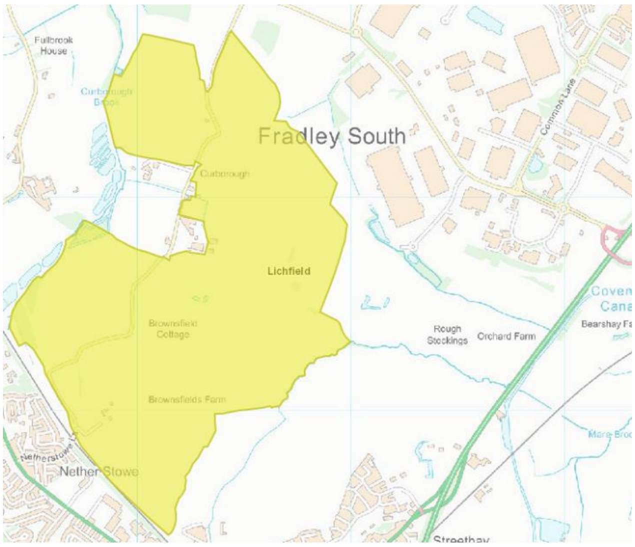
Number of dwellings: 2,780

Greenbelt or brownfield site: Greenfield

Food Exposure: 1.93 ha (0.9%) of the site is located in FZ3 and 2.3ha (1.2%) located in FZ2. Parts of the site are also exposed of <0.6m of surface water flooding for 1 in 100 and <1.21m of for 1 in 1000.

NFVI: Relatively low

HSVI: Relatively Low



Additional information: The site was identified as a proposed allocation within the Lichfield Local Plan Review: Preferred Options consultation document. It is located adjacent to Lichfield and is therefore in close proximity to public transport, services and facilities. It is also adjacent to agricultural and residential uses. The site is within the Cannock Chase SAC zone of influence and falls within part-grade 2 and part-grade 3 agricultural land.

5.2.1.1. Risk Related Indicators

Table 5.4 below identifies the climate change risks that "urban extension" sites, such as the examples presented above, are exposed to, along with their potential impacts on key physical and environmental risk indicators.

The indicators presented have been developed to help identify how the design of future development considers the expected impacts associated with relevant climate risks. Consideration of these indicators in policy and the design of development sites would influence the developments' resilience to these risks.

Table 5.4: Risk-related Indicators for urban extension typology.

UCCRA Risks of "High Relevance"	*Risk Related Indicators*
Natural Environment & Assets	
NE8: Risk of land management practices exacerbating flood risk.	- Number of properties within the existing urban area that will experience increased flood risk due to the development on the new site. - Capacity of existing Sustainable Drainage Systems (SuDS) on and around the site and consideration of climate projections in design. - Influence of new development on existing SuDs capacity.
NE14: Risks and opportunities from changes in landscape character.	- Extent of change expected to the urban area's landscape character as a result of the development.
Infrastructure	
IN1: Risks of cascading failures from interdependent infrastructure networks.	- Connection of the new development to existing, interdependent infrastructure. - Capacity of new development to include decentralised energy generation (e.g. PV panels)

IN2: Risks to infrastructure services from river, surface water and groundwater flooding.	- The presence of infrastructure services (utilities, road, rail) in areas at risk from surface or ground water flooding.
IN4: Risk of sewer flooding due to heavy rainfall.	- Capacity of existing and newly developed sewage and SuDs infrastructure including, designed to accommodate high-emission scenario climate projections. - Increased demand on sewage infrastructure from the new development.
IN9: Risks to public water supplies from drought and low river flows	- Capacity and cross-sectoral demand of public water supplies against high-emission scenario climate change projections. - Increased demand from the new development.
IN13: Risks to transport, digital and energy infrastructure from extreme heat	- Extent of green infrastructure in the new development and surrounding area. - Infrastructure services designed and built to consider extreme heat protection measures against high emissions climate change projection scenarios.
People and the Built Environment	
PB1: Risks to health and wellbeing from high temperatures.	- Amount of green space retained and coverage of green space within the new development site. - The extent of the existing urban area and new development designed for temperatures consistent with high-emission scenario climate projections. - Occupant demographics; vulnerable population groups.
PB3: Opportunities for increased outdoor activities from higher temperatures.	- Accessibility of green sites / areas for outdoor recreation. - Coverage of green space on the new development site.
PB4: Potential benefits to health and well-being from reduced frequency of cold weather.	- Number of health and well-being incidences from extreme cold events.
PB5: Risks to people, communities and buildings from flooding.	- Change in the risk of riverine and surface water flood risk for existing urban areas due to the new development. - Number of new properties developed on floodplains. - Consideration of site-specific flood mitigation measures in new development.
PB7: Risks to building fabric from moisture, wind and driving rain.	- Number of developments designed with building measures to prevent risks from moisture, wind and driving rain.
PB9: Risks to health and social care delivery from extreme weather	- Capacity of local health and social care providers to meet a change in demand from new development and climate change impacts.
PB10: Risks to health from changes in air quality	- Number of AQMAs within close proximity to the development site. - Access to sustainable transport options (e.g. public transport, cycle lanes) for residents / employees within the site.

	- Number / proximity of access to Electric Vehicle Charge Points within and near to the site.
PB13: Risks to health from poor water quality	- Impact of climate change hazards e.g. drought on water quality. - Increased demand on water supply from new development. - Consideration of high-emission scenario climate projections on new potable water network infrastructure.
PB14: Risk of household water supply interruptions	- Will water providers be able to maintain water supply needs with climate projections and additional use from urban expansion?

5.2.2. Urban Infill / Replacement

An "Urban infill / replacement" site describes a new development that is located on either vacant, occupied or undeveloped land within an existing urban environment, enclosed by other types of development. This plot typology descriptor is commonly used for plots in an urban or village setting that occupy a gap in the street scene, rather than extending beyond the boundaries.

Example Site 4: London Rd, Newcastle (former Bristol St Motors). I.D: TC26.

District: Newcastle-under-Lyme

Site area: 1.41 ha

Use of site: Housing

Number of dwellings: 506

Greenbelt or brownfield site: Brownfield

Flood Exposure: No exposure to FZ3, but 0.005 ha (0.40%) of the area is located in FZ2. Parts of the site are also exposed to <0.30m of surface water flooding for 1 in 100 and <0.6m for 1 in 1000.

NFVI: UK Average

HSVI: Relatively High

Additional information: Located in Newcastle town centre, the site has had a previous Historic landfill within 250m.

Example Site 5: Coors - Middle Yard, off Hawkins Ln. I.D: 7.

District: East Staffordshire

Site area: 9.08 ha

Use of site: Housing

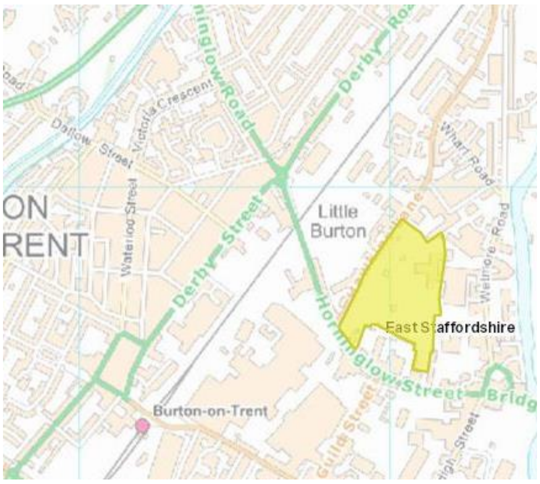
Number of dwellings: 272

Greenbelt or brownfield site: Brownfield

Flood Exposure: 8.76 ha (96%) of the site is located in FZ3, with 99% of the site located in FZ2. Parts of the site are also exposed to <0.6 of surfacing water flooding for 1 in 100 and <0.9m for 1 in 1000.

NFVI: UK Average

HSVI: Extremely High



Additional information: The site is located in Burton upon Trent town centre.

Example Site 6: Land at Nash Street, Knutton. I.D KS18

District: Newcastle Under-Lyme

Site area: 0.29ha

Use of site: Housing

Number of dwellings: 8

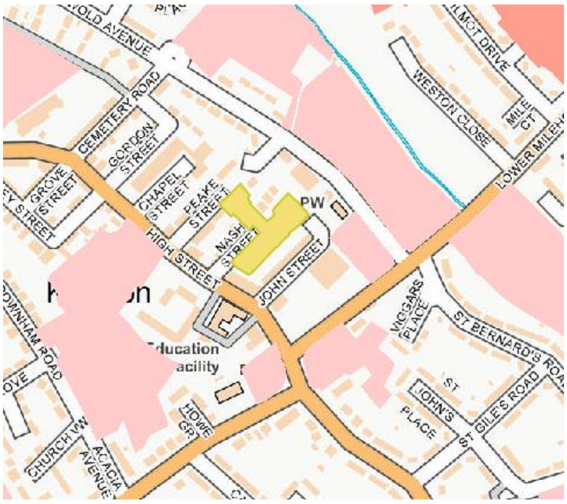
Greenbelt or brownfield site: Brownfield Site.

Flood Exposure: No

NFVI: Relatively high

HSVI: Relatively high

Additional information: The site is located with Knutton, just North of Newcastle-Under-Lyme. It is allocated as a 'developable' site, and is not located in either FZ2 or FZ3.



5.2.2.1. Risk Related Indicators

Table 5.5 below identifies the climate change risks that "urban infill / replacement" sites, such as the examples presented above, are exposed are exposed to, along with their potential impacts on key physical and environmental risk indicators.

The indicators presented have been developed to help identify how the design of future development considers the expected impacts associated with relevant climate risks. Consideration of these indicators in policy and the design of development sites, would influence the developments' resilience to these risks.

Table 5.5: Risk related indicators for Urban Infill typology.

UCCRA Risks of "High Relevance"	*Risk Related Indicators*
Natural Environment & Assets	
NE8: Risk of land management practices exacerbating flood risk.	- Number of surrounding properties that will experience increased flood risk due to the development/ replacement on the site. - Capacity of existing Sustainable Drainage Systems (SuDS) on and around the site and consideration of climate projections in design. - Influence of new / retrofit / refurbished development on existing SuDs capacity.
NE14: Risks and opportunities from changes in landscape character.	- Extent of change expected to the urban area's landscape character as a result of the development e.g. hardscape vs softscape.
Infrastructure	
IN1: Risks of cascading failures from interdependent infrastructure networks.	- Connection of the new / retrofit / refurbished development to existing, interdependent infrastructure. - Capacity of new development to include decentralised energy generation (e.g. PV panels)
IN2: Risks to infrastructure services from river, surface water and groundwater flooding.	- Percentage of existing infrastructure services located in areas at risk from surface or ground water flooding.

IN4: Risk of sewer flooding due to heavy rainfall.	- Capacity of existing sewage and SuDs infrastructure including, designed to accommodate high-emission scenario climate projections. - Increased demand on sewage infrastructure from the new / retrofitted / refurbished development.
IN9: Risks to public water supplies from drought and low river flows	- Capacity and cross-sectoral demand of public water supplies against high-emission scenario climate change projections. - Increased demand on water supply from the new / retrofit / refurbishment development.
IN13: Risks to transport, digital and energy infrastructure from extreme heat	- Extent of green infrastructure in the new / retrofit / refurbishment development and surrounding area. - Existing and new infrastructure services designed and built to consider extreme heat protection measures against high emissions climate change projection scenarios.
People and the Built Environment	
PB1: Risks to health and wellbeing from high temperatures.	- Coverage of green space within the new / retrofit / refurbished development site. - The extent of the existing urban area and new / retrofit / refurbished buildings designed for temperatures consistent with high-emission scenario climate projections. - Occupant demographics; vulnerable population groups.
PB3: Opportunities for increased outdoor activities from higher temperatures.	- Coverage of green space on the new / retrofit / refurbished development site.
PB4: Potential benefits to health and well-being from reduced frequency of cold weather.	- Number of health and well-being incidences from extreme cold events.
PB5: Risks to people, communities and buildings from flooding.	- Change in the risk of riverine and surface water flood risk for existing urban areas due to the new development site. - New / retrofit / refurbished development on existing flood plain.
PB7: Risks to building fabric from moisture, wind and driving rain.	- Number of new / retrofit / refurbished properties designed with building measures to prevent risks from moisture, wind and driving rain.
PB9: Risks to health and social care delivery from extreme weather	- Capacity of local health and social care providers to meet a change in demand from the new / retrofit / refurbished developments population and climate change impacts.
PB10: Risks to health from changes in air quality	- Number of AQMAs within close proximity to the development site. - Number / proximity of access to Electric Vehicle Charge Points within and near to the site.
PB13: Risks to health from poor water quality	- Impact of climate change hazards e.g. drought on water quality standards. - Alteration in demand on water supply from new / retrofitted refurbished development.

	- Consideration of high-emission scenario climate projections on potable water network.
PB14: Risk of household water supply interruptions	- Alteration in demand on water supply from new / retrofitted refurbished development. - Consideration of high-emission scenario climate projections on existing / new potable water network. - Impact of climate change hazards on potable water infrastructure.

5.2.3. New Settlement

A "New Settlement" typology is defined as a free-standing settlement in a more rural environment. Where bordering an existing settlement, a "new settlement" is defined by being 50% larger than the existing settlement in regard to population or number of dwellings.

Example Site 7: LEEK EM2

District: Staffordshire Moorlands

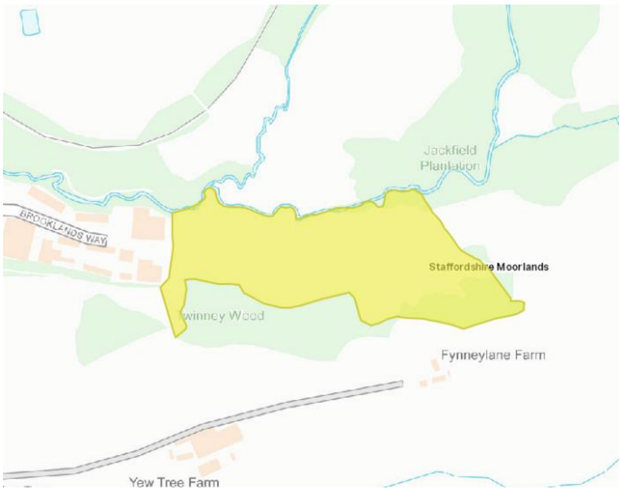
Site area: 7.66 ha

Use of site: Employment

Number of dwellings: Unknown.

Greenbelt or brownfield site: Greenfield

Flood Exposure: Approximately 0.68 ha in located in FZ3 (9.4%), with 0.72ha (12.7%) of the site located in FZ2. Parts of the site are also exposed <0.9m of surface water flooding for 1 in 100 and <1.21m for 1 in 1000.



NFVI: Relatively Low

HSVI: Relatively Low

Additional information: This site has been allocated for employment, and it is considered that the this will contribute to future employment for residential areas in Leek brook village and the town of Leek will contribute towards future.

5.2.3.1. Risk Related Indicators

Table 5.6 below identifies the climate change risks that "new settlement" sites, such as the examples presented above, are exposed to, along with their potential impacts on key physical and environmental risk indicators.

The indicators presented have been developed to help identify how the design of future development considers the expected impacts associated with relevant climate risks. Consideration of these indicators in policy and the design of development sites, would influence the developments' resilience to these risks.

Table 5.6: Risk-related indicators for the "new settlement" typology.

UCCRA Risks of "High Relevance"	Risk Related Indicators
Natural Environment & Assets	
NE8: Risk of land management practices exacerbating flood risk.	- Amount of green & blue infrastructure areas (m^2). - Number of Sustainable Drainage Systems (SuDS) on and around the site. - Percentage of development located on a river floodplain.
NE14: Risks and opportunities from changes in landscape character.	- Percentage of area located within an existing greenfield site.
Infrastructure	
IN1: Risks of cascading failures from interdependent infrastructure networks.	- Connection of the new community infrastructure to existing inter-dependent networks located outside of the boundary of the new site.

	- Capacity of new development to include decentralised energy generation (e.g. PV panels)
IN2: Risks to infrastructure services from river, surface water and groundwater flooding.	- Existing and new development Infrastructure services built with site-level flood protection measures against high-emission scenario projections. - Percentage of new development infrastructure services developed in areas at risk from surface or ground water flooding.
IN4: Risk of sewer flooding due to heavy rainfall.	- Expected increase in flow from new development. - Capacity of new sewage and SuDs infrastructure, and incorporation of high-emission scenario climate projections in design.
IN6: Risks to transport networks from slope and embankment failure	- Site accessibility to key services. - Percentage of transport networks from the new site which are at risk from slope / embankment failure.
IN9: Risks to public water supplies from drought and low river flows	- Capacity and cross-sectoral demand of public water supplies against high-emission scenario climate change projections. - Increased demand from the new development.
IN13: Risks to transport, digital and energy infrastructure from extreme heat	- Infrastructure services designed and built to consider extreme heat protection measures against high emissions climate change projection scenarios.
People and the Built Environment	
PB1: Risks to health and wellbeing from high temperatures.	- Amount of green space retained and coverage of green space within the new development. Sites. - Occupant demographic; vulnerable population groups. - The extent of the development designed for temperatures consistent with high-emission scenario climate projections.
PB3: Opportunities for increased outdoor activities from higher temperatures.	- The conservation of and accessibility too nearby green sites and outdoor recreational areas.
PB4: Potential benefits to health and well-being from reduced frequency of cold weather.	- Number of health and well-being incidences from extreme cold events.
PB5: Risks to people, communities and buildings from flooding.	- Change in the risk of riverine and surface water flood risk for existing urban areas due to the new development site. - Number of new properties developed on floodplains.
PB7: Risks to building fabric from moisture, wind and driving rain.	- Development designed with building measures that prevent risks from moisture, wind and driving rain.
PB9: Risk to health and social care delivery from extreme weather	- Capacity of local health and social care providers to meet an increase in demand from the new development population and climate change impacts.
PB10: Risks to health from changes in air quality	- Number of AQMAs within close proximity to the development site.

	- Are their sufficient sustainable transport options (e.g. public transport, cycle lanes) for residents / employees within, too and from the site. - Number / proximity of access to Electric Vehicle Charge Points included on the site.
PB13: Risks to health from poor water quality	- Impact of climate change hazards e.g. drought on water quality standards. - Increase demand on water supply from new development. - Consideration of high-emission scenario climate projections on potable water network.

5.3. Vulnerability Related Indicators

Table 5.7 below outlines the socio-economic, physical and environmental indicators that would help to inform the vulnerability of allocation sites to flooding and heat related impacts of climate change.

It is important to understand, consider and act upon these vulnerability indicators when planning new development. This will help to enhance the population's resilience to climate events, whether through reducing the communities' susceptibility and sensitivity to them, by increasing community support, or by improving the communities' ability to prepare, respond to and recover from an event.

Table 5.7. Flooding and heat vulnerability related indicators that are relevant to all allocation sites.

Vulnerability related Indicators
Socio-Economic
- Availability and accessibility of community services
- Average disposable income
- Average minimal travel time to reach emergency / health services from allocation site.
- Community awareness of climatic risks and adaptation actions
- Community employment rate
- Current population vs population projections.
- Current resources available to support community adaptation
- Current vs projected population density
- Funding for local emergency / health services
- Index of Multiple Deprivation
- Percentage of areas not accessible for emergency / firefighting services.
- Percentage share of the population who are part of a minority ethnic groups.
- Percentage share of the population that are elderly residents
- Percentage share of households that are owned by the occupant
- Percentage share of the population who have limited physical mobility
- Percentage share of the population who identify as having poor health
- Percentage share of residents who live with a mental or physical disability
- Strength of social networks / extent of community cohesion and neighbourhood reciprocity.
Physical and Environmental
- Current energy and water consumption per capita vs projections.
- Length and number of transport connections to the allocation site.
- Percent of population living in areas at risk to climate hazards.
- Percentage change in average annual / monthly temperature.
- Percentage change in average annual / monthly precipitation
- Percentage of community infrastructure located in areas at risk to climate hazards.

The recent COVID-19 pandemic has demonstrated how crisis events can have different impacts across social groups and geographic areas. COVID-19 also presents an opportunity for deepening our understanding of resilience and sustainable development. It has highlighted the key role that socio-economic vulnerabilities play in the impacts that are experienced throughout the wider population, and how vulnerabilities disproportionately affect those groups and communities which are least able to adapt to shifts in the social and economic landscape. This is called the "resilience gap".

Parallels can be drawn between the COVID-19 pandemic and climate change. The impacts that are currently being experienced as a result of the strains (e.g. rising temperatures) and the stresses (e.g. flooding) of climate change also have a disproportionate effect on those groups and communities that are least able to cope.

By understanding and recognising the socio-economic vulnerabilities present within Staffordshire (as outlined in Table 5.7) and acting on the lessons learned from the COVID-19 pandemic, new development has the potential to help reduce the 'resilience gap'.

5.4. Intervention Options

Based on the climate risks and potential impacts identified within the Baseline Report, alongside the exposure to flooding and vulnerability to flood and heat analysed above, a range of potential Local Plan adaptation interventions has been established, and are displayed in the table below alongside the climate risk that they address. Interventions are grouped according to whether they primarily address (a) flooding, (b) heat, or (c) can be considered 'cross-cutting' issues.

5.4.1. Adaptation Measures

Flooding

Table 5.8 presents potential Local Plan adaptation measures that would increase the resilience of, and reduce risks to, future development areas from surface water and riverine flooding within Staffordshire.

Table 5.8: Potential Local Plan measures for flooding.

Adaptation Measure	Climate Risk(s) Addressed
Require planning applications to assess the impact of new development sites on existing stormwater and sewage infrastructure capacity.	**In2:** Risks to infrastructure services from river, surface water and groundwater flooding
Direct / restrict future development to areas in fluvial Flood Zone 1.	**In2:** Risks to infrastructure services from river, surface water and groundwater flooding **PB5:** Risks to people, communities and buildings from flooding
Direct / restrict development to areas at low risk from surface water flooding.	**In2:** Risks to infrastructure services from river, surface water and groundwater flooding **PB5:** Risks to people, communities and buildings from flooding
Direct / restrict development to areas not prone to sewer flooding.	**In4:** Risks of sewer flooding due to heavy rainfall
Encourage flood resilient design responses where development on a floodplain is unavoidable.	**PB5:** Risks to people, communities and buildings from flooding
Require planning applications to include site-level flood risk assessments.	**In2:** Risks to infrastructure services from river, surface water and groundwater flooding **PB5:** Risks to people, communities and buildings from flooding
Require planning applications to demonstrate plans to include SUDs in future development.	**Ne8:** Risks of land management practices exacerbating flood risk **In2:** Risks to infrastructure services from river, surface water and groundwater flooding **In4:** Risks of sewer flooding due to heavy rainfall

	PB5: Risks to people, communities and buildings from flooding
Ensure all future infrastructure development occurs away from watercourses where possible. Where these developments must occur in close proximity to rivers, ensure they are located away from areas at risk from high river flows and high levels of erosion and incorporate high-emission scenario climate projections in design.	**In5:** Risks to bridges and pipelines from high river flows and bank erosion
Ensure a flood risk assessment is conducted where land management practices are proposed to be changed.	**Ne8**: Risks of land management practices exacerbating flood risk
Require planning applications for future development to consider long term flood risk projections and include site-level flood protection measures where necessary.	**Ne8:** Risks of land management practices exacerbating flood risk **In2:** Risks to infrastructure services from river, surface water and groundwater flooding **In4:** Risks of sewer flooding due to heavy rainfall **PB5:** Risks to people, communities and buildings from flooding
Use Catchment Management Plans to evaluate the effect of new developments within the catchment on flooding.	**Ne8:** Risks of land management practices exacerbating flood risk **In2:** Risks to infrastructure services from river, surface water and groundwater flooding **In4:** Risks of sewer flooding due to heavy rainfall **PB5:** Risks to people, communities and buildings from flooding

Heat

Table 5.9 presents potential local plan adaptation measures that would increase the resilience of, and reduce risks to, future development areas from heat related hazards such as drought and heatwaves within Staffordshire.

Table 5.9: Potential Local Plan measures for heat related hazards.

Adaptation Measure	Climate Risk(s) Addressed
Ensure all future development considers high-emission scenario climate projections for temperature extremes in their design, with regards to topics such as urban design, road and infrastructure locations.	**In9:** Risks to public water supplies from drought and low river flows **In13:** Risks to transport, digital and energy infrastructure from extreme heat
Require planning applications for future developments to consider thermal comfort, through a dedicated overheating assessment (in line with CIBSE TM52 or equivalent) that assesses, for example, solar shading, ventilation, and active cooling against high-emission scenario climate projections.	**PB1:** Risks to health and wellbeing from high temperatures
Develop controlled burning and emergency management strategies for areas at high current or future risk of wildfire.	**PB1**: Risks to health and wellbeing from high temperatures
Ensure all future development considers the urban heat island effect in its design; incorporating, green space, green cover and material selection (e.g. light-coloured surfaces instead of tarmac).	**PB1:** Risks to health and wellbeing from high temperatures **PB3:** Opportunities for increased outdoor activities from higher temperatures **PB13:** Risks to health from poor water quality **In13:** Risks to transport, digital and energy infrastructure from extreme heat

Ensure that existing and proposed buildings (especially those inhabited by vulnerable groups e.g. care homes, hospitals, prisons and schools) are equipped to protect the health of inhabitants from overheating in the event of extreme heat events.	**PB1**: Risks to health and wellbeing from high temperatures
Require planning applications for new developments to demonstrate reduced water consumption compared to average water consumption levels, including the use of rainwater collection and / or greywater recycling as standard.	**In9**: Risks to public water supplies from drought and low river flows

Cross cutting issues

Table 5.10 presents potential local plan adaptation measures that would increase the resilience of, and reduce risks to, future development areas from cross-cutting hazards within Staffordshire.

Table 5.10: Potential Local Plan measures for cross-cutting hazards

Adaptation Measure	Climate Risk(s) Addressed
Require planning applications for new development to maximise opportunities for on-site renewable electricity generation (e.g. PV panels) and install these systems unless it is demonstrated to be not economically feasible.	**In13:** Risks to transport, digital and energy infrastructure from extreme heat **In1:** Risks of cascading failures from interdependent infrastructure networks **In11:** Risks to energy, transport and digital infrastructure from high winds and lightning
Develop severe weather management plans for individual sites that are deemed to be at high risk to potential impacts from climate events.	**In1:** Risks of cascading failures from interdependent infrastructure networks **In2:** Risks to infrastructure services from river, surface water and groundwater flooding **In4:** Risks of sewer flooding due to heavy rainfall **In6**: Risks to transport networks from slope and embankment failure **PB1**: Risks to health and wellbeing from high temperatures **PB5**: Risks to people, communities and buildings from flooding **PB7:** Risks to building fabric from moisture, wind and driving rain **PB9:** Risks to health and social care delivery from extreme weather
Encourage all development to explore opportunities for site-wide heating and cooling networks and/or micro-grids.	**In1:** Risks of cascading failures from interdependent infrastructure networks **In2:** Risks to infrastructure services from river, surface water and groundwater flooding **In11:** Risks to energy, transport and digital infrastructure from high winds and lightning **In13:** Risks to transport, digital and energy infrastructure from extreme heat
Consider climate projections (temperature and precipitation changes) and severe weather risks (flooding, wildfire, heatwaves etc.) in land management and spatial planning.	**In1:** Risks of cascading failures from interdependent infrastructure networks **In2:** Risks to infrastructure services from river, surface water and groundwater flooding **In4:** Risks of sewer flooding due to heavy rainfall **In6**: Risks to transport networks from slope and embankment failure **PB1**: Risks to health and wellbeing from high temperatures **PB5**: Risks to people, communities and buildings from flooding **PB7:** Risks to building fabric from moisture, wind and driving rain. **PB9:** Risks to health and social care delivery from extreme weather

Ensure that biodiversity offsets developed to achieve net gain are located where the negative risks of impacts from climate change are low. This would involve considering flood risks (depending on the habitat type) and proximity / connections to the wider habitat networks (to allow for biodiversity migrate / relocate during a severe weather event)	**Ne14:** Risks and opportunities from changes in landscape character
Prevent future development from destroying priority habitats, habitats which are important for priority species, and habitats which provide high levels of natural carbon storage and carbon sequestration (e.g. peatland and woodland).	**Ne14:** Risks and opportunities from changes in landscape character

5.4.2. Policy Wording for Adaptation Interventions

As a truly cross-cutting issue, it is challenging but necessary to set policy for climate change adaptation. Local Plans can act as a tool for Councils to both enhance and implement resilience and adaptation measures through:

- **Spatial strategy (see Section 5.4.2.1):** using planning policy to influence and manage the distribution of development and activities within an area.
- **Masterplanning and urban design (see Section 5.4.2.2):** using planning policy to make connections between buildings, infrastructure, community settings and the surrounding environment.
- **Development management policy (see Section 5.4.2.3):** using planning policy to set standards and criteria against which planning applications for development will be assessed.

This section breaks down these three elements, providing examples of policy wording (outlined within a **green** box) that could be implemented to address flood, heat and cross-cutting climate risks based on the intervention options laid out within Section 5.4.1. Where appropriate, a case study has also been provided (outlined within a **blue** box) to a demonstrate validation of the policies.

5.4.2.1. Spatial Strategy

When looking at spatial strategy considerations in order to address climate risks and increase resilience, there is a need to avoid development that would encroach on areas of flood risk, on land that contributes to green infrastructure and ecological connectivity, and on high-quality agricultural land. This is reflected within the following priority of the Government's 25 Year Environment Plan[134]:

"New development will happen in the right places, delivering maximum economic benefit while taking into account the need to avoid environmental damage. We will protect ancient woodlands and grasslands, high flood risk areas and our best agricultural land."

Flood risk

A clear regime for avoiding development in flood risk zones is presented within the National Planning Policy Framework (NPPF)[135] and the Planning Practice Guidance (PPG)[136]. However, building new homes in locations where they are at risk from flooding is unavoidable in some areas due to spatial constraints. Where this is the case, the PPG states that development should only be allowed in areas at risk of flooding where:

"(a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

(b) the development is appropriately flood resistant and resilient;

(c) it incorporates sustainable drainage systems…;

[134] HM Government, '*A Green Future: Our 25 Year Plan to Improve the Environment*' (2018). Available at: https://www.gov.uk/government/publications/25-year-environment-plan
[135] Ministry of Housing, Communities & Local Government, '*National Planning Policy Framework*' (2018). Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2
[136] Ministry of Housing, Communities & Local Government, '*Planning Practice Guidance'* (2014). Available at: https://www.gov.uk/government/collections/planning-practice-guidance

(d) any residual risk can be safely managed; and

(e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan."

The Borough / District Council's within Staffordshire will need to ensure that a robust Sequential Test is undertaken alongside the selection of development sites and the design of the spatial strategy. This should direct and restrict development to areas at low risk of fluvial, surface-water, groundwater or sewer flooding wherever possible. In particular cases, where there is no alternative for development to occur in flood risk areas, the Local Plan should set out strict requirements and mitigation measures, that go above and beyond those set out in the PPG (see points (a) to (e) above).

Moreover, as flood risk is projected to change and intensify under climate change projections, Local Plans should go beyond just considering current flood risk within their spatial strategies. It is important that spatial strategies have been 'future-proofed', and consideration is given to long-term changes in flood risk when selecting development sites.

Example policy wording for addressing flood risks through spatial planning:

Development will be restricted to areas of low flood risk (both currently and under long-term high-emission climate projections) where possible. Where development in flood risk zones is unavoidable due to spatial constraints, the following requirements must be met:

1. All vulnerable development (e.g. hospitals, care homes, schools etc.) must be located away from areas at high risk from flooding;
2. All development is designed to be flood resistant and resilient and site-level adaptation measures are designed to withstand long-term high-emission climate projections;
3. All development must include sustainable drainage systems which have been designed considering the local flood risk issues and the implications for local geology; and
4. The development site has a clear flood emergency plan (including safe and alternative access and escape routes) and a long-term monitoring and maintenance plan.

Case Study: Salford Revised Draft Local Plan[137]

Policy WA5: Development and flood Risk, within the Salford Revised Draft Local Plan, ensures that development will not be permitted where it is subject to unacceptable risk of flooding or increases the risk of flooding elsewhere.

The Local Plan states that any proposed development site at risk of flooding must meet the Sequential Test then, for more vulnerable uses, it must also pass the Exception Test (which requires the development to be safe, not increase flooding elsewhere, and lead to sustainability benefits which outweigh the flood risk).

The plan specifically prevents vulnerable development (e.g. fire stations, command centres and telecommunications to be operational during flooding, basement dwellings, and sites for gypsies, travellers and travelling showpeople) from being permitted on areas that would be subject to a 1 in 100-year risk of flooding.

Importantly, Policy WA5 within the plan also instructs all planning applications that require a flood risk assessment, to take full account of the most recently predicted impacts of climate change.

It also lays out clear guidelines for what developments need to do if they are subject to either a 1 in 100 and 1 in 1000 year risk, which includes ensuring design minimises the impact of flooding proportionate to the flood risk and maintain or where possible increase the flood water storage capacity of the flood cell within which the building is located.

Extreme heat risks

Within built-up areas, the urban heat island effect can be reduced by effective natural landscaping. In this regard, strategic spatial planning of green infrastructure, including green space, green cover, green roofs, green walls and urban trees, will be essential. The importance of green Infrastructure is increasingly being recognised at the same level as other essential urban (grey) infrastructure, and therefore a clear, well-connected network of green spaces should be set-out within the spatial strategies for each District / Borough. Such spaces will also support natural capital objectives, as described in Section 4.2.

[137] Salford City Council, 'Revised Draft Local Plan' (2019). Pg. 189. Available at: https://www.salford.gov.uk/reviseddraftlocalplan

The spatial planning of green infrastructure will need to consider the areas that are deemed highly vulnerable to extreme heat events. Local Plans will not only need to ensure that new development includes an appropriate allocation of green infrastructure, but also that new development adds to and complements the existing network of green infrastructure across Staffordshire.

Example policy wording for addressing extreme heat risks through spatial planning:

At least 40% of the total area of all new development should constitute green infrastructure (including, green roofs, green walls, green space between buildings and trees), in line with the good practice guidance for green infrastructure and biodiversity produced by the Town and Country Planning Association (TCPA). This green infrastructure should be designed considering the vulnerability of the surrounding area to extreme temperatures associated with climate projections under a high-emission scenario. The green infrastructure should also be designed to complement the existing network of green infrastructure within the local area.

Case Study: Cambourne[138]

The new settlement of Cambourne within South Cambridgeshire has three inter-linked villages with approximately 4,200 new homes and a further 2,350 under planning application. South Cambridgeshire District Council's 'Landscape in New Developments Supplementary Planning' Document states that green infrastructure should be a *"fundamental part of the design and planning process from the start of new development"*.

Cambridgeshire's Green Infrastructure Strategy sets out a Strategic Network of green infrastructure based on seven themes; biodiversity, climate change, green Infrastructure gateways, heritage, landscape, publicly accessible open space and rights of way. It also covers three cross-cutting issues; economic development, health and well-being, and land and water management. The Strategic Network provides a county-wide framework on which to provide or enhance green infrastructure in Cambridgeshire beyond 2031. Cambourne being one of six target areas contributing to the Strategic Network.

As a result of a partnership between the Wildlife Trust, the housing developers and the local authorities, the development in Cambourne retained all existing habitats and included designs to connect the fragmented habitats with a ratio of 60% greenspace to 40% development. The 60% green space includes pre-existing and new woodlands, scrub, meadows, lakes, grasslands, playing fields, allotments and formal play areas. There are also 12 miles of new footpaths, cycleways and bridleways, and 10 miles of new hedgerows. The green infrastructure on the site has since been shown to play an important role for flood management, enhancing resident's health and well-being, and cooling external temperatures during periods of extreme heat.

Cross-cutting risks

The predicted cross-cutting impacts and uncertainties associated with climate change emphasise the importance of maintaining the national resource of the 'best and most versatile' agricultural land. Therefore, spatial planning should direct and/or restrict development away from grade 1, grade 2 or grade 3a quality agricultural land within the District / Borough wherever possible.

Additionally, spatial planning should acknowledge and consider the impacts of climate change on natural assets which are important for biodiversity. Local Plans should encourage new development to go beyond just avoiding priority habitats within the District / Borough, and actively enhance the ecological network across Staffordshire.

As discussed in Section 4.2.3.3, the recently published Environment Bill[139] makes provision for mandatory Biodiversity Net Gain as part of development proposals, and the development of Local Nature Recovery Strategies can be used as a spatial planning tool to guide planning for net gain. With regards to planning for environmental net gain, understanding of implications for Local Plans is at a relatively early stage; however, it is well understood that there can be opportunities for targeted development to deliver a range of benefits, including enhanced biodiversity, reduced flood risk, greater recreation opportunities and improved air quality. A natural capital approach, as described previously, could be used to assess and value the ecosystem services from the habitats created through BNG, and this information could be used to inform decision making within the masterplanning and early planning stages of development.

[138] Ecosystem Knowledge Network, '*Green Infrastructure and Housing Development'* (2016). Available at: https://ecosystemsknowledge.net/sites/default/files/wp-content/uploads/Green%20infrastructure%20and%20housing%20report%202016.pdf
[139] Department for Environment, Food & Rural Affairs, 'E*nvironment Bill 2020*' (2020). Available at: https://www.gov.uk/government/publications/environment-bill-2020

It is important to consider that while the principles behind BNG are intended to help deliver the aims of the 25 Year Environment Plan[140], they do not necessarily translate well to urban areas, where most developments occur on previously developed land with no biodiversity value. In such areas, it is argued that the Urban Greening Factor (UGF) is a more suitable method of consistently delivering multifunctional green space, that also provides an increase in biodiversity. The UGF requires a developer to include a certain amount of greening in all development in order to deliver a local need i.e. urban cooling, flood alleviation, etc. Therefore, Local Plans should encourage the use of the UGF within existing urban areas, through features such as green walls, green roofs, rain gardens and other SuDS. In addition, consideration should be given to how the well-being and community benefits from these features can be maximised, such as providing urban fruit trees or edible plants that can be used and maintained by residents.

Example policy wording for addressing cross-cutting climate risks through spatial planning:

All development should deliver a Biodiversity Net Gain of at least 10%. Planning for the provision of this net gain should be informed by a natural capital approach whenever possible, to assess and value the full range of ecosystem services and wider societal benefits that can be provided alongside the biodiversity benefits.

Case Study: Oxfordshire Cotswolds Garden Village[141]

The land to the North of the A40 near Eynsham has been allocated for development of a new garden village with around 2,200 homes, as well as business space and supporting services. A minimum biodiversity net gain of 25% has been set for the Oxfordshire Cotswolds Garden Village development, based on guidance provided by Lichfield District Council, who have set a biodiversity net gain at 20% in their supplementary planning document 'Biodiversity and Development' (2016).

The biodiversity net gain approach will focus first on the development site itself through on-site mitigation, enhancement and compensation, and then include off-site compensation where necessary. Off-site compensation will be secured within the nearest Conservation Target Areas, for the restoration of designated sites, the creation of a Nature Recovery Network, the restoration of priority habitats and species or the creation of new green infrastructure within the local area. The Area Action Plan also specifies the need for biodiversity net gain to result in wider natural capital and ecosystem service benefits.

5.4.2.2. Masterplanning and Urban design

It is important for Local Plans to consider masterplanning and design options at the same time as spatial strategy and site options, recognising that all of these topics are important for ensuring climate change adaptation. The resilience section within the National Design Guide[142] outlines the following:

- *"Well-designed **places**… contribute to community resilience and climate adaptation by addressing the potential effects of temperature extremes… increased flood risk and more intense weather events…"*
- "*Well-designed **buildings** make the most of passive design strategies to minimise overheating and achieve internal comfort. These include: the layout and aspect of internal spaces; insulation of the external envelope and thermal mass; management of solar gain; and natural ventilation."*
- *"Well-designed **public and open spaces** incorporate planting, structures and water for comfort. They create shade and shelter for their users… [and] contribute to reducing the 'heat island' effect."*
- *"Well-designed places have **sustainable drainage systems**… and make use of 'green' sustainable drainage systems and natural flood resilience wherever possible...."*

With this in mind, masterplanning should aim to achieve a balance between maximising development in those locations that are less exposed and less vulnerable to climate risks (e.g. areas with low risk of flooding and areas that are well-connected to emergency services) with the competing objective of ensuring sufficient space is provided for other land uses, particularly nature-based solutions to climate change (e.g. green space and SuDs). For example, tall buildings can enable both higher densities and extensive space for other uses, but can give rise to their own issues, e.g. in respect of solar gain, therefore, mid-rise buildings may be an appropriate balance. In

[140] HM Government, '*A Green Future: Our 25 Year Plan to Improve the Environment*' (2018). Available at: https://www.gov.uk/government/publications/25-year-environment-plan

[141] West Oxfordshire District Council, 'Oxfordshire Cotswolds Garden Village: Area Action Plan' (2019). Available at: https://www.westoxon.gov.uk/media/nazn42gz/garden-village-app-preferred-option-paper-july-2019.pdf

[142] Ministry of Housing, Communities & Local Government, '*National Design Guide'* (2019). Available at: https://www.gov.uk/government/publications/national-design-guide

order to create an appropriate balance and enhance resilience to climate change within new and existing development, masterplanning and urban design must be context-specific and take a long-term perspective.

5.4.2.3. Development Management

Flood risk

SuDs are a national requirement for major development, but there is also the potential to encourage the use of SuDs through Local Plan policies. Firstly, Local Plans can specify the types of development that require SuDs, by making it compulsory for more developments to include SuDS within their designs. Secondly, Local Plan policies can guide the local approach to SuDS, in order to address local flood risk in-line with climate change projections and to maximise the generation of co-benefits, such as biodiversity, recreation and air quality.

Example policy wording for addressing flood risks through development management:

All development will be required to demonstrate adequate land drainage and active reduction in run-off rates and volumes. All new development is required to use SuDS to manage surface water unless alternative measures are demonstrated to be more appropriate. SuDS should be designed considering the local flood risk issues, high-emission scenario climate projections, and the implications for local geology. Wherever possible, SuDS should maximise ecological, health and social benefits and link into the existing Green Network.

Case Study: Salford Revised Draft Local Plan[143]

Policy WA-6: Surface Water and sustainable drainage, in combination with policy CC1: Climate Change, demonstrate a requirement of developments to ensure that surface water across the whole site is managed in a sustainable way, helping to minimise flood risk, water pollution and promote co-benefits such as increased biodiversity, whilst also considering climate change.

Salford's revised Draft Local Plan contains a dedicated policy section for climate change, the intention of which is to reduce the burden that falls on future generations to respond to climate change and to tackle the negative impacts which comes with it. An aspect of this policy focuses on mitigation of and adaptation to the impacts of climate change. This includes the following wording "Managing flood risk associated with higher peak river flows and more extreme weather events, and relocating vulnerable uses where appropriate".

Extreme heat risks

With projected increases in the frequency and intensity of heat waves, it is fundamental that Local Plan policies are in place to maximise thermal comfort within new development, in order to mitigate against overheating and the urban heat island effect. Development management policies can be designed to address the following aspects of thermal comfort:

- **Passive Design Building measures -** Local Plan polices should encourage development to consider how the layout, orientation, design and construction of a building can be modified to maximise cooling. For example, new development should consider best practice guidance on solar gain, natural day lighting, ventilation, thermal mass, insulation and active cooling. Please see Section 3.1.2 for more details on appropriate passive design measures. New buildings should be designed considering long-term temperature projections under a high emissions scenario to ensure thermal comfort will be provided for the lifetime of the building. This will be particularly important for buildings that will be inhabited by vulnerable groups, including care homes, hospitals, prisons and schools.
- **Landscaping –** Local Plans must specify landscape requirements that need to be met within future planning applications. New development should demonstrate a consideration of climate change with regards to the type, location, and management of on-site landscape design. Specifically, green roofs, living walls, green spaces and tree planting should be used wherever possible to provide natural cooling to the development site.

[143] Salford City Council, 'Revised Draft Local Plan' (2019). Pg.,192 and Pg36. Available at: https://www.salford.gov.uk/reviseddraftlocalplan

Example policy wording for addressing extreme heat risks through development management:

All new development must demonstrate consideration of long-term temperature projections under a high-emission scenario, within the following aspects of design:

a) Building layout (e,g, use of internal and external shading);

b) Building orientation (e.g. designing orientation of single aspect units to minimise average daylight factor);

c) Building materials (e.g. use of high albedo (light colour) materials);

d) Ventilation (e.g. fully opening windows are used where it is safe to do so);

e) Insulation (e.g. application of best practice guidance for insulation); and

f) Landscaping (e.g. provision of green roofs and green infrastructure wherever possible).

Case study: North West Cambridge Urban Expansion[144]

A major urban expansion in North West Cambridge will include 1500 staff hours for Cambridge University, 100,000m^2 of new academic and research facilities, 1500 market houses, and community facilities. The sites location within the green belt has resulted in high sustainability standards for the development.

During the planning phase, a Climate Change Adaptation Strategy was developed, which included analysis of Urban Heat Island effect and summer overheating. The strategy proposed that for external overheating, extensive green infrastructure will be provided to reduce the area of hard landscaping where suitable. To address internal overheating, the following principles were taken forward to the details design phase:

- Minimisation of single aspect dwellings;
- Careful control of solar gains and use of solar control glass and shutters;
- Large openings to allow for ventilation in summer; and
- Exposure to thermal mass in living areas / kitchens.

Drought risks

With regards to maximising water efficiency and increasing resilience during periods of drought, Local Plan policies should prevent development which could negatively impact water sources, and also encourage new buildings to be designed with best-practice water efficiency measures.

In 2006, the Code for Sustainable Homes[145] was launched to help create more sustainable homes and this was used as the national standard for the design and construction of new homes in the UK. The code was withdrawn in 2015, and some of its standards were consolidated into Building Regulations[146], including the requirement for new dwellings to achieve a water efficiency standard of 125 litres of water per person per day. The Government also updated Building Regulations Part G[147], introducing an 'optional' requirement of 110 litres of water per person per day for new residential development, and it is recommended that this should be implemented through local policy where there is a clear evidence need. Given the likely increases in water stress under future climate change projections, local plans across Staffordshire should require all new residential development to meet the water efficiency requirements in Building Regulations Part G as a minimum.

Example policy wording for addressing drought risks through development management:

Any development which has the potential to negatively impact the quality and/or quantity of water availability in the surrounding area will not be permitted.

All new residential development must also design and implement water efficiency measures in order to comply with the Building Regulations Optional Requirement of 110 litres of water per person per day.

[144] AECOM, '*North West Cambridge Development: Climate Change Adaptation Strategy'* (2013), Available at: https://www.arcc-network.org.uk/wp-content/D4FC/D4FC10-NW-Cambridge-full-report.pdf

[145] Communities and Local Government, 'Code for Sustainable Homes: Technical Guide' (2010). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/5976/code_for_sustainable_homes_techguide.pdf

[146] HM Government, 'The Building Regulations' (2010). Available at: https://www.gov.uk/guidance/building-regulations-and-approved-documents-index

[147] HM Government, 'Approved Document G: Sanitation, hot water safety and water efficiency' (2015). Available at: https://www.planningportal.co.uk/info/200135/approved_documents/69/part_g_-_sanitation_hot_water_safety_and_water_efficiency

Case study: Swale Borough Local Plan[148]

The new Local Plan for Swale Borough includes a policy on water use efficiency that requires the Building Regulations Optional Requirement of 110 litres of water per person per day. This water-efficiency policy is supported by Policy SP1 in the Core Strategy which states that '*development proposals should promote ways to reduce energy and water use and increase use of renewable resources, including locally sourced and sustainable building materials*'.

The Local Plan was approved in 2017 after going through extensive public consultation. Throughout the consultation process, no objections were raised regarding the water efficiency requirements, demonstrating support for responsible management of water resources.

Cross-cutting risks

Finally, due to the uncertainties and complexities associated with climate change, flexibility within building design is fundamental to ensure resilience (this is discussed further in Section 3.1.2.6). Local Plan policies must encourage new buildings to be designed from the outset to be flexible to accommodate the changing needs with respect to both climate change and socio-economic matters (for example family size, home working, old age and disability).

Safeguarding against future climatic impacts may include measures such as requiring on-site renewable energy generation, diversifying transportation links to essential services, and developing site level monitoring and management plans. Incorporating these measures into Local Plan policies will provide resilience against unforeseen severe weather events and climate extremes.

[148] Save Water South East, '*Water Efficiency in New Homes*' (2019). Available at: https://waterwise.org.uk/wp-content/uploads/2019/09/Toolkit-Efficiency-in-New-Homes.pdf

Appendix A – Planning for the Future (2020)

A.1 Overview

Following the preparation of the Baseline Report and draft Final Report, the Planning for the Future consultation White Paper was published by the Ministry of Housing, Communities and Local Government on 6th August 2020. This consultation document sets out a package of proposed measures that, if implemented, would comprehensively transform the current planning system in England. The stated aim is to streamline and modernise the planning process, including to improve design and sustainability outcomes.

The Consultation is structured into three 'pillars' which each set out an outcome to be achieved in the creation of a future forward planning strategy. These pillars are:

- Planning for development;
- Planning for beautiful and sustainable places; and
- Planning for infrastructure and connected places.

The Consultation proposes the role of Local Plans to be simplified, with less repetition of national policy. Local Plans will instead focus on setting out clear rules limited to a core set of standards and requirements for development, including site-specific and area-specific requirements. It is also proposed that a National Model Design Code be introduced following the publication of the National Design Guide in October 2019, to be supplemented by local design guides and codes, although it is not clear what topics would be delegated to the latter.

The consultation states that the priority with simplifying the planning process towards a rules-based system is to free up resource within local authorities to focus on enforcement. In principle, this emphasis on clear rules, monitoring and enforcement could help Local Authorities to ensure that targets related to climate change mitigation and adaptation are met, provided that such targets are set in national or local policy.

Some of the proposed key changes in the consultation relevant to this study are outlined below.

- Local Plans would be significantly reduced in scope to include fewer policies. The majority of policies would be set nationally while Local Plans would primarily address development site allocations.
- Specifically, Local Plans would designate land as falling into the category of either 'protection', 'renewal' or 'growth'. Outline planning permission may automatically be granted for 'growth' areas and restricted in 'protection' areas, while areas suitable for 'renewal' would accommodate some forms of development such as infill / densification.
- Proposals would still need to adhere to locally specific Design Codes that set out more detailed requirements. The process for developing these would require significant community engagement and support, an issue that is strongly emphasised throughout the consultation document.
- The planning application system would be streamlined and digitised; in particular, the number of supporting application documents would be reduced.
- The current system of S106 contributions and the Community Infrastructure Levy (CIL) payments would be replaced with a nationally standardised, flat-rate infrastructure levy based on development and land values.

The 'Planning for the Future' consultation closes on the 29th October 2020. It is not clear when the government is intending to respond to the consultation or the timeline for any future implementation or presentation to Parliament.

A.2 Implications for Policy Recommendations

If Local Plans are to be reduced in scope, then it will become all the more important for Local Authorities to determine which types of requirements they wish to prioritise. We have presented a relatively long list of potential policy responses in this report, and have explained how these could be justified, but recognise that it will be up to individual Local Authorities as to how this information is used.

The policy recommendations set out in this study generally fall into one or more of the following categories:

1. Setting standards that go above and beyond current standard practice (e.g. requiring CO_2 reductions that go beyond current Building Regulations);

2. Requiring developers to demonstrate that those higher standards and other sustainable design measures have been implemented (e.g. through submission of an Energy or Sustainability Statement); and

3. Where measures cannot be implemented onsite, considering the introduction of, for example, carbon offset funds, biodiversity banks or other mechanisms, that would allow the Council to facilitate improvements elsewhere.

It is noted in Section 3.1.1.2 that the Future Homes Standard would potentially limit Local Authorities' opportunity to set higher standards than those required by Building Regulations (affecting recommendations that fall under the first category listed above). In regard to the second category, the White Paper includes several proposals aimed at streamlining the planning process, including reducing the number of supporting documents that must be submitted in support of a planning application (e.g. Energy Statements). Similarly, in regard to the third category, the consultation includes changes to S106 and CIL requirements that may result in these being replaced with a more standardised infrastructure contribution set at a national level. Since carbon offset contributions are typically secured through S106 or CIL arrangements, again this would tend to limit the Local Authorities in their response to carbon and/or biodiversity priorities. In light of these proposed changes and uncertainty around what a future Infrastructure Levy would entail, and how it would work as a potential mechanism for carbon adaptation and mitigation project funding, the viability of alternative funding mechanisms should be explored.

Although these issues would tend to restrict Local Authorities in their ability to set and implement climate change mitigation and adaptation policies, some of the other changes potentially offer new avenues for doing so. In particular, there may be the potential for Design Codes to include stronger sustainability requirements under the new rules-based approach. Perhaps more significantly, the designation of different sites as being suitable for 'growth', 'renewal' or 'protection' would have a major impact on outcomes in terms of climate change mitigation and adaptation. **Local Authorities would need to consider how these designations would impact the ability to deliver natural capital improvements and large-scale renewable energy schemes or associated infrastructure because, as this study has shown, these will be significant in terms of delivering on Authorities' Net Zero targets.**

The outcome of the 'Planning for the Future' consultation, like that of the Future Homes Standard consultation, remains uncertain. (We note that the Future Homes Standard consultation response is due in Autumn 2020 which may clarify the role that Local Authorities can play in setting energy efficiency standards for new build developments.) Therefore, the policy recommendations set out in this document reflect the powers delegated to local planning authorities at the time of writing (August 2020) and for the most part these are similar in scope to policies that have already been adopted elsewhere.

Recognising that the adoption of Net Zero targets and Climate Emergency declarations requires a step change in the scale and pace of response, in some instances, we have put forward 'higher ambition' options that go beyond current practice. However, in each case we have sought to highlight this, and provide technical justification where appropriate.

Appendix B – Estimated CO_2 Savings in Existing Dwellings

In order to estimate the potential impacts of heating demand reduction and switching to DEH or ASHP systems, the following assumptions were used.

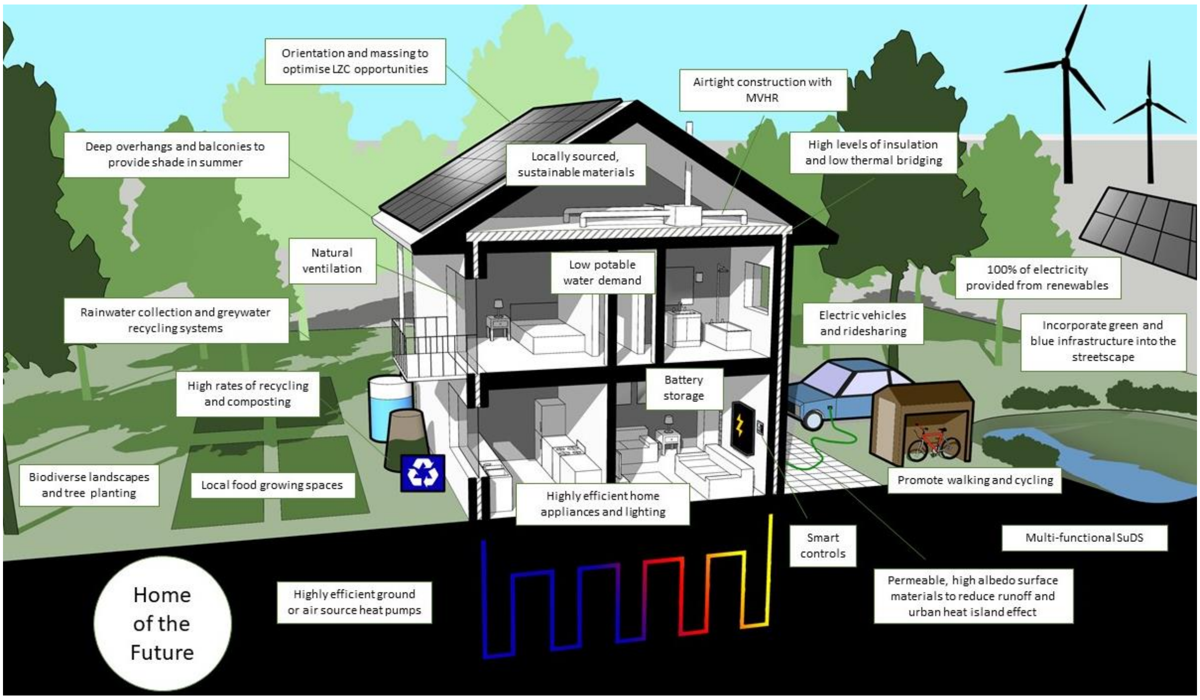
Fuel use	kWh p.a.	Reference
Current median gas consumption	13,073	NEED (2016) median gas consumption in Staffordshire
... with demand reduction	6,537	Based on user inputs for % reduction in heat demand
… if delivered by DEH	5,229	Assumes gas boiler is 80% efficient and DEH is 100% efficient
… if delivered by ASHP	2,092	Assumes ASHP with COP of 2.5 versus 80% efficient gas boiler
Current median electricity consumption	3,136	NEED (2016) median electricity consumption in Staffordshire
… of which regulated	1,254	Estimate based on 'Powering the Nation'
… of which unregulated	1,882	Estimate based on 'Powering the Nation'

Assumptions about heating systems		
Typical boiler efficiency	80%	AECOM estimate
Typical ASHP COP	2.5	AECOM estimate

Carbon emission factors	**$kgCO_2$ /kWh**	
Gas CEF	0.186	BEIS, *'Local Authority CO_2 emissions'* (2019) For more information, see the Baseline Report
Electricity CEF (current)	0.254	BEIS, *'Local Authority CO_2 emissions'* (2019) For more information, see the Baseline Report
Electricity CEF (decarbonised)	0.130	Based on current highest level of national grid decarbonisation, per https://carbonintensity.org.uk/

Assumptions about demand reduction		
Heating demand reduction (Compared with median gas consumption figures)	50%	AECOM estimate – *NEED statistics indicate that the typical savings from common cost-effective measures result in heating demand reduction of around 5-12% whereas statistics from the Passivhaus Institute and Energiesprong show that deep energy retrofits can reduce heating demands by 75-90%*

Appendix C – What Does a 'Home of the Future' Look Like?



In response to net zero carbon targets and the need for climate change resilient buildings, the home will be required to undergo a significant evolution over the coming decades. This vision will influence the way we design, construct and occupy our homes.

The geometry of the home will be expected to adapt in order to optimise the form factor, limiting the exposed envelope area and potential for heat transfer to occur with the surrounding environment. Other changes will include a tendency toward high ceilings and shallow plans. Reserved usage of high-performance glazing will assist in mitigating against the increased overheating risk. It is likely that we will see an increase in fixed external shading devices on homes, for example shutters and louvres, to assist with adaptation.

Dwellings will have a high fabric efficiency due to well-insulated air-tight envelopes which will assist in reducing heating and cooling demands for the space. The structure will have an increasingly important role to play, properties of thermal mass will be exploited to regulate internal temperatures within the dwelling and to take advantage of lower night-time temperatures.

Materials will be sustainably procured through accredited schemes whilst their specification will consider both human health and environmental impact. Use of healthy materials will be commonplace, with no VOCs and which take into account the implications for embodied carbon and circular economy. For example, products derived from biological materials and non-composites, encouraging recycling and disassembly will be used. Self-finished materials are likely to be favoured, reducing the material intensity of construction. Use of high albedo surfaces externally will be common to assist in mitigating overheating risk.

A future home will have a low space heating demand with the most considerable demand attributable to the domestic hot water requirement. With the phasing out of gas boilers, this demand will likely be met by an electric heat pump or through a district heating network. Through the implementation of strategic design measures to combat overheating, the need for active cooling can be reduced, although current climate forecast projections indicate that this is likely to be unavoidable by the end of the century.

Where an efficient thermal envelope will assist in reducing space heating and cooling demands, unregulated loads will have a relatively more significant influence on electricity demand. Whilst energy efficient appliances and fittings will be standard in all dwellings, demand-response ready appliances are expected to emerge for domestic use, which alongside smart metering technologies will regulate load. Increased uptake of EVs will increase demand for home charging facilities, significantly influencing the way power is used domestically.

The electrical load is expected to be met through clean energy from the grid and supported by local renewable energy infrastructure. Installations of photovoltaics are expected to be widely taken up, with other technologies, such as solar hot water heaters and small-scale wind, expected to also grow in popularity. In partnership with increased renewable energy generation, the installation of home battery storage is expected to increase, allowing electricity to be drawn from the battery at peak times to regulate load on the grid and the cost on time-of-use system tariffs.

The need for water efficiency in buildings will become increasingly significant as climate change creates warmer and drier summers in the UK. The use of low-flow fittings and metering have become standard for new-build dwellings, but rainwater harvesting and greywater recycling are expected to become more common in dwellings for uses such as toilet flushing.

In contrast, more frequent extreme rainfall will require an increased resilience to flooding, with dwellings likely to have improved provision and capacity of rainfall gutters and adapted flood-tolerant foundations. Direct flood risk to buildings will also be mitigated through the integration of SuDS to manage rainfall and surface water, with the aim of reducing runoff to greenfield rates.

Utilisation of SuDS and other blue-green infrastructure features will be integrated within residential developments to assist in combatting the urban heat island effect, particularly in denser areas. These features will encourage nature conservation and biodiversity and the potential for local food growing in these residential areas. Other planting will need to be resistant to droughts to avoid the need for supplementary watering during drier summers. There is also an opportunity for local planting to provide shade to dwellings during the summer period, which will reduce the cooling demand.

Much of the building stock that will exist in 2050 has already been built, with new construction adding only 1-2% annually. In order to meet net zero carbon targets many of the homes of the future will retrofitted for resilience and enhanced energy efficiency.

Appendix D – LZC Results for each Local Authority (Source: SQW, 2011)

The table below shows the results of the area-wide LZC assessment undertaken by SQW (2011) as presented in Tables 3-2 and 3-2 of that report. When interpreting these results, please refer to the more detailed discussion of limitations and other considerations in Section 4.1.

Technology		**Cannock Chase**	**East Staffordshire**	**Lichfield**	**Newcastle-under-Lyme**	**South Staffordshire**	**Stafford**	**Staffordshire Moorlands**	**Tamworth**	**Total**
Onshore wind	Large scale	40	1,209	1,148	540	497	1,901	1,208	23	**6,565**
	Small scale	0	45	45	27	0	40	52	0	**209**
Hydro		0	2	0	0	0	2	3	0	**8**
Solar	Photovoltaics	22	32	26	28	27	40	29	15	**219**
	SWH	18	25	21	24	22	34	22	12	**179**
Heat Pumps	GSHP	40	48	42	46	42	59	42	25	**345**
	ASHP	160	191	167	184	170	237	170	102	**1,381**
Biomass	Managed woodland - elec	0	1	1	1	1	2	1	0	**7**
	Managed woodland - heat	0	1	1	1	1	2	2	0	**9**
	Energy crops - elec	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**45**
	Energy crops - heat	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	**259**
	Waste wood - elec	1	1	1	1	1	1	1	0	**6**
	Waste wood - heat	1	1	1	1	0	1	0	0	**6**
	Agricultural arisings (straw)	0	1	2	0	2	2	0	0	**8**
	Animal waste (wet organic waste)	0	9	3	5	4	15	14	0	**50**
	Animal waste (poultry litter)	0	0	0	0	0	0	0	0	**1**
	Municipal solid waste	3	4	4	4	4	4	3	2	**28**
	Commercial & Industrial waste	2	4	3	3	2	4	2	2	**22**
	Landfill gas	2	0	0	0	0	0	0	0	**3**
	Sewage gas	0	1	0	0	2	1	1	0	**5**
	Co-firing of biomass	106	0	0	0	0	0	0	0	**106**

Appendix E – Key Variables Impacting the DECC (2010) LZC Capacity Assessment

The table below summarises the results of AECOM's review of the SQW (2011) study which followed the DECC (2010) methodology for assessing potential future LZC capacity. It highlights whether any changes may have occurred in the past decade that would impact the results.

Technology	Change since 2011?	Notes
Commercial scale wind	Yes – policy constraints	No change in physical resource but policy context places significant new restrictions on deliverable capacity
Small scale wind	No	Little or no change in physical resource. Calculation is based on the number of properties with different windspeeds adjusted by rural/urban classification, so any change would be due to large amounts of new development. However, it is assumed that the density of any new major development would make those properties unsuitable
Biomass - Managed woodland	No	Recommendations in Section 4.2 of this report would increase the amount of managed woodland in Staffordshire. However, this is not recommended for widespread adoption due to air quality concerns and competing priorities with regard to habitats and biodiversity, in line with CCC and DEFRA recommendations.
Biomass - Energy crops	No	The principle of the DECC Methodology is that land no longer needed for food production could be used for energy crops to avoid competing with other land uses. The amount of utilised agricultural land in the UK has remained stable since 2000 so it is assumed there has been no significant change in the potential resource. However, uptake of the Energy Crop Scheme was extremely low and it ended in 2013; financial incentives would be needed to support this change. The real potential lies in freeing up land that is currently used for livestock (grazing or growing feed) which is not considered as part of this study.
Biomass - Waste wood	N/a	As per 'managed woodland'. Furthermore, it is desirable to reduce the amount of waste generated, including waste wood.
Biomass - Agricultural arisings (Straw)	N/a	Not recommended due to air quality concerns.
Biomass - Wet organic waste	Yes - Minor	The SQW study used 2007 figures for numbers of livestock. Since then there has been a 4% decrease in cattle and 3% increase in pigs in Staffordshire.
Biomass - Poultry litter	Yes - Major	The SQW study used 2007 figures for numbers of poultry. Since then there has been a roughly 92% increase in poultry numbers in Staffordshire, suggesting that this resource has increased. However, the DECC methodology assumes that this will be used in direct combustion, which is not recommended due to air quality concerns, in line with DEFRA guidance.
Municipal Solid Waste	-	Not recommended because the priority should be to reduce and separate biodegradable waste.
Commercial & Industrial Waste	-	Not assessed as there is no central data held; also see notes on MSW (above).

Landfill gas	Yes – Major	DECC (2010) states: *'Current landfill sites have a limited useful lifetime as sources of bio-gas and will be exhausted by around 2020. There is unlikely to be much new landfill gas resource due to the EU Landfill Directive which caps landfill, especially post-2014, and due to policies to promote other waste management processes such as AD, composting and recycling, which will reduce significantly the biodegradable fraction of landfill waste.'* Therefore it is assumed that there is no additional capacity.
Sewage gas	Yes - Minor	DECC (2010) suggests using records of existing sewage gas installations to assess capacity, on the assumption that the majority of sewage gas resource is already utilised. Our review of the REPD and RO database suggests that there has been no change since 2011. The population has increased by around 3.5% across the County since 2010 so in principle there would be some additional potential capacity.
Co-firing of biomass (with a fossil fuel)	-	This was assessed as part of the SQW (2011) study but is not recommended due to use of fossil fuel and due to air quality concerns related to biomass (see above).
Hydropower	No	Assume no change in physical resource. The SQW report indicates that the EA would likely oppose the construction of additional barriers.
PV and SHW ASHPs GSHPs	Yes	Calculations rely on the number of domestic, non-domestic and industrial buildings in a given area. These have been updated based on Census 2011 figures for numbers of households. No information was available regarding current non-domestic or industrial buildings.

Appendix F – Carbon Sequestration Links to Current Actions

The table below provides detail on key habitats and current actions outlined within green infrastructure and/or green space strategies for each Local Authority which also have the potential to improve and increase carbon sequestration. Making these links can help to outline opportunities to secure and protect carbon stocks whilst delivering wider environmental, social, and economic objectives.

Table 5.11: Key habitats for sequestration and their links to actions within existing strategies

Local Authority	Key habitats for sequestration	Link to wider actions within GI / green space strategies
Staffordshire	-	▪ Protect and improve existing natural habitats ▪ Increase connectivity by linking, buffering and expanding existing sites of importance ▪ Measure and monitor the value of ecosystem services ▪ Achieve environmental net gain for developments and utilise opportunities for habitat creation through the planning system
Stafford	▪ Floodplain meadow ▪ Heathland ▪ Bog ▪ Wetland ▪ Agricultural ▪ Woodland	▪ Wetland habitat connectivity ▪ Improving woodland habitat connectivity ▪ Opportunities through Environmental Net Gain activities from HS2 ▪ Maintaining/enhancing connections between communities and the countryside ▪ Improving accessibility and use of green/blue spaces
Staffordshire Moorlands	▪ Moorland and upland habitat ▪ Agricultural ▪ Peak District National Park ▪ Limestone calcareous grassland & diverse grassland habitats	▪ Provide a wide variety of parks, wild areas and open spaces to meet the needs of both nature and people ▪ Create and enhance green travel links ▪ Create and enhance biodiversity and ecological networks ▪ Improve flood and water management ▪ Protect and enhance the ecosystem services green infrastructure provides such as soil conservation, water management, air quality and crop pollination ▪ Preventing decline of moorlands ▪ Restoring moorlands
Newcastle-under-Lyme	▪ Urban greenspace ▪ Agricultural ▪ Lowland habitat ▪ Brownfield ▪ Wetland	▪ Improving green infrastructure network and connectivity ▪ Further create grasslands on restored opencast coal sites such as Apedale Community Country Park ▪ Opportunities through Environmental Net Gain activities from HS2 ▪ Capturing the benefits of green infrastructure ▪ Making the Borough more resilient and biodiverse
South Staffordshire	▪ Agriculture ▪ Lowland heath ▪ Grassland ▪ Floodplain ▪ Woodland	▪ Reconnect the southern heathlands: provide ecological connectivity between sites such as Highgate Common, Kinver Edge and Penn Common.
Tamworth	▪ Urban greenspace ▪ Agricultural ▪ Grassland	▪ Creation and management of new community woodland ▪ Improving local nature reserves ▪ Provide opportunities for key species to move across urban areas ▪ Provide suitable quality greenspace ▪ Protect fringing habitats along watercourses
East Staffordshire	▪ Woodland / National Forest ▪ Floodplain ▪ Lowland habitat ▪ Heathland ▪ Moorland ▪ Grassland	▪ Enhancement of habitat connectivity in urban areas ▪ Creation / enhancement of quality greenspace ▪ Protect fringing habitats along watercourses ▪ Continue to identify opportunities for habitat creation as part of quarry restoration
Lichfield	▪ Lowland heathland ▪ Woodland ▪ Grasslands ▪ Wetland areas ▪ National Forest	▪ Creation / enhancement of green spaces ▪ Wider AONB management including surrounding landscape and habitats ▪ Enhancement of ecological networks and connectivity ▪ Parks maintained to a favourable condition ▪ Sustainable heathland management ▪ Increasing and improving woodlands, hedgerows ▪ Opportunities through Environmental Net Gain activities from HS2
Cannock Chase	▪ Lowland heath, ▪ Acidic grassland, ▪ Woodland and ▪ Urban greenspaces	▪ Enhancement and restoration of woodland and heathland ▪ Mitigate the impact of development and recreation on Cannock Chase SAC ▪ Linking of heathland sites in the Cannock Chase to Sutton Park area ▪ Enhancement of brownfield habitats

Key habitats and environmental actions summarised from Staffordshire Wildlife Trust (2016) and green infrastructure strategy and/or infrastructure delivery documents for each local authority - see Appendix J for more detail.

Appendix G – Overview of Potential Costs, Funding and Delivery Mechanisms for Offsetting and Sequestration Projects

Some Staffordshire Local Authorities have set a target of reaching Net Zero for their own emissions. While it is important to prioritise demand reduction and energy efficiency measures, it is likely that some residual emissions may need to be offset e.g. through the delivery of LZC or carbon sequestration projects. This appendix provides a brief overview of some of the key considerations related to costs and delivery mechanisms for such projects.

All costs shown below are illustrative. Costs and funding opportunities are subject to change over time. This information is intended only as a starting point for further investigation.

G.1 Afforestation

Woodland creation ('afforestation') offers a non-technological carbon reduction solution with multiple co-benefits and relatively low costs of establishment. One of the key costs will be the initial purchase of land (if applicable). This varies depending on the location and use class but may range from £10,000 per hectare to upwards of £20,000 per hectare.[149] Other initial costs depend on the size and type of trees planted, and the intended maintenance regime or purpose of the woodland.[150] These may include:

- planning, design and consultancy fees;
- machinery (if used);
- site and ground preparation;
- planting materials (e.g. seedlings, tree protection, etc.)
- fencing; and
- labour.

A report by the Forestry Commission that consolidated data from multiple studies indicates that these one-off costs add up to £5,000- £7,700 per hectare for sites in England.[151] The subsequent costs associated with upkeep and maintenance, including fencing repairs, weeding, replacement of trees, insurance, etc. were around £400-700 per hectare per year. Depending on the previous land use, there may also be opportunity costs associated with the cessation of agricultural production.

Depending on the type of woodland and how it is managed, afforestation can provide revenue from the sale of timber products, the sale of carbon credits, and other sources such as recreation activities. A report by the Forestry Commission suggests that new woodland could generate £400 to £1,300 per hectare in this way – although it is important to note that the costs and benefits vary widely. [152]

There are various sources of funding available for woodland creation in the UK, which are summarised below.[153]

Woodland Creation Planning Grant (WCPG)

The WCPG offers funding to develop a 'Woodland Creation Design Plan' that is compliant with the UK Forestry Standard, as a first step towards developing a new woodland. The scheme requires new woodland to be at least 10 hectares in size (other criteria apply). [154] The grant scheme operates in two stages, which in total would provide £150 per hectare, up to £30,000 per project. WCPG outputs can be used as part of a subsequent application to the Woodland Carbon Fund (see below).

Woodland Carbon Fund (WCF)

Note: At the time of writing the WCF is open to new applications until March 2021. The WCF[155] offers landowners and local authorities capital funding to help with the cost of planting trees, protection items (such as individual tree

[149] Research from Savills suggests that the average price of agricultural land in the West Midlands was around £7,294 per acre (£18,024 per hectare) in December 2019. Source: https://www.savills.co.uk/property-values/rural-land-values.aspx
[150] https://forestry.gov.scot/support-regulations/farm-woodlands/costs-of-creating-and-managing-woodland
[151] Forestry Commission, *'Comparing the cost-effectiveness of forestry options for climate change mitigation'* (2019). Available at: https://www.forestresearch.gov.uk/research/comparing-cost-effectiveness-forestry-options-climate-change-mitigation/
[152] Forestry Commission, *'Assessing the investment returns from timber and carbon in woodland creation projects'* (2017). Available at: https://www.woodlandcarboncode.org.uk/images/PDFs/FCRN031a.pdf
[153] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/844836/Woodland_grants_and_incentives_overview_table_-_Nov._2019.pdf
[154] https://www.gov.uk/guidance/woodland-creation-planning-grant
[155] https://www.gov.uk/guidance/woodland-carbon-fund

shelters, fencing, and so on), and the creation of forest roads or other infrastructure for access or maintenance. As with the WCPG, applications are subject to a minimum size requirement of 10 ha. Applicants can choose from two different funding rates:

- The 'standard' planting rate (for most proposals) which covers 80% of the capital costs for establishment, capped at £6,800 per hectare; or
- The 'priority places' planting rate (for proposals close to certain urban areas that offer public pedestrian access), which covers 100% of the above costs, capped at £8,500 per hectare.

After the woodland is established, applicants can also receive £1,000 per hectare in Year 5.

Countryside Stewardship Woodland Creation Grant

Note: At the time of writing the Countryside Stewardship scheme only offers funding for projects that are agreed and signed prior to 31st December 2020. Like the WCF, this grant is intended to help fund capital works associated with woodland creation. It provides a one-off payment for trees and associated protection items. Successful applicants have two years in which to purchase and install these items. After the final capital claim is paid, applicants can apply for an additional 'Woodland Management Grant' which helps to cover the cost of ongoing maintenance of trees after they have been planted, at £200 per hectare per year for 10 years.[156]

Woodland Carbon Code (WCC)

The Woodland Carbon Code[157] is the national standard for verifying and validating carbon savings from afforestation projects in the UK. Accredited schemes have the opportunity to sell 'carbon credits' which represent CO_2 savings generated by the new woodland. This can provide an additional source of revenue if, for example, a project is not cost-effective with WCF funding.

Woodland Carbon Guarantee (WCaG)

In November 2019 the Government announced a new £50 million scheme aimed at promoting afforestation, whereby the Government would agree to purchase WCC carbon credits from a participant at an agreed price set by auction. Instead of a grant or loan towards the cost of woodland creation or maintenance, this scheme offers WCC participants a guaranteed income over a 35-year period, although they are also free to sell carbon credits on the open market.[158]

G.2 Solar (PV) Farms

Despite the closure of the UK's Feed-in Tariff in 2019, solar energy remains a cost-effective way of generating electricity and avoiding CO_2 emissions thanks to technological improvements, radically reduced equipment costs and rising wholesale energy prices.

The initial costs of developing a solar farm depend on multiple variables, such as the price of land, the type and layout of panels, grid connection, planning or environmental permissions, availability of grants / subsidies, and so on. These can range from around £500,000 to £1 million per megawatt (MW) of installed capacity, although research by the Solar Trade Association suggests that the lower end of the range is more typical – and that costs will continue to decrease in the coming years.

Annual operational costs are estimated at roughly 1.5% to 2.5% of capital costs, which would be around £20,000 per year for a £1,000,000 project.[159] Most manufacturers offer warranties that guarantee at least 80% of the original output after 25 years.

Since the closure of the Feed-in Tariff (FiT) in 2019, there is little financial support for developing solar farms in the UK, although it is still possible to generate revenue via the sale of surplus electricity through participation in the Smart Export Guarantee (SEG), which came into force in January 2020. The SEG requires electricity suppliers to offer export tariffs to (relatively) smaller-scale LZC energy generators that export electricity to the grid. The scheme applies for LZC energy installations up to 5MW in size.[160]

[156] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/823699/Woodland_Creation_Manual_2018.pdf
[157] www.woodlandcarboncode.org.uk
[158] https://www.gov.uk/guidance/woodland-carbon-guarantee
[159] https://www.solarpowerportal.co.uk/news/uk_solar_costs_plummeting_beyond_forecasts_as_cheap_as_40_mwh_by_2030
[160] https://www.ofgem.gov.uk/publications-and-updates/smart-export-guarantee-guidance-generators

In addition, a Local Authority could 'sleeve' electricity back to its own sites via a PPA, allowing it to benefit from price certainty. This would reduce exposure to energy price hikes and help to reduce energy costs in the long term. If the Local Authority owns the site but does not operate the solar farm, it could potentially collect rent as a landlord e.g. as a percent of revenue.

If battery storage is co-located with the solar farm, this opens up the potential for generating additional revenue streams by providing grid services. This was the approach taken by West Sussex County Council in delivering the UK's first subsidy-free solar farm, located in Westhampnett and completed in 2018. The installation includes a 7.4 MW PV capacity and a 4.4 MW battery unit.[161] Other subsidy-free solar farms have since continued to come forward.

G.3 Other Sources of Funding

It is likely that, in the coming decades, additional funding schemes will be made available to support afforestation and LZC uptake, if the UK is to meet its targets under the Climate Change Act. However, even without subsidies, Local Authorities have a range of options for funding these projects. Examples could include:

- Direct investment using the Councils' own reserves;
- Taking out loans e.g. from the Public Works Loan Board;
- Unspent capital project funding;
- The Housing Revenue Account (HRA); or
- Joint ventures with other Local Authorities or businesses.

There are also opportunities to explore more innovative sources of funding such as bond or share offers to the local community. For example, Chapel Farm Solar Park, a 5 MW solar farm on a disused landfill site in Swindon, was partially funded by the Council along with community members and businesses, thanks to 'solar ISAs' that offered participants a tax-free return on their investment over 20 years.

Both afforestation and PV farms could provide potential sources of revenue (or cost savings) that could, in turn, be used to fund additional offsetting projects. These include:

- Sale of timber products from new woodland;
- Sale of renewable electricity;
- Sale of carbon credits generated by new woodland creation or renewable electricity;
- Rent from PV projects where the Council is the landlord;
- Grid services using battery storage; and
- Cost savings on the Councils' energy bills.

G.4 Delivery Methods

There are a range of potential options for delivering carbon offsetting projects ranging from direct investment and long-term ownership (or renting) by the Councils to 3rd party investment and ownership. If capital is available, there are advantages to ownership as this would result in direct benefit from the revenues or other benefits of the projects and long-term control of the assets. There are also various options between these two extremes including power purchase agreements, partnerships and community share schemes.

Given the different financial implications of renewable energy and sequestration projects, one approach that could be considered would be to create an offsetting vehicle that initially invests in one/more large renewable energy projects like a large PV farm and then uses the revenues from this to build up a fund that could be used to support the longer-term investment needed for the creation and management of sequestration projects like woodlands.

We would recommend that options for delivering and commercialising the offsetting opportunities are discussed internally within the Councils to understand the appetite for funding via capital investment or borrowing and the benefits and risks associated with long term ownership and management of renewable energy and sequestration assets.

[161] /www.solarpowerportal.co.uk/news/uks_second_subsidy_free_solar_farm_completed_by_west_sussex_council_using_b

Appendix H – Climate Risk: Source of Data / Information

H.1 Anticipated Development Shapefiles

The following shapefiles were provided by and confirmed with the district councils within Staffordshire for analysis within the climate risk aspect of this work.

District Council	Shapefiles agreed for anticipated
Cannock Chase	No shapefiles received
East Staffordshire	New Mapped SHLAA Sites 2016
Lichfield	Local Plan Review Proposed Residential allocation
Newcastle Under-Lyme	SHLAA (2019)
South Staffordshire	SHSID Housing Growth
Stafford	SDL Employment Region SDL Housing Region Leftover Allocation.
Staffordshire Moorlands	Preferred Employment Allocation Preferred Housing Allocation Preferred Mixed Use Allocation
Tamworth	Employment Allocation -presub Housing Allocation – presub

H.2 Vulnerability Data Acknowledgements

The Climate Just Tool is a product of the University of Manchester in collaboration with Tell Us tookit: http://climatejust.org.uk/

Neighbourhood Flood Vulnerability Index (NFVI):

The origin and IPR of the data for the NFVI is from Sayers and Partners; Sayers, P . B ., Horritt, M ., Penning Rowsell, E ., and Fieth, J . (2017. Present and future flood vulnerability, risk and disadvantage: A UK scale assessment. A report for the Joseph Rowntree Foundation published by Sayers and Partners LLP.

Socio-Spatial heat Vulnerability Index (HSVI)

The origin of the IPR of the data is from Lindley, S. J., O'Neill, J., Kandeh, J., Lawson, N., Christian, R. & O'Neill M. (2011) "Climate change, justice and vulnerability", Joseph Rowntree Foundation Report, York.

A further data acknowledgement for the HSVI:

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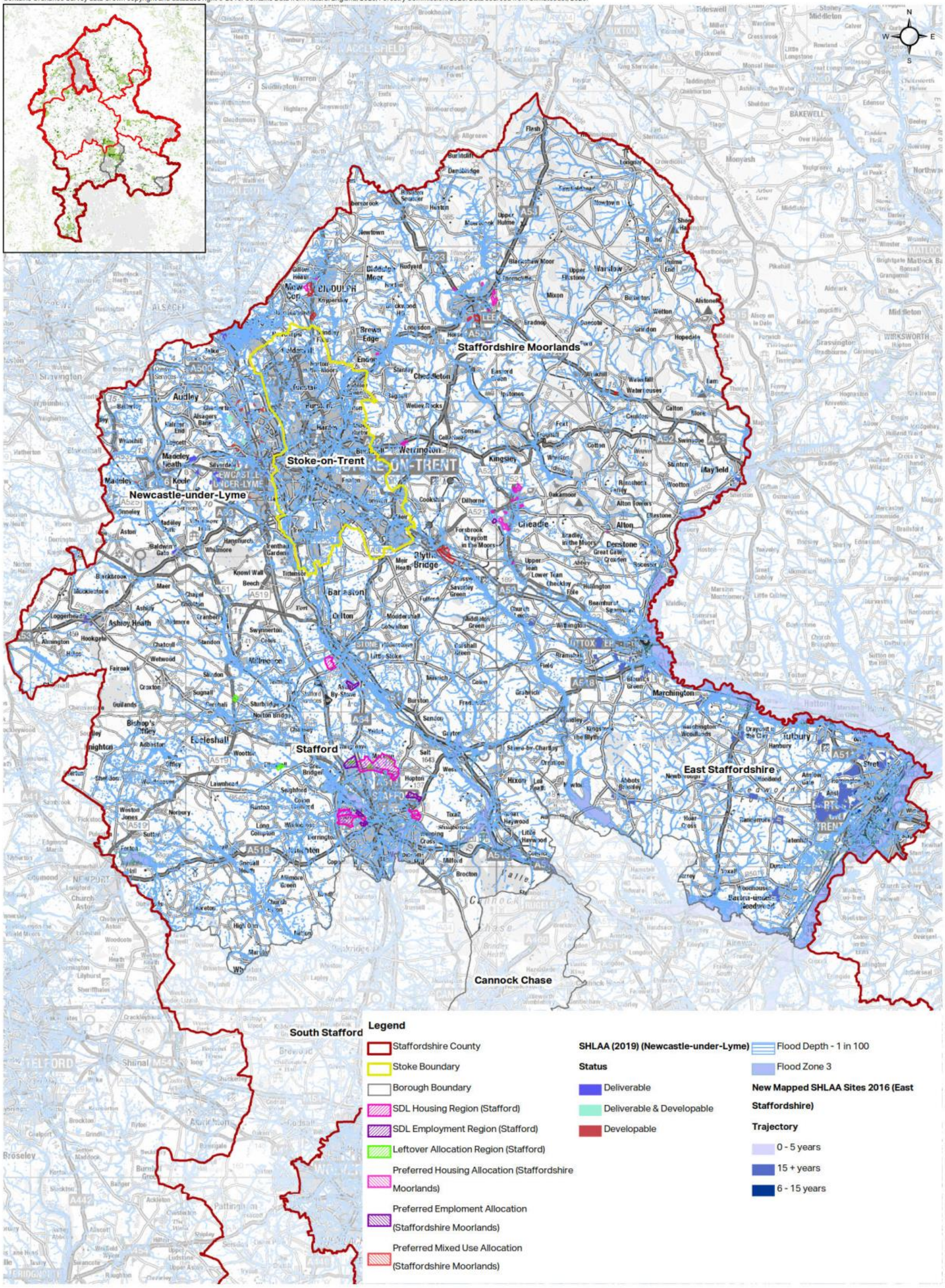
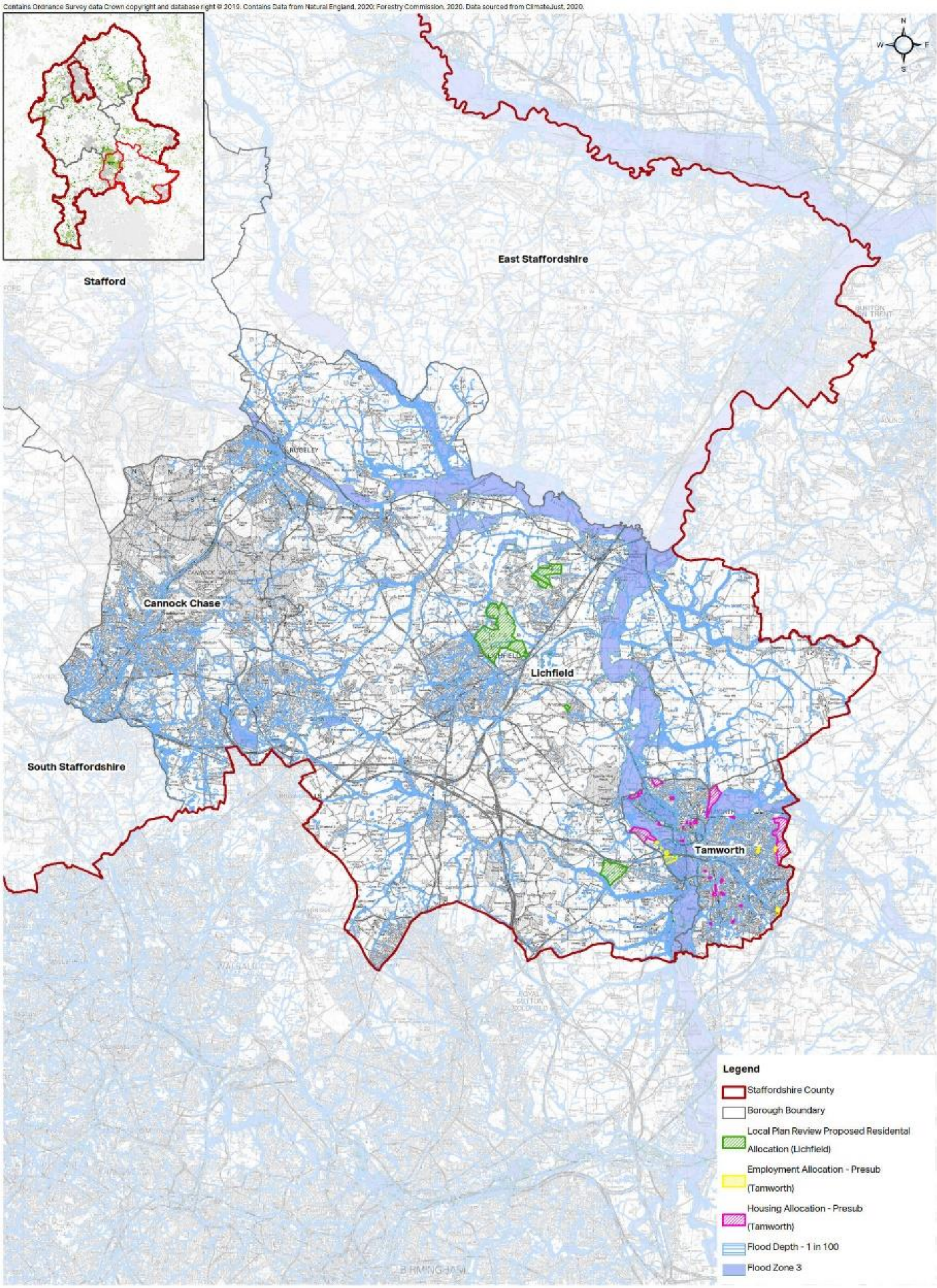
Appendix I Exposure to Flood Maps per District

I.1 Flood Zone 3 and 1 in 100 Exposure Maps



Staffordshire Climate Study: Flood Zone 3, 1 in 100 - North

Climate Change Adaptation & Mitigation for Staffordshire County Council

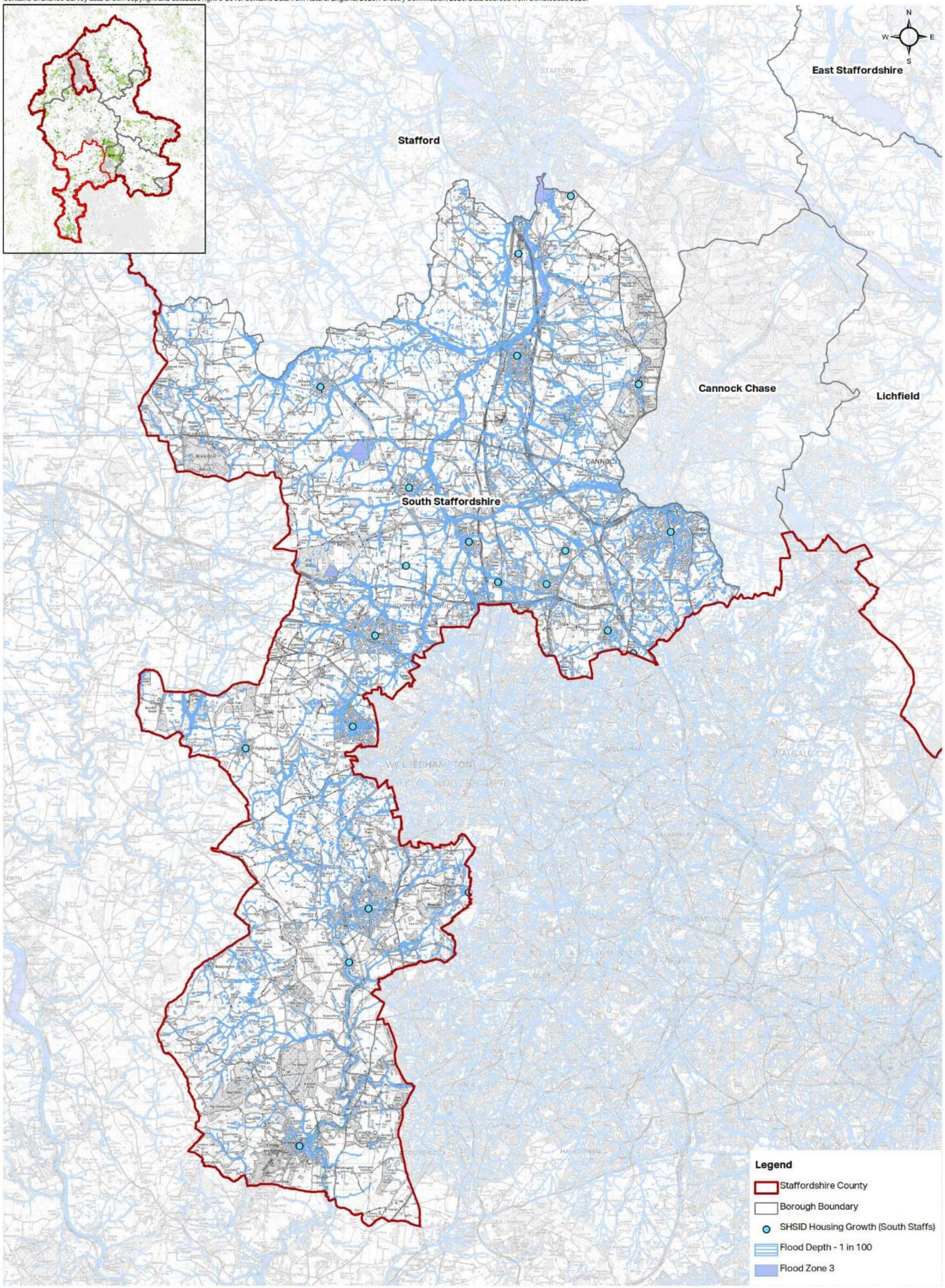


Staffordshire Climate Study: Flood Zone 3, 1 in 100 - East

Climate Change Adaptation & Mitigation for Staffordshire County Council

0 1.75 3.5 km

AECOM

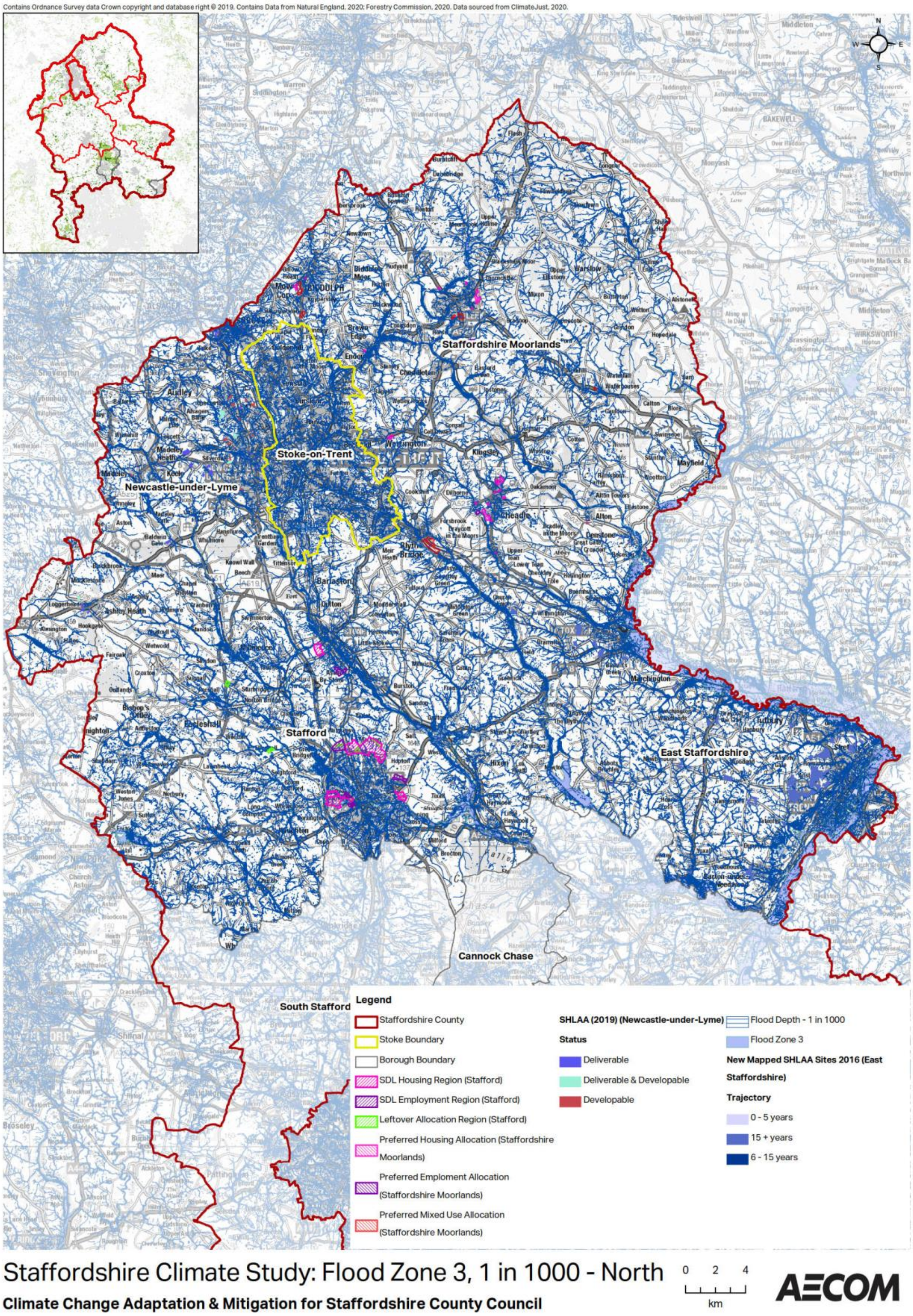


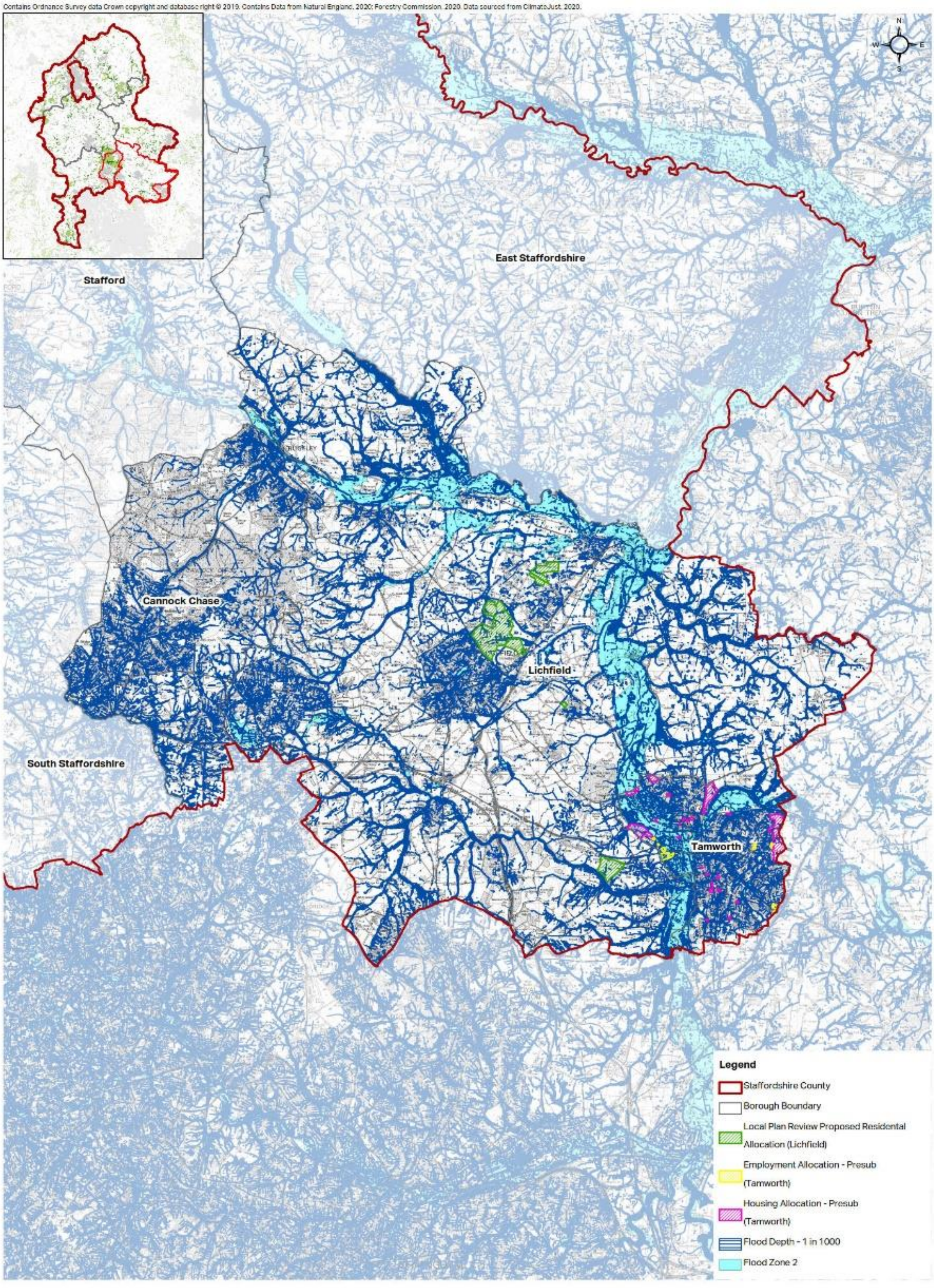
Staffordshire Climate Study: Flood Zone 3, 1 in 100 - South

Climate Change Adaptation & Mitigation for Staffordshire County Council

AECOM

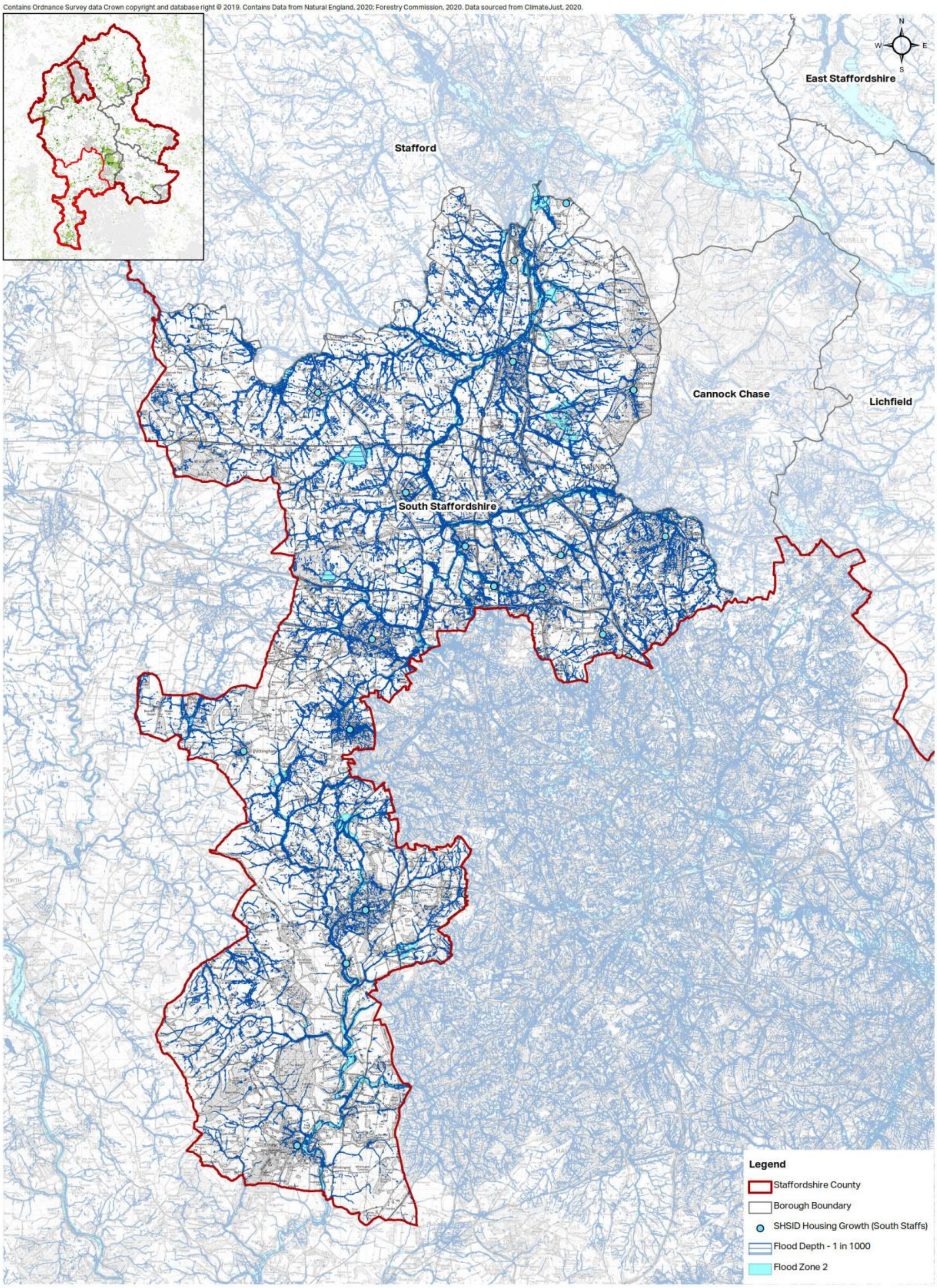
I.2 Flood Zone 2 and 1 in 1000 Exposure Maps





Staffordshire Climate Study: Flood Zone 2, 1 in 1000 - East

Climate Change Adaptation & Mitigation for Staffordshire County Council



Staffordshire Climate Study: Flood Zone 2, 1 in 1000 - South

Climate Change Adaptation & Mitigation for Staffordshire County Council

Appendix J – Carbon Sequestration Document Review

The table below presents references used for the carbon sequestration document review which informed the development of Section 4.1.3.3.

Table 5.12: Carbon sequestration document review - references

Reference	Category	Geography
Natural Capital Committee (2020). Advice on using nature based interventions to reach net zero greenhouse gas emissions by 2050.	Advice to Government	UK
BWOC at Yoxall, a Woodland Carbon Code project in Staffordshire run by Forest Carbon	WCC project details	Yoxall, Staffordshire
KIER at Montgomery Wood, a Woodland Carbon Code project in Staffordshire run by Forest Carbon	WCC project details	Alrewas, Staffordshire
Natural England (2019). Natural England's role in meeting climate change targets.	Government	UK
Staffordshire Wildlife Trust (2018). Staffordshire Wildlife Trust Vision 2017-2020.	Vision document	Staffordshire
Stafford Borough Council (2009). A green infrastructure strategy for Stafford Borough: the strategic plan.	GI strategy	Stafford
Staffordshire Wildlife Trust (2016). State of Staffordshire's Nature report.	Technical report	Staffordshire
Hölzinger, O. and Everand, M. (2014). Staffordshire Ecosystem Assessment. Stafford: Staffordshire County Council.	Technical report	Staffordshire
East Staffordshire (2018). Tree Planting Guidance.	Guidance	
Budget announcements for UK peatland restoration	Government	UK
Peatlands in the UK after Common Agriculture Policy (CAP)	Government	UK
Staffordshire Ecological Record (2013). Habitat atlas.	Mapping	Staffordshire
IUCN (2011).		UK
Committee on Climate Change (CCC) (2018). Land use: Reducing emissions and preparing for climate change.	Government	UK
Chrichton Carbon Centre (2015). Developing Peatland Carbon Metrics and Financial Modelling to Inform the Pilot Phase UK Peatland Code.	Technical report	UK
Committee on Climate Change (CCC) (2020). Land use: Policies for a Net Zero UK,	Government	UK
Committee on Climate Change (CCC) (2018). Land use: reducing emissions and preparing for climate change.		
Committee on Climate Change (CCC) (2015). Review and update the UK Agriculture Marginal Abatement Cost Curve to assess the greenhouse gas abatement potential for the 5th carbon budget period and to 2050.		
Stoke-on-Trent Greenspace strategy (2018)	Greenspace strategy	Stoke-on-Trent
Vivid (2020). Economic impacts of Net Zero land use scenarios. https://www.theccc.org.uk/wp-content/uploads/2020/01/Economic-impacts-of-Net-Zero-land-use-scenarios-Vivid-Economics.pdf	Government	UK

Newcastle-under-Lyme (2017). Newcastle-under-Lyme Green Infrastructure Strategy. Available at: https://www.newcastle-staffs.gov.uk/sites/default/files/IMCE/Planning/Planning_Policy/GreenSpaceStrategy/Newcastle_under_Lyme_Green_Infrastructure_Strategy_Final.pdf	GI strategy	Newcastle-under-Lyme
Staffordshire Moorlands District Council (2018). Staffordshire Moorlands Local Plan: Green Infrastructure Strategy. Available at: https://www.staffsmoorlands.gov.uk/media/3355/Green-Infrastructure-Strategy/pdf/22.10_SMDC_Green_Infrastructure_Strategy_May_2018.pdf?m=1531894585753	GI strategy	Staffordshire Moorlands
Stafford Borough Council (2009). A green infrastructure strategy for Stafford: the research and evidence base. Available at: https://www.staffordbc.gov.uk/live/Documents/Forward%20Planning/Examination%20Library%202013/D35-GREEN-INFRASTRUCTURE-STRATEGY-EVIDENCE-BASE.pdf	GI strategy	Stafford
Tamworth Borough Council (2018). Infrastructure delivery plan. Available at: https://www.tamworth.gov.uk/sites/default/files/planning_docs/Appendix-B-Infrastructure-Delivery-Plan.pdf	Infrastructure delivery plan	Tamworth
East Staffordshire Borough Council (2013). Green infrastructure study update 2013. Available at: https://www.eaststaffsbc.gov.uk/sites/default/files/docs/planning/planningpolicy/lpevidence/environment/East_Staffordshire_GI_Study%20Update%20Oct13.pdf	GI strategy	East Stafford
Lichfield District Council (2017). Strategic infrastructure delivery plan. Available at: https://www.lichfielddc.gov.uk/downloads/file/620/infrastructure-delivery-plan-2017-october-	Strategic infrastructure plan	Litchfield
Centre for Sustainable Energy (2019). West of England carbon reduction requirement study - carbon offsetting in the West of England. Available at: https://www.bristol.gov.uk/documents/20182/3368102/Carbon+Offsetting+in+the+West+of+England.pdf/894f7c11-33e4-a8b4-ec89-383828553184	Literature review	West of England Local Authorities