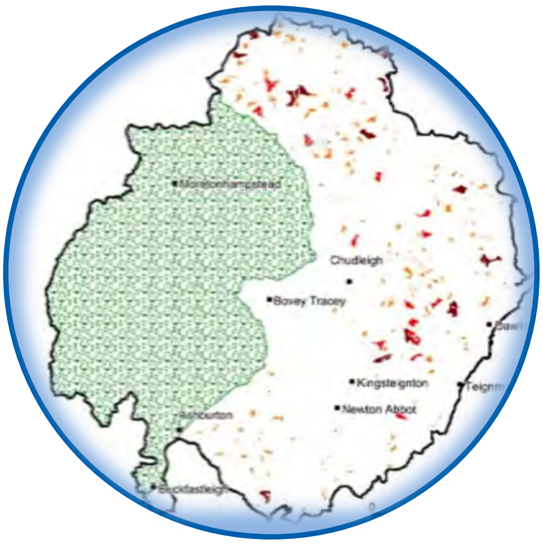
2021 low carbon evidence base for the Teignbridge local plan

CENTRE FOR ENERGY AND THE ENVIRONMENT

Internal Document 994

May 2021



Report Name:	2021 low carbon evidence base for the Teignbridge local plan
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Report Number:	Internal document 994
Publication Date:	May 2021

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Management Summary

Teignbridge District Council is developing its local plan and, in the context of Climate Emergency declarations and the Government's net zero target, commissioned the Centre for Energy and the Environment at the University of Exeter to provide an evidence report which addresses greenhouse gas (GHG) emissions, low carbon development and renewable energy generation options for the district.

The District's emissions in 2018 (including Dartmoor National Park) are dominated by transport (43%) followed by the domestic and commercial sectors (13% and 11% respectively; 24% combined) most of which is used for heating buildings. Electricity (a total of 12%, split evenly between the domestic and commercial sectors) is followed by waste (11%) agriculture (8%) and f-gases (2%). F-gas emissions arise mainly from refrigerant use in fridges, air conditioners and heat pumps.

Mapping at parish level shows emissions concentrated in the population centres and the road corridors through the district with waste emissions in Kingsteignton parish.

While waste and transport emissions have increased 17% and 6% respectively since 2008, overall emissions have been on a downward trend. However, while progress in Teignbridge has been made in the reducing emissions from the F-gas (-50%) , buildings (-17%) and agricultural (-14%) sectors the main cut has been in the power sector (-58%) where the increase of renewable's share of electricity on the national grid outside the District has achieved power emission reductions four times those achieved in the other sectors.

Local plan policy advice for key sectors includes:

- Encouraging renewable electricity generation particularly from onshore wind and solar photovoltaic (PV) panels by identifying areas of the district that are suitable for deployment of wind turbines and PV panels, encouraging the use of PV on new buildings, and requiring decarbonisation pathways for new fossil fuel plant.
- Promoting a fabric-first approach to new buildings to reduce heating demand followed by the use of low carbon and renewable energy technologies to supply heat (and power) to buildings.
- The co-location of new homes with likely existing or new employment sites and selecting sites which take advantage of public transport links to employment and leisure locations together with infrastructure provision to support walking, cycling, public transport, modal shift from cars, electric vehicle (EV) charging and provision of sites for large freight consolidation centres near major road links and smaller sites near urban centres with use encouraged by local HGV and delivery service restrictions.
- Afforestation and wetland restoration (peatland, marshland and estuaries) to remove carbon dioxide from the atmosphere.
- The use of low global warming potential refrigerants and systems which minimise the volume of refrigerant.

When considering strategic new development the order in which the carbon and energy impacts are considered has a key impact on their eventual emissions.

The recommended hierarchy is as follows:

Priority	Measure	Key aspects
1	Development location	Reduces transport need and gives access to sustainable transport
2	Site master planning	Solar master planning optimises use of natural light and heat
3	Building fabric	High performance fabric gives maximum thermal efficiency
4	Building services	Low carbon building services support fabric measures
5	Clean onsite energy	Low carbon / renewable energy reduces unavoidable emissions
6	Offsite measures	Developer contributions finance offsite carbon reduction where onsite measure are not practical/viable
7	In-use performance	To ensure actual performance aligns with design intent.

The development of local policy takes place in the context of the National Planning Policy Framework and Building Regulations. The Government is currently updating Building Regulations and has set out changes to the section which refers to energy and carbon dioxide emissions in homes (Part L) which come into effect in June 2022, prior to further implementation of tighter standards in the Future Homes Standard and the Future Buildings Standard (for non-domestic buildings) scheduled for 2025.

The reduction of carbon dioxide emissions mandated by Part L has slipped significantly behind the trajectory set out for zero carbon homes in 2007. A 29% reduction on 2006 Part L took place in 2013 marginally ahead of the 25% targeted for 3 years earlier. The 2016 zero carbon homes target was abandoned in the July 2015 Budget. The proposed 2021 uplift to the 2013 building regulations achieves a 50% reduction on Part L 2006, a marginal improvement on the 44% reduction which was due for implementation in 2013, a delay of eight years.

The Government has announced that it will not amend the Planning and Energy Act 2008, which means that local authorities will retain powers to set local energy efficiency standards for new homes. A number of English local authorities, including Exeter City Council, have required lower carbon dioxide emission requirements in their local plans. In Exeter, a local planning policy requirement for a 44% reduction on 2006 Part L, has been in place since 2013. Exeter has delivered significant amounts of housing since 2013 and has developed low carbon heat networks. Exeter's experience illustrates that the Part L 2021 standard is achievable in the region and therefore one which could have been delivered across a wider area in the intervening period. Experience in Exeter supports Teignbridge's existing Policy S7 requiring a 48% reduction over 2006 Part L and indicates that new policy should go further, in line with the more ambitious policies in the UKGBC's New Homes Policy Playbook.

Teignbridge currently produces some 35.2 GWh of renewable electricity from large scale wind and ground mounted solar photovoltaic (PV) sources, 7.5% of the Districts 468 GWh 2019 consumption. This compares with over 50% renewable generation for the UK as a whole. The wind resource in Teignbridge (excluding Dartmoor National Park) within a 2km of the national grid is estimated at 217 GWh. Without the grid constraint the resource rises to 313 GWh. The ground mounted PV resource is 771 GWh within 2 km of the national grid and 1,111 GWh without the grid constraint. While some wind and PV development will be mutually exclusive, the minimum total wind and PV resource identified significantly exceeds the district's current annual electricity demand. A more detailed PV resource assessment for the Bovey Basin with less stringent constraints identifies up to 57 sites with potential output of up to 353 GWh.

The combined overall electricity demand of 10,000 new homes and 10,000 EVs is estimated at some 66 GWh, equivalent to 14% of Teignbridge's current electricity consumption. Resourcing 66 GWh needs the identification of either 337 ha of land for wind or 161 ha of land for PV. Provided by wind alone, 66 GWh would require 30% of the 217 GWh wind resource to be developed. If distributed evenly across wind turbine sizes in this would result in four 2 MW turbines, two 1 MW turbines and thirty six 500 kW turbines. Alternatively, if provided by PV alone 9% of the resource would be required to generate 66 GWh resulting in approximately thirteen 5 MW PV farms, each occupying 12.2 ha.

It is estimated that an additional 406 GWh of electricity will be required to replace gas and liquid fossil fuels in Teignbridge indicating that replacing existing fossil fuel use with electricity requires six times more additional electricity supply than would be required to supply ten thousand new homes and electric cars. The total wind and PV resource in Teignbridge is technically sufficient to provide this amount of power. This scale of development will require far reaching changes to the electricity supply system. However, the extent of the local challenge of integrating new renewable energy generation in Teignbridge into the local and national electricity grid infrastructure, including energy storage, will depend on how much of the district's renewable energy resource is brought forward for development.

In the Sixth Carbon Budget the Committee on Climate Change provides guidance for local authorities recommending that they should work with their Distribution Network Operators, neighbouring authorities and across their wider climate and energy partnerships to prepare local energy plans for their area. Teignbridge will need to work closely with WPD on these plans, part of which will concern the connection of renewable energy and the provision of electricity storage. Local policy should be developed in the context of the Teignbridge local energy plan.

Contents

Glossary

Term	Meaning
£/m^2	Pounds per metre squared
AD	Anaerobic digestion
APSH	Annual probable sunlight hours
ASHP	Air source heat pump
BAU	Business as usual
BEIS	Department for Business, Energy and Industrial Strategy
CEE	Centre for Energy and the Environment
CHP	Combined heat and power
CIBSE	Chartered Institution of Building Services Engineers
CIL	Community infrastructure levy
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CSH	Code for Sustainable Homes
DCC	Devon County Council
DER	Dwelling Emission Rate
DNO	Distribution network operator
DNP	Dartmoor National Park
EfW	Energy from waste
EV	Electric vehicle
FBS	Future buildings standard
F-gases	Fluorinated gases
FHS	Future homes standard
g CO_2/kWh	Grams of carbon dioxide per kilowatt-hour
GESP	Greater Exeter Strategic Plan
GHG	Greenhouse gas
GIA	Gross internal area
GIS	Geographical information system
GWh	Gigawatt-hour
GWP	Global warming potential
ha	Hectare
heat load	A use of heat energy
HMU	Height monitoring unit
HP	Heat pump
kg CO_2/kWh	Kilogrammes of carbon dioxide per kilowatt-hour
kg CO_2/m^2	Kilogrammes of carbon dioxide per metre squared
km	Kilometre
km^2	Kilometres squared
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hour
kWh/m^2	Kilowatt-hour per metre squared
kt CO_2e	Kilotonnes of carbon dioxide equivalent

Term	Meaning
LPA	Local planning authority
LULUCF	Land use, land-use change and forestry
LZC	Low and zero carbon
m	Metre
m^2	Metres squared
$m^3/h/m^2$	Metres cubed per hour, per metre squared
MHCLG	Ministry of Housing, Communities and Local Government
MOD	Ministry of Defence
ms^{-1}	Metres per second
MSOA	Middle layer super output area
MVHR	Mechanical ventilation with heat recovery
MW	Megawatt
MWe	Megawatt electricity
MWth	Megawatt thermal
NATS	National Air Traffic Services
NEF	National Energy Foundation
NM	Nautical miles
NPPF	National Planning Policy Framework
NSIP	Nationally Significant Infrastructure Project
Pa	Pascal (metric unit of pressure $kg/m/s^2$)
PHPP	Passive House Planning Package
PSR	Primary surveillance radar
PV	Photovoltaic
RICS	Royal Institution of Chartered Surveyors
S106	Section 106
SAP	Standard Assessment Procedure
SSR	Secondary surveillance radar
t CO_2e	Tonnes of carbon dioxide equivalent
W/K	Watts per Kelvin
$W/m^2/K$	Watts per metre squared, per Kelvin
Wh	Watt-hour
WPD	Western Power Distribution

Introduction

Teignbridge District Council is developing its local plan and, in the context of Climate Emergency declarations and the Government's net zero target, commissioned the Centre for Energy and the Environment at the University of Exeter to provide an evidence report which addresses greenhouse gas (GHG) emissions, low carbon development and renewable energy generation options for the district.

The scope of the report is GHG emissions from energy use and other sources and renewable energy generation for future strategic development in the plan area. Anticipated shifts in travel modes, heating technologies and other emerging trends over the plan period such as energy storage have been taken into consideration.

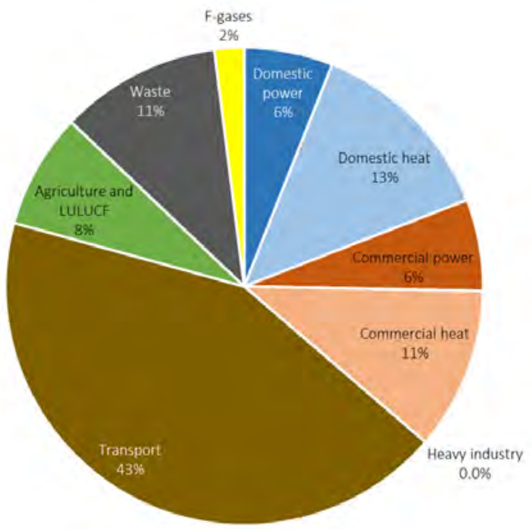
Where practical, the report is specific to the Teignbridge planning area which excludes Dartmoor National Park (DNP).

Greenhouse gas emissions in Teignbridge

Total GHG emissions for the district are presented in this section, followed by a commentary on the main contributing sectors: local factors, policy drivers and best practice measures to reduce sectoral emissions.

District wide emissions

Total GHG emissions for the district have been derived from published government data for fuel-derived emissions, supplemented by additional data sources for non-fuel emissions. The methodology is described elsewhere[1]. Government GHG and energy statistics do not separate DNP so it is not practical to exclude DNP emissions in this part of the report.



Sector	Emissions t CO_2e
Domestic power	57,620
Domestic heat	125,558
Commercial power	59,509
Commercial heat	105,477
Heavy industry	0
Transport	412,194
Agriculture and LULUCF	74,857
Waste	104,577
F-gases	19,205
Total	958,996

Figure 1: Teignbridge[2] greenhouse gas emissions in 2018

Figure 1 shows greenhouse gas (GHG) emissions for Teignbridge in 2018 expressed in percentages and tonnes of carbon dioxide equivalent (tCO_2e). Domestic and commercial emissions are split into power (meaning electricity consumption) and heat (meaning direct combustion of natural gas, bottled gas, oil and solid fuel). Although emissions from electricity generation and distribution may not occur within Teignbridge, emissions implicit in the consumption of electricity are attributed to Teignbridge as so-called Scope 2 (indirect) emissions. Emissions are dominated by transport (43%) followed by the domestic and commercial sectors (13% and 11% respectively; 24% combined) most of which is used for heating buildings. Electricity (a total of 12%, split evenly between the domestic and commercial sectors) is followed by waste (11%) agriculture (8%) and f-gases (2%). F-gas emissions arise mainly from refrigerant use in fridges, air conditioners and heat pumps.

Trends in emission since 2008 are show in Figure 2 and Figure 3.

[1] "Greenhouse Gas Inventories for SWEEG: Methodology Paper" SWEEG Internal Document 964, 2019
[2] Including the portion of Dartmoor National Park falling within the Teignbridge boundary

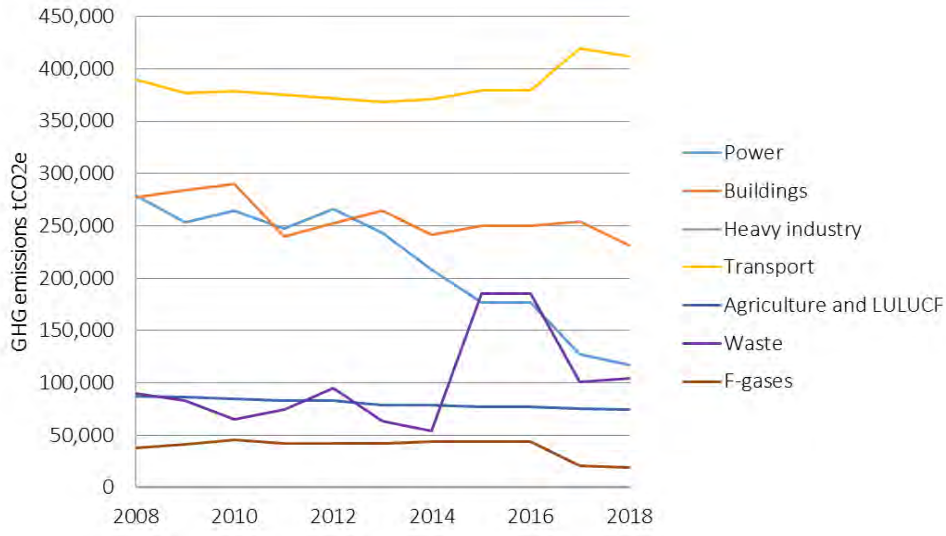


Figure 2: Trends in GHG emission in Teignbridge from 2008 to 2018 for individual sectors

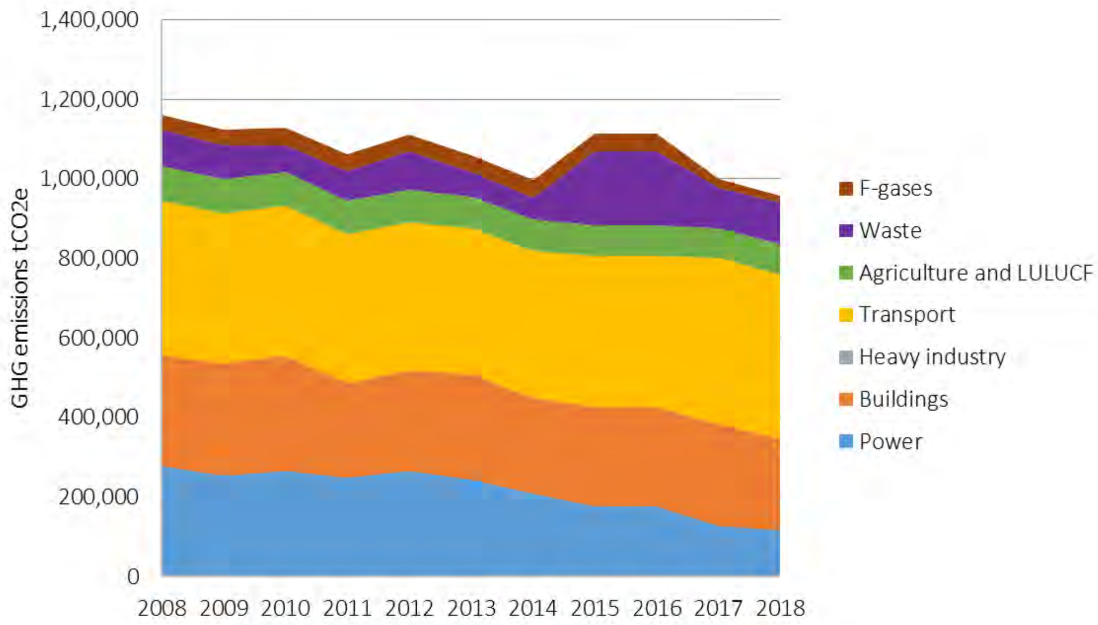


Figure 3: Trends in GHG emission in Teignbridge from 2008 to 2018 for all sectors

GHG emission from the transport sector have been rising, showing a 22 kt CO_2e increase (6%) since 2008. Waste emissions have risen by 15 kt CO_2e or 17%. All other sectors have shown reductions as shown in Table 1.

Table 1: Changes in Teignbridge GHG emissions from 2008 to 2018

Sector	Change 2008 - 2018 t CO_2e	Change 2008 – 2018 %
Power	-161,715	-58%
Buildings	-46,292	-17%
Heavy industry	0	
Transport	22,428	6%
Agriculture and LULUCF	-12,611	-14%
Waste	15,011	17%
F-gases	-18,956	-50%

Sector summaries

In a broad context local authorities can influence emission across all sectors. The influence of land use planning on GHG emissions varies from sector to sector. Spatial planning at district level can particularly influence emissions in power, buildings, transport and agriculture and land use sectors. Policy recommendations are highlighted in the subsections below.

1.1.1 Power

Power, distributed through the national and regional electricity networks, is the sector of the UK economy which has decarbonised most rapidly. Over the period 2008 to 2018, the rise in low carbon generation (21% to 54%) and consequent decline in coal fired generation (33% to 5%) has meant that emissions from the power sector have fallen by around 62% [3]. As a result the carbon intensity of the grid fell from 477 g CO_2/kWh in 2010 to 219 g CO_2/kWh in 2018. Projections by the Committee on Climate Change (CCC) show near-zero carbon electricity by 2035[4]. The historic trends and future projections are shown in Figure 4.

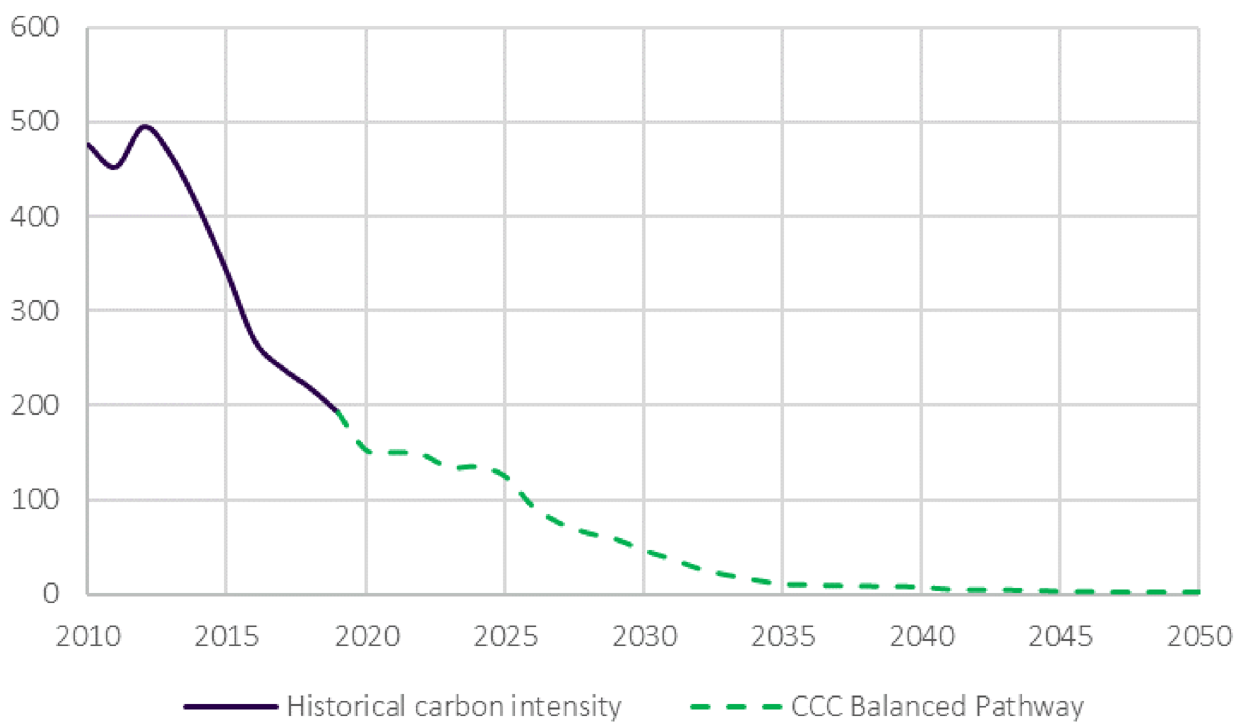


Figure 4: UK electricity grid intensity projections (source CCC)

The use of national electricity emission factors for local calculations of Scope 2 (indirect) emissions precludes the consideration of actual carbon emissions from local electricity generation. Renewable electricity generation in Teignbridge is therefore not attributed to the district as a CO_2 reduction. All renewable energy generation in the UK contributes to national emissions reduction, so while Teignbridge should do everything possible to deliver renewable electricity generation (and has lots of scope to do so) the emission reduction benefits will be shared across the country.

Local plan policy should encourage the generation of renewable energy particularly from onshore wind and solar photovoltaic (PV) panels. Areas of the district that are suitable for deployment of wind turbines (through the development of a Teignbridge wind generation strategy) and PV panels at scale should be identified, and the use

[3] "Reducing UK emissions: Progress report to parliament", CCC, 2020 p78
[4] "Sixth Carbon Budget – the path to net zero", CCC 2020 p137

of PV on new buildings should be encouraged. The provision of electricity storage facilities should also be supported.

New sources of fossil-fuelled electricity generation in the district, such as gas peaking plant, may be proposed.

Any proposals for new fossil-fuelled generation plant should be required to provide a clear pathway to complete decarbonisation by 2035 at the latest.

Demand reduction is also essential in delivering emissions reduction and ensuring that low and zero carbon electricity is efficiently utilised in appliances: particularly as more electricity is used for space heating in buildings and electric vehicles (see below). Electricity storage and demand side management is likely to play an increasing role in the electricity system.

1.1.2 Buildings

GHG emissions arise from buildings (of all types: domestic, commercial, public sector etc.) both from the direct combustion of fossil fuels (mainly for space heating), and from the use of electricity to power lighting and equipment. The consumption of electricity is considered above so this section covers only direct emissions typically arising from space heating and hot water provision.

Reducing emissions arising from space heating relies on both reducing demand through efficiency measures, and supplying any required heat using low-carbon technologies. The approach will differ depending on whether the building is a new build or existing, whether it is on the gas grid or not and if it is suitable for connection to a heat network.

Local plan policy should promote a fabric-first approach to new buildings to reduce heating demand followed by the use of low carbon and renewable energy technologies to supply heat (and power) to buildings.

National plans to ban the installation of gas boilers in new homes in 2025 will necessitate a shift to electric heating or connection to a low carbon heat network. Policy will need to guard against direct electric space heating which has the potential to raise bills for occupiers and ensuring suitable building fabric and large surface area heat emitters (e.g. underfloor heating) to ensure that heat pumps can operate with low discharge temperatures. Noise from air source heat pump condenser units will need to be considered. Where buildings are in an area where there is a low carbon heat network or an area which is suitable for such a network there should be a requirement to connect.

The decarbonisation of existing heating of buildings is perhaps the greatest challenge in achieving net zero. As with new buildings much of the required reduction is likely to be delivered through electrification and it is important that all electrically heated buildings use precious low and zero carbon electricity efficiently.

Local plan policy should require that:

- **electrically heated buildings meet high energy efficiency standards**
- **electric heating has a minimum coefficient of performance of 3.0**
- **buildings with electric heating utilising wet distribution systems have low temperature systems with flow temperatures of less than 55°C**

Specific policy for new homes including consideration of embodied energy is covered in Section 1.1.11.

1.1.3 Industry

The industry sector represents primarily heavy industry including cement, petrochemicals and ammonia, iron and steel, refining, and fossil fuel production. Teignbridge has few heavy industrial sector businesses, aside from clay extraction and related activity, and therefore has minimal sector emissions. One of the few energy intensive businesses, British Ceramic Tiles in Heathfield, went into administration in 2019. Any proposals for new heavy industry in Teignbridge would need to be carefully assessed for their carbon impact.

1.1.4 Transport

Transport GHG emissions generally arise from the direct combustion of fossil fuels across the different modes. The relatively high proportion of transport emissions in Teignbridge are a consequence of the busy trunk roads running through the district including the A30 to Okehampton and beyond, the A38 to Exeter/Plymouth and the A380 and A385 to Torbay. This combines with many Teignbridge residents working outside the district in Exeter, Torbay and Plymouth (see Figure 5) to generate high traffic volumes and associated GHG emissions. Reducing transport emissions is a priority for the district.

Figure 5: Typical commuting patterns from Teignbridge[5]
(red – journeys to workplaces outside Teignbridge; blue – journeys to workplaces within Teignbridge)

Spatial planning should encourage a reduction in the need for transport by the co-location of new homes with likely existing or new employment sites and selecting sites which take advantage of public transport links to employment and leisure locations. Masterplans need to prioritise walking and cycling infrastructure.

Policies should support walking, cycling and public transport and provide for modal shift from cars to these other modes. The uptake of electric vehicles (EV) will play an important role in reducing transport emissions and this needs to be supported through the installation of EV charging infrastructure.

[5] Source https://commute.datashine.org.uk/#mode=allflows&direction=both&msoa=E02004219&zoom=11.0&lon=-3.7618&lat=50.5373

Sites for larger freight consolidation centres need to be identified near major road links. Smaller sites near urban centres also need to be provided locally. Use of these facilities can be encouraged by imposing local HGV and delivery service restrictions.

1.1.5 Agriculture

GHG emissions from the Agriculture, Land Use Change and Forestry sectors have been considered together here. A high proportion of agricultural emissions come from methane sources such as livestock, waste and manure management. Much of the current agricultural emissions from the District occur in Dartmoor National Park.

Afforestation and wetland restoration (peatland, marshland and estuaries) can play a role in removing carbon dioxide from the atmosphere and these measures should be part of the local plan.

1.1.6 Waste

Waste emissions primarily comprise methane from biodegradable waste deposited in landfill sites which are the responsibility of the waste disposal authority; Devon County Council. The variation in historic emissions in Figure 2 stems from the source data from the National Atmospheric Emissions Inventory base data. There is an active landfill site near Heathfield and numerous historic landfills in disused clay pits and quarry workings along the A30/A380 corridor and in other smaller sites across the district.

Methane emissions from waste already deposited can be mitigated by collecting and utilising the gas produced for electricity production. Where electricity production is not feasible landfill gas should be flared to reduce its climate impact (methane has a global warming potential 28 times that of CO_2). In all instances there will be some methane escape.

Future landfill emissions can be halted by banning biodegradable waste from landfill. Any development of new energy from waste facilities should be carefully considered and include a requirement for prior recovery of recyclates, a high level of efficiency through the maximum use of heat and the provision for capturing and storing GHG emissions.

1.1.7 F-gases

Fluorinated gases (F-gases) account for a small percentage of Teignbridge's emissions (2% in 2018) and although released in small volumes they can have a global warming potential (GWP) up to 26,000 times greater than CO_2. Nationally 94% of F-gas emissions are hydrofluorocarbons. These are used in refrigeration, air-conditioning appliances, aerosols and foams, metered-dose inhalers and fire equipment. They are emitted during the manufacture, lifetime and disposal of these products and can stay in the atmosphere for up to 270 years. 77% of national emissions are leaks from refrigeration and air conditioning systems[6]. National and international regulation has proven to be an effective way of reducing F-gas emissions.

Lack of resources at the Environment Agency to carry out adequate inspections may be hampering compliance with F-gas regulations. Local enforcement of management measures focused on larger commercial installations (through trading standards or similar bodies) could help reduce local F-gas emissions. Measures could include regular leak checks and repair, gas recovery at end-of-life, record keeping, training and certification of technicians and product labelling.

In new development good practice including the use of low global warming potential refrigerants and air-to-water systems which minimise the volume of refrigerant should be encouraged and evidenced in development proposal.

[6] "Sixth Carbon Budget – F-gases", CCC 2020 p7

Parish level emissions

Figure 6 shows total emissions at parish level in 2018.

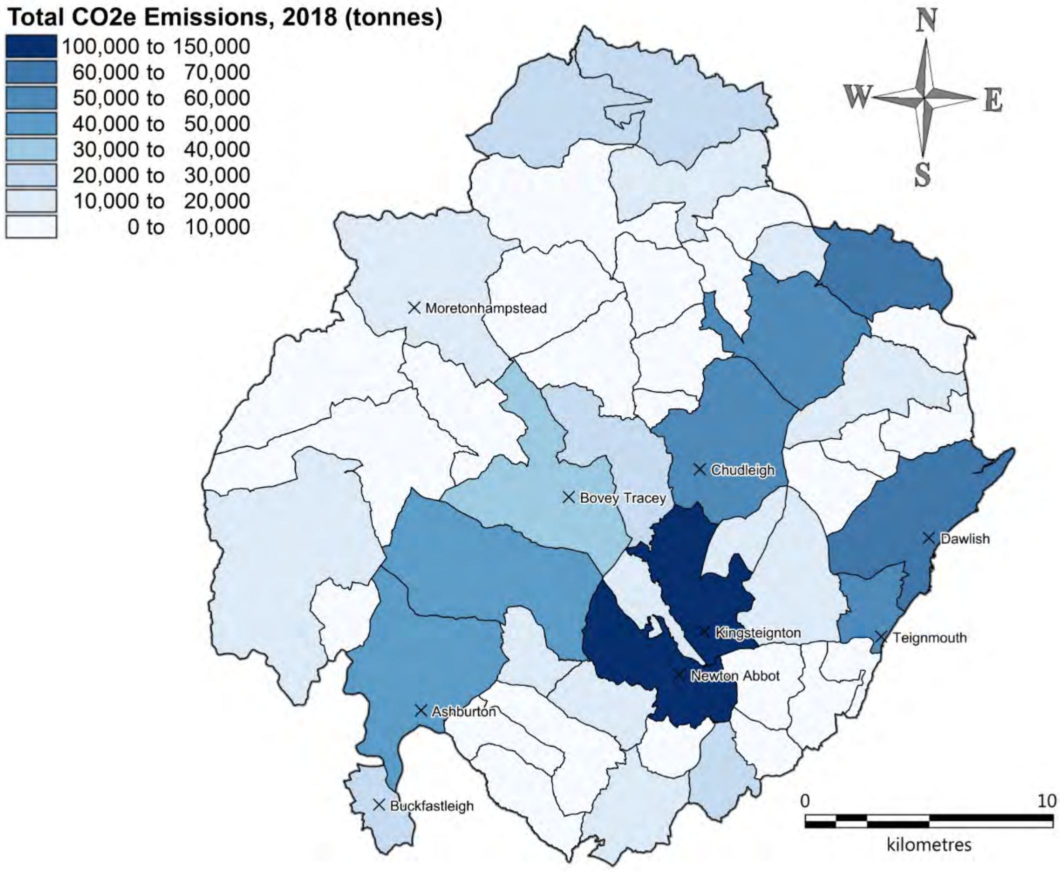


Figure 6: Total parish level emissions (t CO_2e)

The distribution of emissions reflect the centres of population in the Heart of Teignbridge, Teignmouth, Dawlish, Chudleigh, Bovey Tracey and Ashburton, the road corridors through the district and the concentration of waste emissions in Kingsteignton parish.

The energy hierarchy in new development

The energy hierarchy is the order in which energy matters should be considered in the design of new developments. Following consultation with the literature (government documents and local plans), the following hierarchy has been developed. It should be considered sequentially.

1. Location
2. Site Masterplanning
3. Building Fabric
4. Building Services
5. Clean Energy
6. Offsite Measures
7. In-use performance

Location

The National Planning Policy Framework[7] (NPPF) paragraph 150 states that *"New development should be planned for in ways that… can help to reduce greenhouse gas emissions, such as through its location, orientation and design".* In addition Section 9 of the NPPF (Promoting Sustainable Transport) contains a range of measures to address sustainable transport, including *"Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes"*.

Previous work[8] by the CEE for Teignbridge District Council developed a quantified method to predict carbon dioxide emissions associated with new domestic development. This method considered emissions from the dwellings that are captured by Part L of the Building Regulations, additional "unregulated" emission that fall beyond the scope of Part L, and emissions from transport (the largest source of GHG emission in Teignbridge which again are unregulated). It was found that location is the single most important factor in determining potential emissions arising from new development (Figure 7). For example, of Teignbridge's then-allocated sites the location with the lowest baseline emissions was NA3 Wolborough (Newton Abbot) at 1.5 tCO_2/person per annum. The location with the highest emissions modelled was BT3 Challabrook (Bovey Tracey) at 2.7 tCO_2/person. In general, transport emissions were lower when development was closer to existing major urban areas. In addition to site location, a number of additional transport measures were considered including:

- Proximity to bus and rail routes
- Connectivity of walking and cycling routes to local amenities
- Electric vehicle charging
- Cycling provision (e.g. bicycle storage)
- Provision of space within dwellings for home-working

When taken cumulatively, these measures can have a significant impact on carbon emission reduction. Therefore, the location of a development and the range of sustainable transportation options available to prospective residents are clearly interlinked.

[7] "National Planning Policy Framework", MHCLG, February 2019
[8] "The Development of a Method to Support Policies S7 and EN3 of the Teignbridge Local Plan 2013-2033" SWEEG Scientist's Report 145, 2013

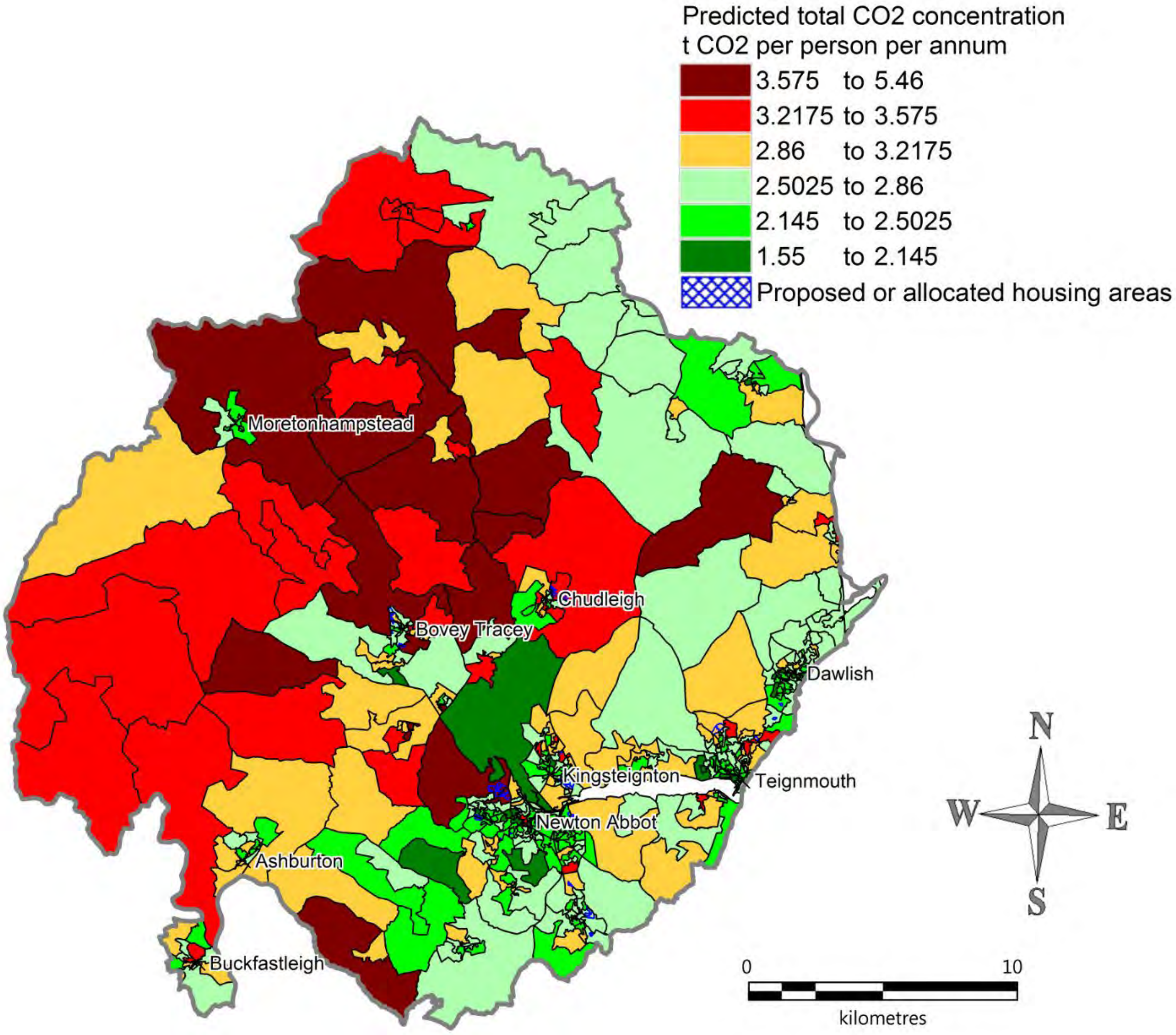


Figure 7: Emissions per person for an 80 m^2 dwelling at 11 kg CO_2/m^2 regulated emissions and a range of sustainable transport measures applied from previous work undertaken by the CEE for Teignbridge District Council

Site Masterplanning

The NPPF paragraph 153 states that *"local planning authorities should expect new development to… take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption"*. In practical terms, this could include location of services within sites, movement strategies, minimising energy demand of site-wide systems (e.g. water pumps or substations), minimising of earthworks, retention of the most effective parts of the site for renewable energy production etc. Section 0 of this report discusses siting of large scale renewable energy infrastructure.

The vast majority of guidance on site masterplanning and energy consumption relates to solar issues. Plymouth City Council[9] commissioned an analysis to quantitatively assess the effect of massing of development on solar gains (and therefore energy demand and overheating risk) and natural daylight. The study demonstrated that by using a quantitative approach at the masterplan stage, the layout generated was able to effectively save energy and carbon – by providing acceptable daylighting (with lower lighting costs and increased well-being), the opportunity for solar gain (subject to its utilisation), increased efficiency for passive solar collectors and

[9] Solar Optimisation Report: Plymouth Development Sites 2014, Julian Brooks and Gary Jackson http://web.plymouth.gov.uk/solar_optimisation_report.pdf

better solar admittance to external amenity spaces. These results have informed the Plymouth and South West Devon Joint Local Plan[10], policy DEV32.4 which states that:

"Developments should reduce the energy load of the development by good layout, orientation and design to maximise natural heating, cooling and lighting, and reduce the heat loss area. For major developments, a solar master plan should show how access to natural light has been optimised in the development, aiming to achieve a minimum daylight standard of 27 per cent Vertical Sky Component and 10 per cent Winter Probable Sunlight Hours.".

The vertical sky component is ratio of vertical illuminance on a plane (the centre of a window) compared to the unobstructed horizontal illuminance. It accounts for obstructions (buildings, trees), and in practice if one had a totally unobstructed view of the sky, looking in a single direction, then just under 40% of the complete hemisphere would be visible[11]. Annual probable sunlight hours (APSH) is a measure of sunlight that a given window may expect over a year period. Only windows with an orientation within 90 degrees of south need be assessed. Building Research Establishment guidance recommends that the APSH received at a given window in the proposed case should be at least 25% of the total available, including at least 5% in winter[12].

Building Fabric

Improving the efficiency of the thermal envelope of a building will reduce its demand for space heat (and in some instances for cooling). Limits are set for the worst acceptable performance levels for walls, roofs, floors, windows and doors in this regard in criterion 2 of the Parts L1A (new dwellings) and L2A (new non-domestic buildings) of the current 2013 Building Regulations. In order to meet those regulations in full (namely criterion 1 which requires an overall carbon target to be met), it is likely that these minimum standards would be significantly improved on. This is because the carbon target is assessed by comparing the calculated carbon emissions of the proposed building against a reference building that has the same form as the proposed building, but fabric standards that are in advance of criterion 2 of the building regulations. Therefore, in order to achieve compliance if a design was to only specify the worst allowable fabric efficiencies then carbon reductions would need to be made elsewhere in the scheme e.g. through increased renewable energy provision. In practice, this does not happen and in general the fabric efficiency of new buildings tends to be in advance of the criterion 2 limits.

Once constructed, it is highly unlikely that the thermal performance of the building envelope would be improved upon further, and so the point of construction remains a critical juncture at which to lock in demand reduction measures that could persist for decades. Consideration should therefore be given by developers to incorporate better fabric standards for their developments, for example the Passivhaus standard. The Passivhaus standard is an approach that was developed in Germany and relies on super-insulation of the building fabric together with mechanical ventilation with heat recovery to drastically reduce the heating energy consumption of buildings. Whilst uprating the specification of the fabric may add capital cost, there are initiatives underway that are seeking to capture the whole life benefit of energy savings within financial instruments. For example, the LENDERS project[13] which is also referenced in the UK Government's Clean

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[10] Plymouth and South West Devon Joint Local Plan 2014 – 2034 Adopted March 2019 https://www.plymouth.gov.uk/plymouthandsouthwestdevonjointlocalplan/plymouthandsouthwestdevonjointlocalplanadoption

[11] https://www.rbkc.gov.uk/idoxWAM/doc/Other-1400520.pdf?extension=.pdf&id=1400520&location=volume2&contentType=application/pdf&pageCount=1

[12] https://www.london.gov.uk/file/14949/download?token=Slu5Dx--

[13] UKGBC 2015 The role of energy bill modelling in mortgage affordability calculations, http://www.ukgbc.org/sites/default/files/The%20role%20of%20energy%20bill%20modelling%20in%20mortgage%20affordability%20calculations.pdf

Growth Strategy[14] aims to link energy bills to mortgage affordability[15] calculations, meaning that improvements to the building fabric may mean that any increase to the cost of a home may be offset by the ability of potential buyers being able to access mortgages.

As carbon emissions from the operation of buildings are reduced more emphasis will be required on cutting the emissions embodied in the materials from which buildings are built. Increasing the amount of timber in buildings is recognised as a way of both replacing higher carbon materials and sequestering the CO_2 which trees absorb over their lifetime. In London, for development proposals referable to the Mayor, "a whole life-cycle carbon emissions assessment, and actions to reduce life-cycle carbon emissions" is required[16].

Building Services

As with the building fabric, Part L of the current 2013 Building Regulations set minimum performance standards for the fixed building services (heating, cooling, ventilation and lighting) within buildings. As is the case with the building fabric it is likely that to meet those regulations in full, these minimum standards would need to be significantly improved on.

Clean Energy

The NPPF paragraph 151 states:

To help increase the use and supply of renewable and low carbon energy and heat, plans should:

a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

In terms of the energy hierarchy it is preferable to meet (and potentially exceed) energy/carbon targets using the demand reduction measures discussed in the previous sections rather than through prioritising low and zero carbon (LZC) generating technologies. This is because demand reduction measures are more likely to be integrated into the building. Renewable energy (e.g. photovoltaic panels) is more readily retrofitted provided consideration has been paid to optimally orienting roofs to enable this. In addition to this, by reducing the need to use energy, you reduce the need to produce it.

A common means of encouraging renewable energy in new development is through the adoption of policy that requires that a certain proportion of energy needs (typically 10 to 20%) to be met through the specification of LZC technology. This is often referred to as a "Merton Rule". The Joseph Rowntree Foundation undertook research[17] that surveyed 30 Local Planning Authorities (LPA) responses, plus analysis of 39 further Local Plans (8 of which overlapped with the survey) to establish what climate change mitigation policies are included in

[14] BEIS 2017 The Clean Growth Strategy Leading the way to a low carbon future

[15] http://www.worldgbc.org/sites/default/files/EeMAP%20Technical%20Report%20on%20Building%20Performance%20Indicators%20that%20Impact%20Mortgage%20Credit%20Risk_0.pdf

[16] "London Plan", 2019, Policy 9.2.10.k

[17] Joseph Rowntree Foundation 2016, Planning for the climate challenge? Understanding the performance of English local plans

their Local Plans. The results can be seen in Figure 8. It can be seen that 37% of LPAs included a local target for renewable energy generation, and 30 – 36% included a carbon target.

In addition, the CEE consulted each of the 37 Local Plans of the LPAs within the south west region to establish what mitigation and climate change adaptation policies are in place. The results can be seen in Figure 9. It can be seen that 41% (15 LPAs) have a quantified renewable energy policy in place[18] with a further 19% (7 LPAs) having qualitative renewable energy policies and the remaining 41% (15 LPAs) having no relevant policy. A quantitative target is much more likely to result in the uptake of renewable energy as it commits a developer to install a minimum amount of renewable energy. A qualitative target does not commit a developer to install a set amount of renewable energy and therefore the policy could be met with either a token amount of renewable energy, or even none at all.

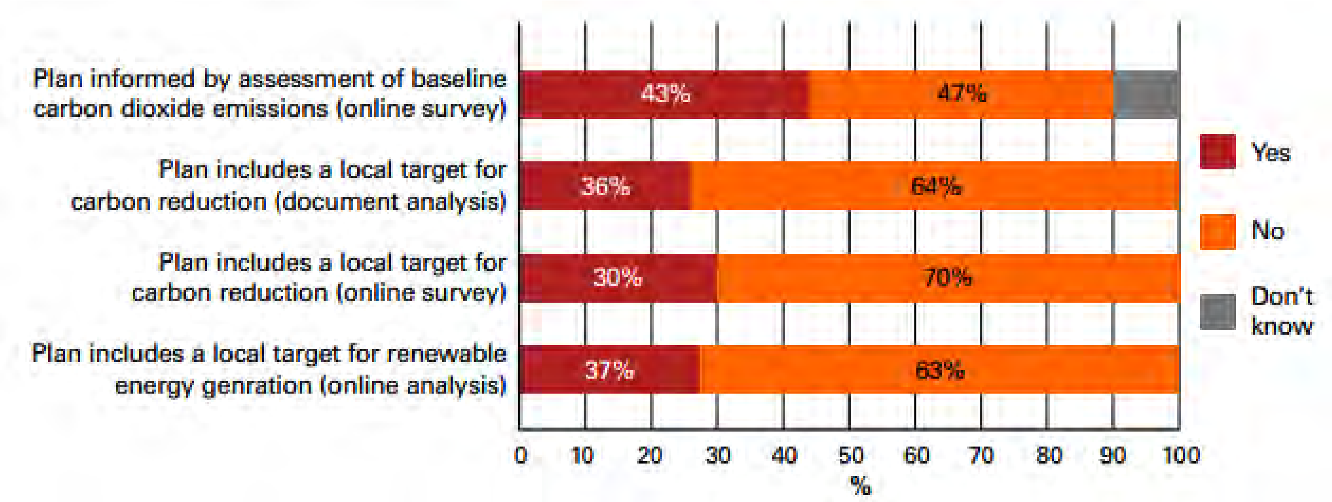

Figure 8: Climate change mitigation policies within Local Plans as studied via surveys and document analyses (Source: Joseph Rowntree Foundation 2016)

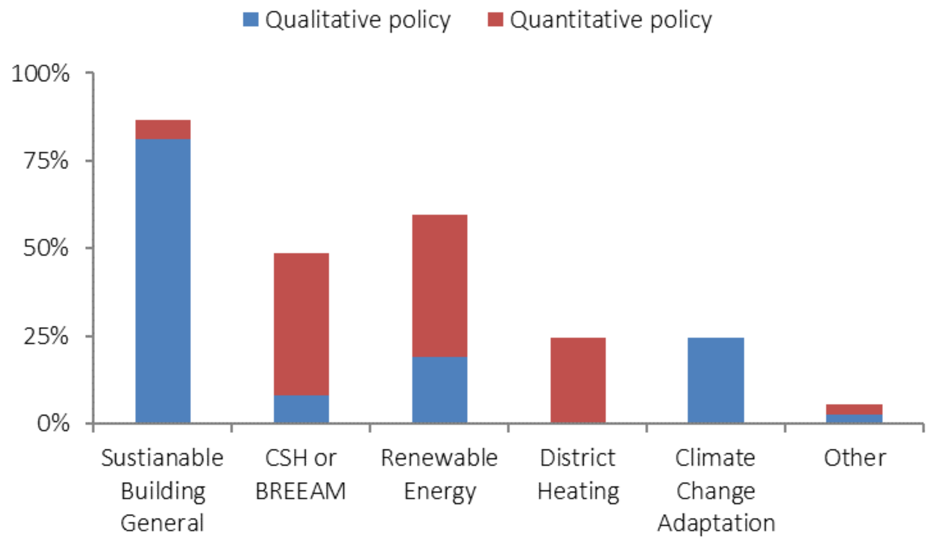

Figure 9: Climate change mitigation and adaptation policies within Local Plans in LPAs in the South West of England

[18] Those authorities are: Bournemouth, Bristol, Exeter, South Hams, West Devon, Christchurch/East Dorset (shared plan), Purbeck, Cheltenham/Gloucester/Tewkesbury (shared plan), Forest of Dean, North Somerset, Plymouth and Poole

Offsite Measures

As an alternative to reducing carbon on-site using energy efficiency and renewable energy, recent national and local policies have proposed offsetting carbon emissions from new development by funding carbon reduction measures elsewhere. This approach was intended to be implemented in Part L of the Building Regulations from 2016 via Allowable Solutions. The approach has also been embedded in various local plans including the 2016 East Devon Local Plan, with perhaps the greatest uptake being in the London boroughs. In London, this has been underpinned by Policy 5.2 of the London Plan which since April 2014 has applied a 35% carbon reduction target beyond Part L 2013 of the Building Regulations. It is stated that *"where this improvement cannot be met on-site, any shortfall should be provided off-site or through a cash-in-lieu contribution to the relevant borough, ring-fenced to secure delivery of carbon dioxide savings elsewhere"*. The London Mayor's Housing SPG, published in March 2016, confirms the authority's policy commitments to zero carbon development. The adopted Plymouth and South West Devon Joint Plan includes "delivering carbon reductions through off-site measures" within the energy hierarchy. The National Energy Foundation (NEF) has undertaken a thorough review[19] of the different approaches in London which are summarised in Appendix I. The review poses questions for local planning authorities including:

- Is there a role for carbon offset funds where developers do not achieve carbon reduction targets? If so,
- What £/tonne level of payments would be required?
- How would payments be collected and managed?
- What offset measures would payments be spent on and how can additionality be ensured?
- How would such payments effect viability and interact with other funding mechanisms (s106, CIL etc.)?

In-Use Performance

Compliance with Part L of the building regulations (including any standards that rely on subsequent improvements) is based on passing a theoretical calculation. There is a significant body of evidence that in practice, buildings do not perform as well when they are completed as was anticipated when they were being designed. The difference between anticipated and actual performance is known as the performance gap[20] with actual energy use and carbon emissions being potentially several times greater than estimated at the design stage. This is in spite of some efforts to aim to close the gap, for example with the introduction of mandatory air pressure tests in Part L. There are many reasons for the performance gap including design issues, quality of construction, problems with commissioning of building systems and handover, and poor building readiness for occupants. Monitoring and addressing this performance gap should be a key driver of policy to ensure that in-use performance meets designed performance and that energy use and carbon emissions are as close to what was expected and permitted as possible.

Milton Keynes's draft policy SC1 states that *"Development proposals should include a quantified explanation of how the targets for carbon dioxide emissions reduction and renewable energy generation outlined above are to be met, and realised in practice".* For homes, a means of demonstrating this could be to target specific areas within the Building Research Establishment's Home Quality Mark Scheme[21] such as "26: Commissioning and Performance", "27: Quality Improvement", "32: Aftercare" and "35: Post-Occupancy Evaluation". For non-domestic buildings a means of demonstrating this could be to implement the Soft Landings Framework[22] or to achieve specific credits within BREEAM such as "Man 01: Project Brief and Design", "Man 04: Commissioning and Handover" and "Man 05: Aftercare".

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[19] National Energy Foundation 2016, Review of Carbon Offsetting Approaches in London
[20] https://www.designingbuildings.co.uk/wiki/Performance_gap_between_building_design_and_operation
[21] https://www.homequalitymark.com/what-is-the-hqm
[22] https://www.bsria.co.uk/services/design/soft-landings/

Current national planning policy and Building Regulations

In the current planning system the NPPF is the framework against which local plans are drawn up and applications for planning permission determined. LPAs must prepare a Local Plan which sets planning policies in their area. Local Plans must be positively prepared, justified, effective and consistent with national policy in accordance with section 20 of the Planning and Compulsory Purchase Act 2004 (as amended) and the NPPF [23]. The Town and Country Planning (Local Planning) Regulations 2012 set out the current process for preparing a Local Plan. The Planning Practice Guidance published by MHCLG covers (amongst many other things) preparing and submitting Local Plans. More detail comes from the Planning Inspectorate's Procedural Practice in the Examination of Local Plans. Changes to the current planning system are being proposed in two consultations which are awaiting the Government's response; the Planning for a Future White Paper[24] and Changes to the Current Planning System[25] which are summarised in Appendix II.

1.1.8 Building Regulations

The Government is updating building standards. In October 2019 the Government published an initial consultation on the Future Homes Standard (FHS) which also contains proposals for changes to Part L of the Building Regulations. The Government gave its response to the consultation in January 2021[26]. In parallel with the response to the FHS the Government issued a consultation[27] mainly focused on the Future Buildings Standard (FBS) which seeks views on new non-domestic buildings; it also consults on overheating mitigation and other details for new homes and improvements to standards when work is carried out on existing homes and non-domestic buildings.

<u>Homes - The Future Homes Standard</u>

Key points from the Government's response to the FHS consultation include:

- The performance standard of the 2025 Future Homes Standard (FHS) will be set at a level which means that new homes will not be built with fossil fuel heating, such as a natural gas boiler and will be future-proofed with low carbon (largely electric) heating and high levels of energy efficiency with no further energy efficiency retrofit work necessary to enable them to become zero-carbon as the electricity grid continues to decarbonise.
- An interim uplift to Part L will require homes to produce 31% less CO_2 emissions compared to current standards.
- The introduction of a Fabric Energy Efficiency Standard into the interim Part L uplift as one of four performance metrics; a primary energy target, a CO_2 emission target, a fabric energy efficiency target and minimum standards for fabric and fixed building services.
- Reducing the performance gap by improving the accuracy of as-built energy calculations and providing clearer information about as-built specifications.

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[23] "Planning for the Future: planning policy changes in England in 2020 and future reforms", House of Commons library briefing paper, January 2021
[24] "White Paper: Planning for a Future", MHCLG, August 2020
[25] "Changes to the current planning system", MHCLG, August 2020
[26] "The Future homes standard: 2019Consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for new dwellings Summary of responses received and Government response" MHCLG, January 2021
[27] "The Future Buildings Standard. Consultation on changes to Part L (conservation of fuel and power) and Part F (ventilation) of the Building Regulations for non-domestic buildings and dwellings; and overheating in new residential buildings" MHCLG, Jan 2021

- Applying a transitional period of one year on individual homes (rather than an entire development) where building/initial notices are deposited before June 2022 and work commences before June 2023[28].

The timeline for implementation is:

- Interim Part L uplift regulated for in late 2021, coming into effect in June 2022
- Consultation on a full technical specification for the FHS in spring 2023
- Part L FHS legislation in 2024
- Part L FHS implementation in 2025.

Other points from the consultation response include:

- Increasing the heat pump minimum seasonal coefficient of performance from 2.5 to 3.0
- Requiring low temperature heating systems designed to operate at a flow temperature of 55°C.

The consultation response acknowledges the need to clarify Local Planning Authorities' role in setting energy efficiency requirements for new homes that go beyond the minimum standards set through the Building Regulations. The new planning reforms which follow on from the 2020 Planning White Paper will clarify the longer-term role of local planning authorities in determining local energy efficiency standards. **However, to provide some certainty in the immediate term, the Government will not amend the Planning and Energy Act 2008, which means that local authorities will retain powers to set local energy efficiency standards for new homes.**

<u>Non-domestic buildings – The Future Buildings Standard</u>

Key points from the Government's FBS consultation include:

- The intention of the Future Buildings Standard is to transition non-domestic buildings to use low-carbon heat sources for heating and hot water. New buildings constructed to the standard will be fit for the future with the ability to become carbon neutral over time as the electricity grid and heat networks decarbonise.
- Two options to uplift the standards for new non-domestic buildings in 2021; a 22% and a 27% reduction in CO_2 emissions on average per building over the current Part L 2013 standard. The Government's preferred option is a 27% reduction.
- Measuring new non-domestic buildings against a newly introduced primary energy target, a continued CO_2 emission target, and an uplifted minimum standard for fabric and fixed building services.
- Changing the calculation methodology to encourage the use of existing heat networks in non-domestic buildings and incentivise new heat networks to be low carbon.
- Uplift to minimum standards for thermal elements (i.e. walls, floors, roofs) and controlled fittings (e.g. windows, rooflights and doors).
- Changes to minimum standards for building services including proposals to introduce a new regulation to ensure buildings have self-regulating devices when a heating appliance is installed and the installation of building automation and control systems.
- Recalibration of relaxation factors applied to modular and portable buildings.

[28] Where notices or plans are submitted after June 2022, transitional arrangements will not apply and homes must be built in line with 2021 Part L standards. Where notices or plans are submitted before June 2022, but work on any individual building does not commence by June 2023, the uncommenced buildings must build in line with 2021 Part L standards. No individual building will need to change once building work has commenced as long as work commences within a reasonable period.

- Introduction of a new airtightness testing methodology.
- Updating energy sub-metering to monitor the as-built performance of non-domestic buildings.

The timeline for implementation is:

- Part L uplift for non-domestic buildings in 2021/2.
- Part L FBS implementation in 2025 (for most building types).

The FBS consultation closes in mid-April 2021. The Government's response time will need to improve on that for the FHS if the implementation timeline is to be achieved.

Delivering low and Zero Carbon homes

The concept of the Zero Carbon home was introduced by the then Labour Government in the 2007 "Building a Greener Future" Policy Statement. This set out a trajectory for the housebuilding industry to provide true Zero Carbon homes, with no regulated or unregulated[29] CO_2 emissions, in 10 years' time i.e. by 2016. The steps towards achieving Zero Carbon was part of the implementation of the Code for Sustainable Homes (CSH), which set out mandatory requirements for reduced CO_2 emissions; 25% (CSH Level 3) and 44% (CSH Level 4) reductions on the Part L of the 2006 Building Regulations to be achieved in 2010, 2013 respectively with true Zero Carbon (CSH Level 6) in 2016.

Figure 10 shows the trajectory as mapped out in 2010[30] compared to the actual.

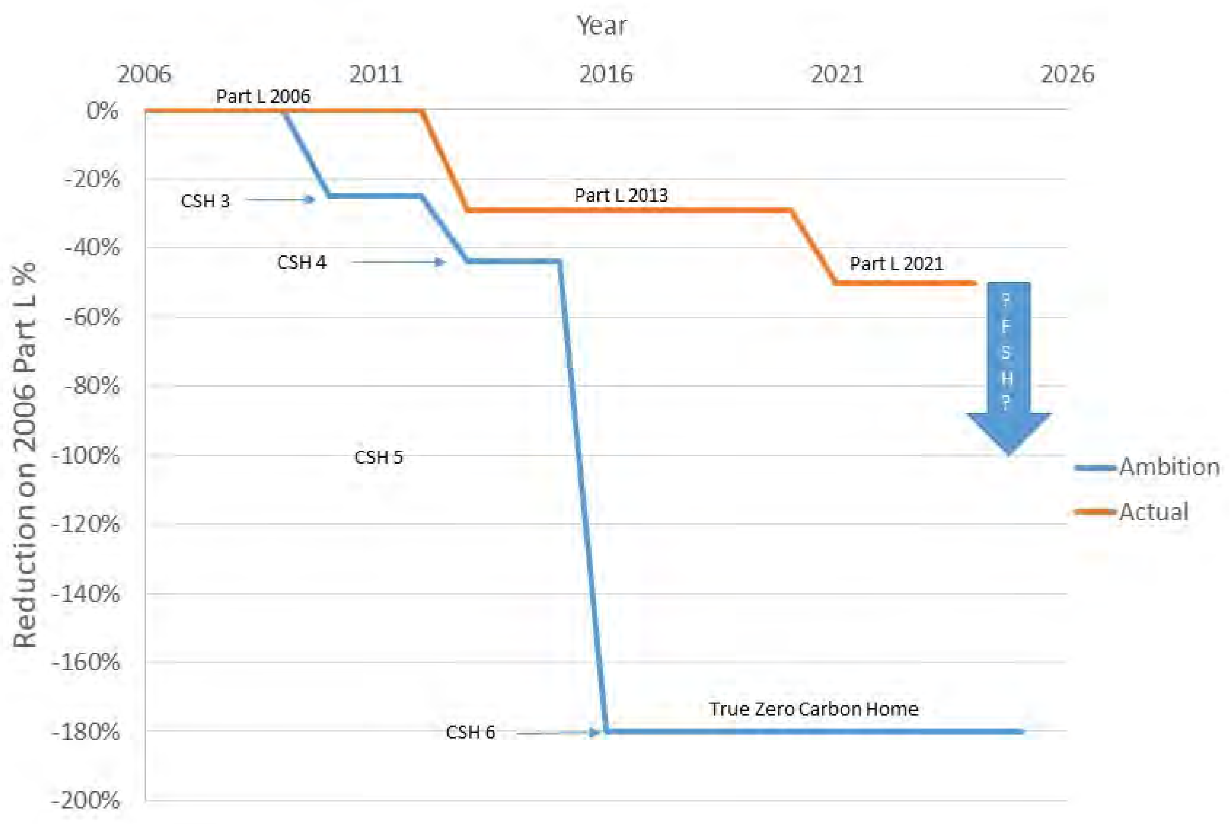

Figure 10: The trajectory of CO_2 emission reduction towards Zero Carbon homes

[29] Regulate CO_2 emissions are those arising from energy use regulated by Part L of the Building regulations e.g. space heating, domestic hot water, fixed lighting etc. Unregulated emissions are those arising from other uses e.g. appliances and cooking

[30] Note that changes in the carbon intensity of grid electricity will have changed the percentage reductions on 2006 Part L in particular for CSH 6 as significant proportion of unregulated emission are electrical appliances

National delivery of the 2007 trajectory has been limited:

- A 29% reduction on 2006 Part L took place in 2013 marginally ahead of the 25% targeted 3 years earlier
- The 2016 zero carbon target and the CSH were abandoned in the July 2015 Budget.

The proposed 2021 uplift to the 2013 building regulations in the FHS consultation achieves a 50% reduction on Part L 2006, a marginal improvement on CSH 4, a 44% reduction on 2006 Part L, targeted in 2013.

A number of English local authorities, including Exeter City Council[31], included the CO_2 emission requirements in their local plans. In Exeter, a local planning policy requirement for CSH 4, a 44% reduction on 2006 Part L, has been in place since 2013. Exeter has delivered significant amounts of housing since 2013 and its experience illustrates that the Part L 2021 standard is achievable in the region and therefore one which could have been delivered across a wider area in the intervening eight years. Experience in Exeter supports Teignbridge's existing Policy S7 requiring a 48% reduction over 2006 Part L.

The Government has committed to setting the performance standard of the 2025 FHS at "a level which means that new homes will not be built with fossil fuel heating, such as a natural gas boiler". A further round of consultation on the details of the FSH will take place over the coming years which, it is to be hoped, will result in national progress in reducing regulated CO_2 emissions towards zero (CSH Level 5), a level of emissions originally targeted between 2013 and 2016 – ten years earlier.

The removal of fossil fuel for heating (i.e. gas and oil) will require new homes to be heated by electricity using heat pumps or by low and zero carbon heat networks. While in the longer term the potential exists in some areas for the use of low or zero carbon hydrogen the CCC has discounted the widespread conversion of the UK gas grid saying that "areas outside of industrial clusters should not assume that hydrogen will provide an answer to heat decarbonisation", "energy efficiency measures to reduce demand, combined with electrification of heat through efficient heat pumps and heat networks is likely to be a preferred solution to displacing gas heating in most areas"[32].

1.1.9 Low and zero carbon heat networks

Connecting new homes to low and zero carbon heat networks can achieve the provision of space heating and domestic hot water. Current plans to provide low carbon heat to the South West Exeter urban extension into Teignbridge from the Exeter Energy Recovery Facility in Marsh Barton[33] illustrate how heat networks can play an important role in decarbonising new development. Conditions for the adoption of heat networks improve where development is for:

- larger scale residential and commercial developments (more than 1,200 homes or 10 ha of commercial development in a locality[34]); or is
- local to low carbon heat sources (within 1 km from the curtilage of a development[35])

All developments of this scale should identify all potential low carbon heat sources within a 1 km radius and those where such sources are identified should assess the feasibility of developing and connecting to low carbon heat networks. Where such networks are feasible developments should be required to connect.

[31] "Core Strategy", Exeter City Council, 2012
[32] "Local authorities and the sixth carbon budget" Committee on Climate Change, 2020 p77
[33] See https://news.exeter.gov.uk/carbon-reducing-multi-million-pound-heating-network-backed/
[34] Based on analysis presented in "2020 low carbon and climate change evidence base for the Greater Exeter Strategic Plan", University of Exeter, February 2020
[35] The SW Exeter development has demonstrated a 1km connection distance

The development of low carbon heat networks reduces future electricity demand and the associated electricity grid infrastructure requirements. District wide energy planning should identify areas of existing buildings that may be suitable for heat networks as they are effective in providing low-carbon heat to dense areas.

1.1.10 Low carbon electricity

The UK electricity system is decarbonising. Figure 11 shows the historic and forecast grid average domestic emission factor over the period 2010 to 2050.

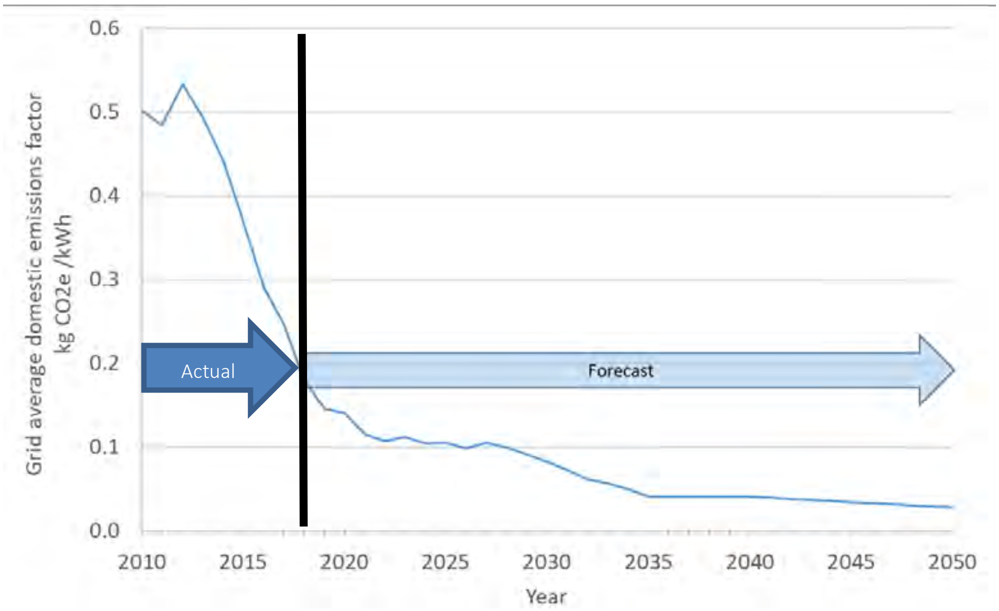

Figure 11: Historic and forecast grid average domestic emission factors[36]

The falling contribution of coal fired generation and increases in renewable energy has led to the carbon intensity of domestic electricity reducing by more than one-half since 2010. Domestic electricity grid intensity is forecast to fall further to around 0.1 kg CO_2e/kWh over the coming 5 years and to near zero by 2050. This change has significant implications for carbon emissions from new buildings.

Firstly, apart from space heating and domestic hot water, lighting, pumps fans and most unregulated appliances use electricity. As the grid emissions factor falls so do emissions from these regulated uses and more significantly the contribution of unregulated emissions (the gap between CSH 5 and CSH 6 in Figure 10).

By specifying a primary energy target, Part L of the 2021 Building Regulations will limit the use of direct electric heating particularly for space heating. This is important to ensure that consumer bills are minimised and that, through the use of heat pumps, the maximum carbon emissions reduction is achieved with the available low carbon electricity.

Heat pumps enable a minimum of three units of heat to be provided by one unit of electricity[37]. The CCC's analysis suggests that heat pumps will become the primary technology for providing heat in buildings[38]. The use of heat pumps in new buildings is therefore likely to become the norm under the FHS with the exception of localities where new buildings can connect to low carbon heat networks. As new buildings form a small proportion of building stock, the electrification of heating in new homes is unlikely to have significant implications for electricity infrastructure in Teignbridge. This said, large developments will need to have greater electrical capacity than has been the case historically, particularly when combined with EV charging needs, and

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[36] Source "Valuation of energy use and greenhouse gas. Supplementary guidance to the HM Treasury Green Book on Appraisal and Evaluation in Central Government", BEIS April 2019

[37] Part L 2021 specifies a minimum heap pump coefficient of performance of 3.0

[38] "Local authorities and the sixth carbon budget" Committee on Climate Change, 2020 p77

in areas with limited electricity infrastructure this may mean that developers need to contribute more towards grid reinforcement costs. The retrofitting of electric heating to existing building stock is a different question and one which has significant implications for electricity provision as discussed in Section 0.

1.1.11 Higher standards for new homes

Analysis undertaken in the Greater Exeter area[39] (see Appendix III) shows that if a standard of net zero carbon for regulated emissions were to be set (over the 2025 FHS), then the additional cost would be approximately £3,000 per dwelling. This would be achieved by adding photovoltaic panels (PV) to a FHS-compliant home (assuming a 30% reduction on Part L 2013), which would have an ASHP in place of a gas boiler. Setting a net zero primary energy target for regulated emissions is more challenging, and calculations show that to achieve this would require Passivhaus levels of energy reduction, in order for the balance of energy demand to be offset by PV generated electricity from available roof areas. This option costs £6,714 per dwelling, and may not be deliverable for certain configurations of flats. In none of the cases was it possible to meet standards that require net zero carbon or primary energy generation to meet both regulated and unregulated loads.

The Greater Exeter analysis also calculated the overall GHG impact of increased energy standards for new homes (see Appendix III Figure A 23). The zero carbon standard contributes a cumulative additional 1.1% to the projected trajectory towards net zero over the period to 2050 with a maximum annual additional reduction of 1.8%. Similar reductions could be expected in Teignbridge.

The UKGBC's New Homes Policy Playbook[40] recommends that, as a minimum, local authorities should set an energy efficiency requirement for new homes as follows:

A 31% reduction on the Dwelling Emission Rate (DER) against the Target Emission Rate (TER) based on the 2013 Edition of the 2010 Building Regulations (Part L). A fabric first approach shall be prioritised, ensuring that at a minimum the thermal performance of the whole envelope exceeds that of the notional specification by 5%.

For those wishing to go further the following set of requirements should also be included:

"An energy use intensity (EUI) target of <70 kWh/m^2/year operational energy use in GIA excluding renewable energy contribution shall be met. This target includes both regulated and unregulated energy consumption.

New build homes shall deliver ultra-high levels of energy efficiency consistent with a space heat demand of 15-20 kWh/m^2/year.

Designers shall evaluate the operational energy use using realistic information on the intended use, occupancy, and operation of the building to minimise any performance gap. They shall demonstrate this through compliance with the above targets using a design for performance methodology such as Passivhaus PHPP or CIBSE TM54 Operational Energy."

Policy recommendations for the reduction of embodied carbon for all new homes are that:

All developments shall demonstrate actions taken to reduce embodied carbon and maximise opportunities for reuse through the provision of a Circular Economy Statement.

For major developments:

Major developments (defined as those with 10 or more dwellings or 1000 square metres of floor space) shall calculate whole lifecycle carbon emissions (including embodied carbon emissions) through a nationally recognised

[39] See p27 of "2020 low carbon and climate change evidence base for the Greater Exeter Strategic Plan", University of Exeter, February 2020

[40] "The new homes policy playbook", UKGBC, February 2021

Whole Lifecycle Carbon Assessment[41] methodology and demonstrate actions taken to reduce lifecycle carbon emissions.

Local planning authorities who wish to go further on embodied emissions should apply the requirement for major developments above to all new homes and, for major developments add the following:

Major developments should target <500 kg CO_2e/m^2 upfront embodied carbon emissions (equating to the emissions covered by Modules A1-A5 of the RICS methodology).

The recommended policy for low carbon energy supply for new homes is:

All new developments should not have onsite combustion of fossil fuel. Where it can be demonstrated that there is no other viable alternative, the rationale must be clearly provided with supporting information as to how the design had considered low-carbon heating sources.

All developments shall assess the viability for onsite renewable generation. For developments with south east through to south west facing roof(s), a minimum 40% solar technologies installation as a percentage of building footprint area shall be met unless it can be clearly demonstrated that this is not practically viable, e.g. on a heavily over shaded site or where there are conflicting spatial limitations due to the use of heat pumps. East/west combinations with low pitch roofs should also be considered.

For large-scale major developments, proposals will be expected to consider the integration of new energy networks in the development. This consideration shall form part of the development proposals and take into account the site's characteristics and the existing cooling, heat and power demands on adjacent sites where readily available. Similarly, any new energy networks should prioritise non-combustible, non-fossil fuel energy as the primary heat source.

Those wishing to go further should also be include:

Major developments shall match their total annual energy demand through a combination of renewable generation capacity, energy storage and smart controls.

Polices for the offsite measures (discussed in Section 0 above) are:

Where it is clearly demonstrated that net zero carbon cannot be fully achieved through on-site measures, all developments shall be required to make a financial contribution to the LPA's carbon tax fund equal to the residual regulated emissions at a rate of £X/tCO_2 over 30 years.

Alternatively, developments can make up the shortfall off-site by funding a carbon reduction or removal project directly, provided the LPA has approved this approach.

Where a local authority is adopting the further policy wordings above this wording can be extended as follows::

Where it is clearly demonstrated that net zero carbon cannot be fully achieved through on-site measures, all developments shall be required to make a financial contribution to the LPA's carbon tax fund equal to the residual regulated and unregulated emissions remaining at a rate of £X/tCO_2 over 30 years.

For clarity, the residual regulated and unregulated emissions should be calculated using a design for performance methodology such as Passivhaus PHPP or CIBSE TM54 Operational Energy.

[41] Currently the RICS Whole Life Carbon Assessment for the Built Environment Professional Statement 2017. Other methodologies are likely to develop and improve over time.

Major developments shall be required to make a financial contribution to the LPA's carbon tax fund equal to the residual upfront embodied carbon (equating to the emissions covered by Modules A1-A5 of the RICS methodology) of the development at a rate of £X/tCO_2 at the point of completion. For clarity, the upfront embodied carbon should be calculated using a nationally recognised Whole Life Carbon Assessment methodology.

The supporting rationale for these polices together with examples are provided in the Playbook. The Playbook also contains recommendations on overheating and acoustics.

In Exeter City CSH4, at 44% reduction on 2006 Part L, has been required since 2013. This requirement is significantly more than the 29% reduction on 2006 Part L required under the 2013 Building Regulations and approaches the 50% reduction on 2006 Part L the Government will implement in 2021. Exeter's requirement for higher energy performance has had no observable impact on housebuilding in the City and provides strong local evidence that enhanced standards can be applied in the region without detriment to housebuilding. It is therefore recommended that Teignbridge, bearing in mind the limited £3,000 uplift, consider setting a standard of net zero carbon for regulated emissions for new homes in the district and look to adopt the further policy wording set out in the Playbook.

Renewable energy planning

Part of the core planning principles in the NPPF (paragraph 17) is to *"encourage the use of renewable resources (for example, by the development of renewable energy)"*. Paragraph 97 states that to *"help increase the use and supply of renewable and low carbon energy"* local authorities should:

- *"have a positive strategy to promote energy from renewable and low carbon sources;*
- *design their policies to maximise renewable and low carbon energy development while ensuring that adverse impacts are addressed satisfactorily, including cumulative landscape and visual impacts;*
- *consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources*[42]*;*
- *support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning; and*
- *identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers"*

In addition Government now requires local planning authorities to specifically allocate land suitable for wind turbines in order for them to come forward.

1.1.12 Principals for renewable energy planning

Renewable energy technologies where the resource requires solely the use of land at the site of the resource are wind, solar photovoltaic (PV) and hydro. These technologies are referred to as "supply push". Other technologies either require the siting of a corresponding heat load (e.g. solar thermal) or are those where a renewable fuel can be transported from the site where it originated to the point of use (anaerobic digestion (AD), biomass, heat pumps). These technologies are referred to as "demand pull" technologies.

These fundamental differences in characteristics require a different approach to planning for the technologies. The "supply push" technologies are perhaps the most straightforward as, if the resource is to be developed, sites have to be located where there is available resource and are therefore driven by the resource assessment (see below). As these technologies produce electricity they also require either adjacent electricity loads, electricity storage or an electricity grid connection.

Efficient "demand pull" technologies need heat loads to serve. These either supply heat alone or, combined heat and power (CHP), and need to be located where appropriate heat loads are to be developed or currently exist or both. CHP schemes need both heat and electricity offtake arrangements. Further optimisation can be planned where heat networks can be deployed as existing local heat generation and offtake can also be included giving the opportunity to use new energy infrastructure to increase the efficiency of existing heat generators and users. A review of heat loads in the Greater Exeter area, undertaken in 2017, is included in Appendix IV.

[42] *In assessing the likely impacts of potential wind energy development when identifying suitable areas, and in determining planning applications for such development, planning authorities should follow the approach set out in the National Policy Statement for Renewable Energy Infrastructure (read with the relevant sections of the Overarching National Policy Statement for Energy Infrastructure, including that on aviation impacts). Where plans identify areas as suitable for renewable and low-carbon energy development, they should make clear what criteria have determined their selection, including for what size of development the areas are considered suitable.*

1.1.13 Other low carbon technologies

Other technologies include nuclear electricity generation, carbon capture and storage, deep geothermal and offshore renewable energy. Table 2 summarises the reasons why these technologies are not included further for Teignbridge.

Table 2: Reasons for not including other technologies for Teignbridge

Technology	Site selection dictated by existing sites and/or national policy	Geology in Teignbridge (excluding DNP) unsuited	Resource lies outside Teignbridge
Nuclear electricity generation	X		
Carbon capture and storage	X	X	
Deep geothermal		X	
Offshore renewables			X

1.1.14 Long list technology review

Table 3 lists electricity, electricity plus heat, and heat only generation technologies and summarises the planning approach recommended for each. Note that small scale technologies such as small/micro scale wind and roof mounted solar systems are not included as these do not have significant spatial planning implications.

District wide resource mapping is recommended for onshore wind and PV (see below). The remaining technologies need to be considered on a site-specific basis with heat technologies in particular requiring review as part of any large scale development proposals.

Mapping and assessment of onshore wind resource

The potential onshore wind resource within Teignbridge has been estimated by applying appropriate spatial constraints in MAPINFO geographical information system (GIS) software[43], applying a density factor to account for acceptable landscape impact, then estimating the installed capacity and annual energy output based on the spatial requirements of wind turbines and a typical capacity factor. The constraints and electricity generation parameters were taken from similar previous assessments[44, 45].

Table 4 lists the spatial constraints applied to determine the onshore wind resource. The percentage of Teignbridge excluded by applying each constraint is shown. The constraints will overlap, and so cannot simply be summed to determine the total available area. The figures do, however, indicate which constraints have the greatest effect in limiting the available area for wind turbines. The parameters found to individually exclude 10% or more of Teignbridge were:

1. residential buildings within 400 m (77%),
2. wind speed < 6.5 m s^{-1} @ 80 m elevation (20%),
3. B-roads and unclassified roads within 75 m (35%)[46],
4. proximity to the Western Power Distribution (WPD) 33 kV grid > 2 km (52%),
5. primary surveillance radar (PSR) within line of site at tip height of 120 m (40%),
6. listed building within 400 m (44%),
7. microwave links (23%),
8. woodland (18%), and
9. national park (38%).

[43] Mapinfo Professional Version 16.0.1 (64 bit).
[44] "Resource assessment for wind and solar in North Somerset and opportunities to support the wider sustainable energy sector", Regen SW, 2014.
[45] "Technical paper E2. An assessment of the renewable energy resource potential in Cornwall", Cornwall Council, 2013.
[46] The 150 m buffer around motorways and A roads buffers out 6.5%; both road buffers combined (eliminating overlaps) buffer out 38%. This compares to 59% if a 150 m buffer is applied to all roads.

Areas within the national park are excluded by a constraint. The percentages excluded are calculated for the whole of Teignbridge, including the national park.

Table 3: Long list of low carbon and renewable energy generation technologies

Technology	Comments	Planning implications	Planning approach recommended
Electricity			
Onshore wind	The greatest unconstrained RE resource, but in practice highly constrained.	Government requires allocation in local / neighbourhood plans	Map resource and consider allocating zones
Photovoltaic (PV)	The South West has the best solar resource in the UK. Ground mounted PV is the greatest RE resource once constraints are applied	Planning support helpful – take same approach as wind	Map resource and consider allocating zones
Run of river hydro	Small scale. Negligible resource. Abstraction licences a constraint. Economics difficult without existing civils infrastructure in place	Typically small schemes make planning constraints less likely	No specific work – encourage in general at a small scale through policy wording
Electricity & Heat			
Biomass energy	Resource not directly linked to location of technology which, to maximise efficiency, needs to be heat led	Tie in with heat demand of development and adjacent existing heat loads where applicable. Planning issues likely to be localised to proposed sites. Transport often a concern	Consider heat led site allocation (see Appendix IV) and site specific policy development
EfW energy	Resource not directly linked to location of technology which, to maximise efficiency, needs to be heat led	Tie in with heat demand of development and adjacent existing heat loads where applicable. Planning issues likely to be localised to proposed sites. Transport often a concern	Consider heat led site allocation (see Appendix IV) and site specific policy development. Integrate with Devon Waste Plan and avoid overlap
Anaerobic Digestion (AD)	Resource not directly linked to location of technology. Biogas export is the preferred technical solution to electricity generation (only). CHP requires an adjacent heat load	Planning issues likely to be localised to proposed sites. Low energy density of AD feedstock intensifies transport concerns. Permitting differences between on-farm and waste feedstocks are significant for planning. On farm sites are less likely to have heat loads	Non-waste site allocation unlikely to be appropriate. Consider specific AD policy wording to encourage biogas export. Where waste is a potential feedstock integrate with Devon Waste Plan and avoid overlap
Heat			
Heat networks	Heat demand led	Requirement to connect to low carbon heat networks with additional incentives for more efficient low temperature heat networks and compatible heating systems in buildings	Determine by development scale and mapping of existing heat demand and generation (Section 1.1.9 and Appendix IV). Heat led site allocation and site specific policy development
Solar thermal	The South West has the best solar resource in the UK. Large scale solar thermal arrays may play an increasing role where there are heat networks as evidenced in Denmark and elsewhere in continental Europe	Provide land allocation adjacent to heat network energy centres	Consider allocation as part of site specific policy on developments suitable for heat networks. PV mapping contributes to the identification of suitable array sites
Heat pumps (HP)	Large scale HP important in waste heat recovery opportunities. Potential for increasing standalone role as electricity grid decarbonises subject to electricity prices and grid constraints	Access to waste heat a particular concern	Wording to provide requirement to deliver waste heat to heat users/networks and provide access and land where planning proposals have waste heat available

Table 4: Spatial constraints applied to determine the onshore wind resource in Teignbridge

Parameter	Constraint	Source of Data	% of Teignbridge removed[47]
Transport & Communications			
Airfield	> 3 km or > 5 km	DCC GIS	0%
Microwave Link	Exclude	DCC GIS	22.5%
NATS Parameters[48]			
Air-Ground-Air communication site	> 10 km	NATS	0%
En route navigation aid site	> 10 km	NATS	0%
Primary Surveillance Radar zone	Exclude	NATS	40.1%
SSR or HMU site	> 15 NM	NATS	0%
Overhead Power Line (33, 132 kV)	> 100 m	National Grid, WPD	5.6%
Railway Line	> 150 m	Ordnance Survey OpenMap	2.0%
Motorway and A Road	> 150 m	Ordnance Survey OpenMap	6.5%
B Road and Unclassified Road	> 75 m	Ordnance Survey OpenMap	34.5%
Built Environment & Heritage			
Building	> 25 m	Ordnance Survey OpenMap	9.5%
Greenspace[49]	Exclude	Ordnance Survey Greenspace	1.1%
Landfill Site	> 1 km from centroid[50]	Google Earth	0.4%
Listed Building	> 400 m from centroid	Historic England	43.8%
MOD Danger Area	Exclude	DCC GIS	0%
Quarry	Exclude	Google Earth	1.0%
Registered Park or Garden	Exclude	Historic England	1.9%
Residential Building	> 400 m from centroid[51]	District authority GIS	76.6%
Scheduled Monument	Exclude	Historic England	1.0%
Natural Features			
Area of Outstanding Natural Beauty	Exclude	Natural England	0%
Heritage Coast	Exclude	Natural England	0%
Local Nature Reserve	Exclude	Natural England	0.2%
Marshland	Exclude	Ordnance Survey Landcover	0.0%
National Nature Reserve	Exclude	Natural England	0.8%
National Park	Exclude	Natural England	37.7%
RAMSAR Site	Exclude	Natural England	1.1%
Site of Special Scientific Interest	Exclude	Natural England	7.3%
Special Area of Conservation	Exclude	Natural England	3.8%
Special Protection Area	Exclude	Natural England	1.1%
Tidal Water	Exclude	Ordnance Survey OpenMap	1.1%
Water	Exclude	Ordnance Survey OpenMap	0.6%
Woodland	Exclude	Ordnance Survey OpenMap	18.1%
World Heritage Site	Exclude	Historic England	0%
Technical Constraints			
Wind Speed	> 6.5 m s^{-1} @ 80 m	NOABL	19.8%
WPD Grid connection (33 kV)[52]	< 2 km	WPD	51.7%

[47] A value of 0% denotes none within Teignbridge. A value of 0.0% indicates a constraint present within Teignbridge, but accounting for less than 0.05% of the land area.
[48] Formerly National Air Traffic Services.
[49] Includes allotments, bowling greens, cemeteries, churchyards, golf courses, play areas, public parks and sports fields.
[50] Only point data (centroids) were identified for this feature, the applied buffer should encompass the feature itself.
[51] Council Tax centroids.
[52] Direct connection of small embedded generation (< 50 MW) to the 132 kV network is unlikely to be cost-effective. For Teignbridge, the constraint excludes areas to the west of the Exe Estuary and west of Newton Abbot that have Western Power 132 kV distribution passing through them.

The wind speed criterion is a minimum wind speed of 6.5 m s^{-1} at an elevation of 80 m, wind speeds being estimated at this elevation by applying the wind profile power law under neutral atmospheric stability conditions[53]; this is realistic for typical turbines with a hub height of about 80 m.

The NATS self-assessment constraints for wind developments[54] pertain to national air traffic control infrastructure, and "*are an aid to developers in understanding where interference with NERL[55] infrastructure is likely. They do not represent an exhaustive list of the areas where there is a potential impact to NERL's infrastructure nor do they represent no-go areas where NERL will automatically object to proposed wind turbines ... For PSR* [Primary Surveillance Radar]*, the plots are based on a line-of-sight method and indicate whether a further more detailed assessment needs to be carried out in relation to primary surveillance radars*". A number of existing wind farms in Devon (including Fullabrook and Den Brook) lie within the constraint areas (Figure 12). Only the PSR constraint impinges upon Teignbridge. For previous work for the Greater Exeter Strategic Plan, an alternative constraint was examined based on reducing the diameter to 25% of that in the source data; reducing the area excluded within Teignbridge from 40.1% to zero. This matches the latest analysis for Cornwall [56] which omits the NATS constraints entirely.

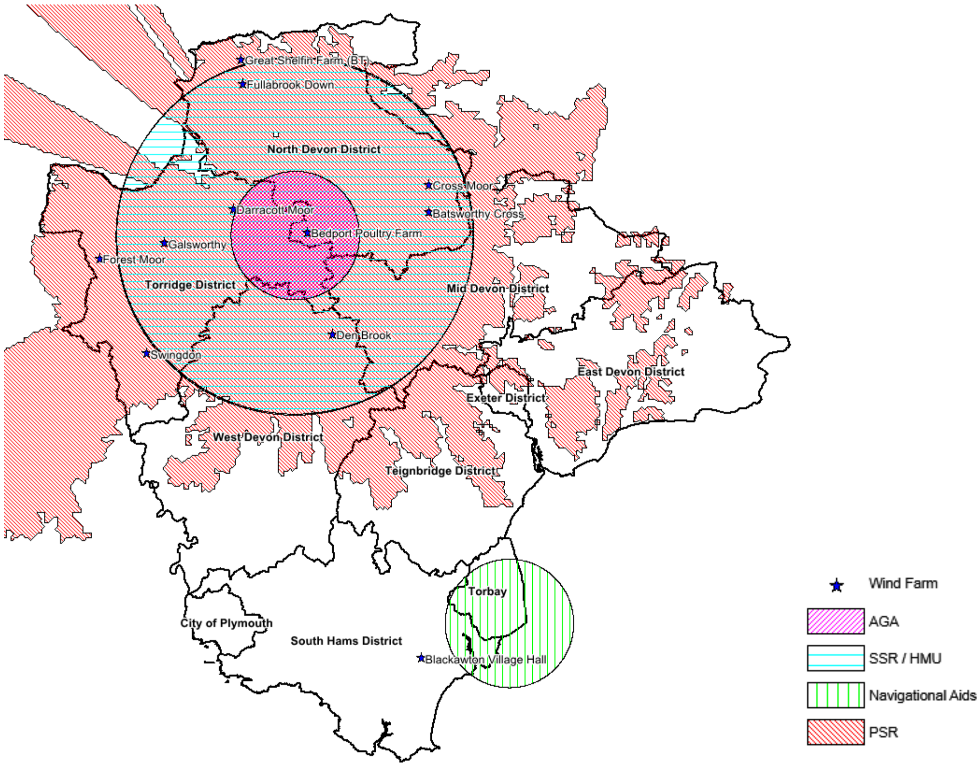

Figure 12: Existing wind farms in Devon compared to the NATS wind farm development self-assessment constraint areas

An alternative scenario was examined in which the maximum distance from a 33 kV grid connection of 2 km was removed. Large scale wind developments are more likely to sustain a longer connection distance and future technological developments including battery storage, smart grids and electric vehicles may increase the feasibility of installing wind turbines further downstream on the grid or autonomously.

A second alternative scenario omitted the woodland constraint. Wind development in woodland areas would only be considered where the ecological impacts are minimal or can be managed; the scenario serves to illustrate the constraint imposed by woodland when combined with the other constraints. Of the woodland

[53] SWEEG, 2019, Internal Document 971 "Implications of Wind Speed on Wind Resource in the Greater Exeter Area"
[54] NATS self-assessment maps. https://www.nats.aero/services/information/wind-farms/self-assessment-maps/, accessed 8/8/2017.
[55] NATS[48] En Route plc, licenced to provide en-route air traffic services in the UK.
[56] SWEEG, 2021, Contract Document 317, "An updated assessment of suitable areas for large-scale renewable energy in Cornwall based on the 2020 Landscape Character Assessment"

within Teignbridge, 60% by area is predominantly broadleaved, 30% is predominantly coniferous and the remaining 10% is felled or immature planting[57].

1.1.15 Mapping

The data for each of the constraints was converted to GIS format where necessary and distance buffers applied. Any overlaps were eliminated and the objects subtracted from the total extent of Teignbridge to form layers with objects representing areas available for wind development. The area of each object was determined and objects smaller than a minimum size threshold of 250 m^2 [44] were eliminated. Finally features less than 5 m in widths were eliminated (these can result from slight mismatches between the geometry of the different layers, or features unlikely to be of importance, such as streams). The resulting maps for the four scenarios are presented in Figure 13 to Figure 16.

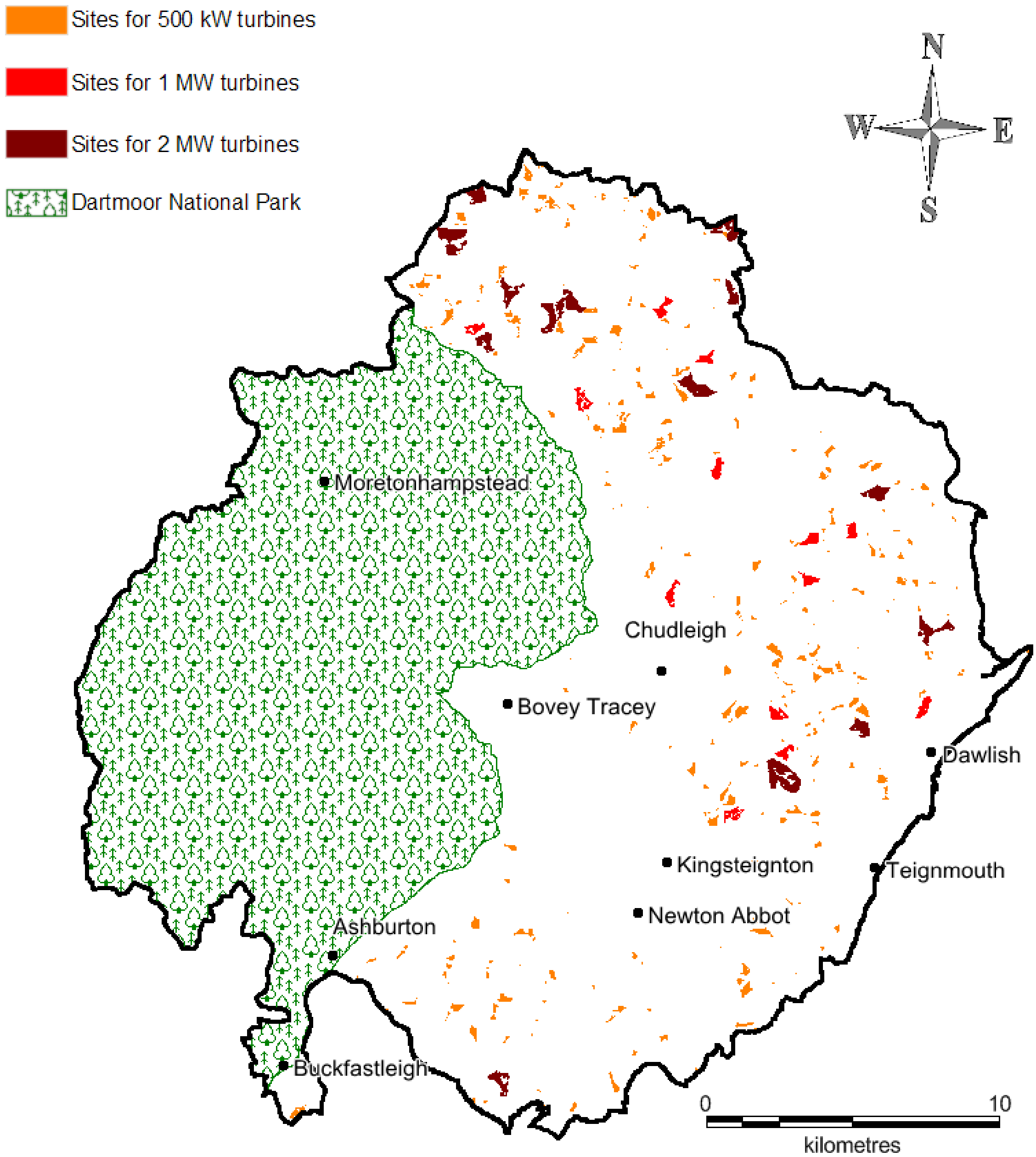

Figure 13: Scenario 1: Areas identified for onshore wind development with no constraint on the maximum distance from the WPD electricity distribution grid (the shading refers to the turbine sizes identified in the resource assessment), with woodland constraint applied

[57] National Forest Inventory, 2018. https://data-forestry.opendata.arcgis.com/datasets/295e0278dc2641e2935c411d28908be9_0, accessed 18/5/2021.

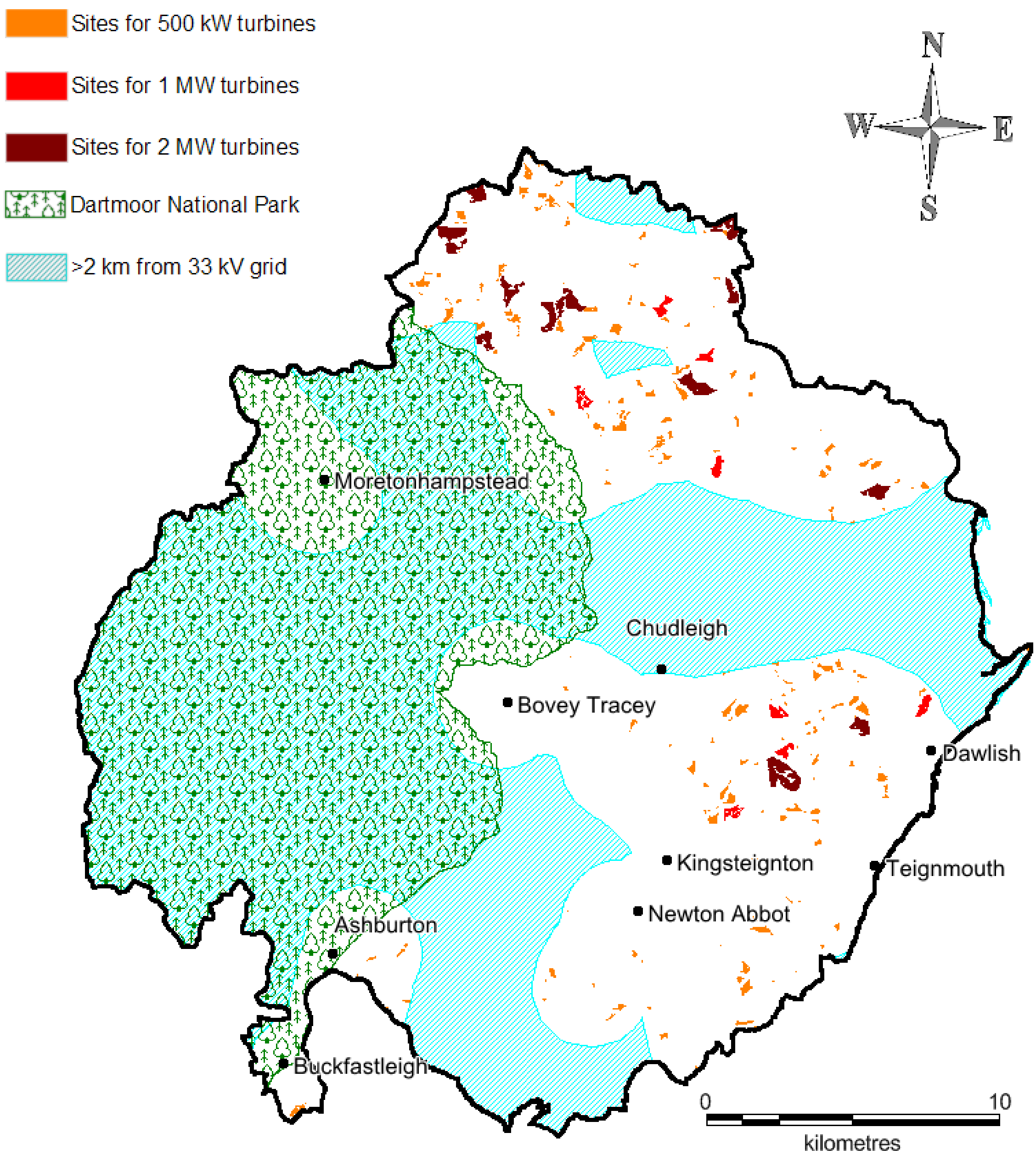

Figure 14: Scenario 2: Areas identified for onshore wind development with a 2 km constraint on the maximum distance from the WPD electricity distribution grid (the shading refers to the turbine sizes identified in the resource assessment), with woodland constraint applied

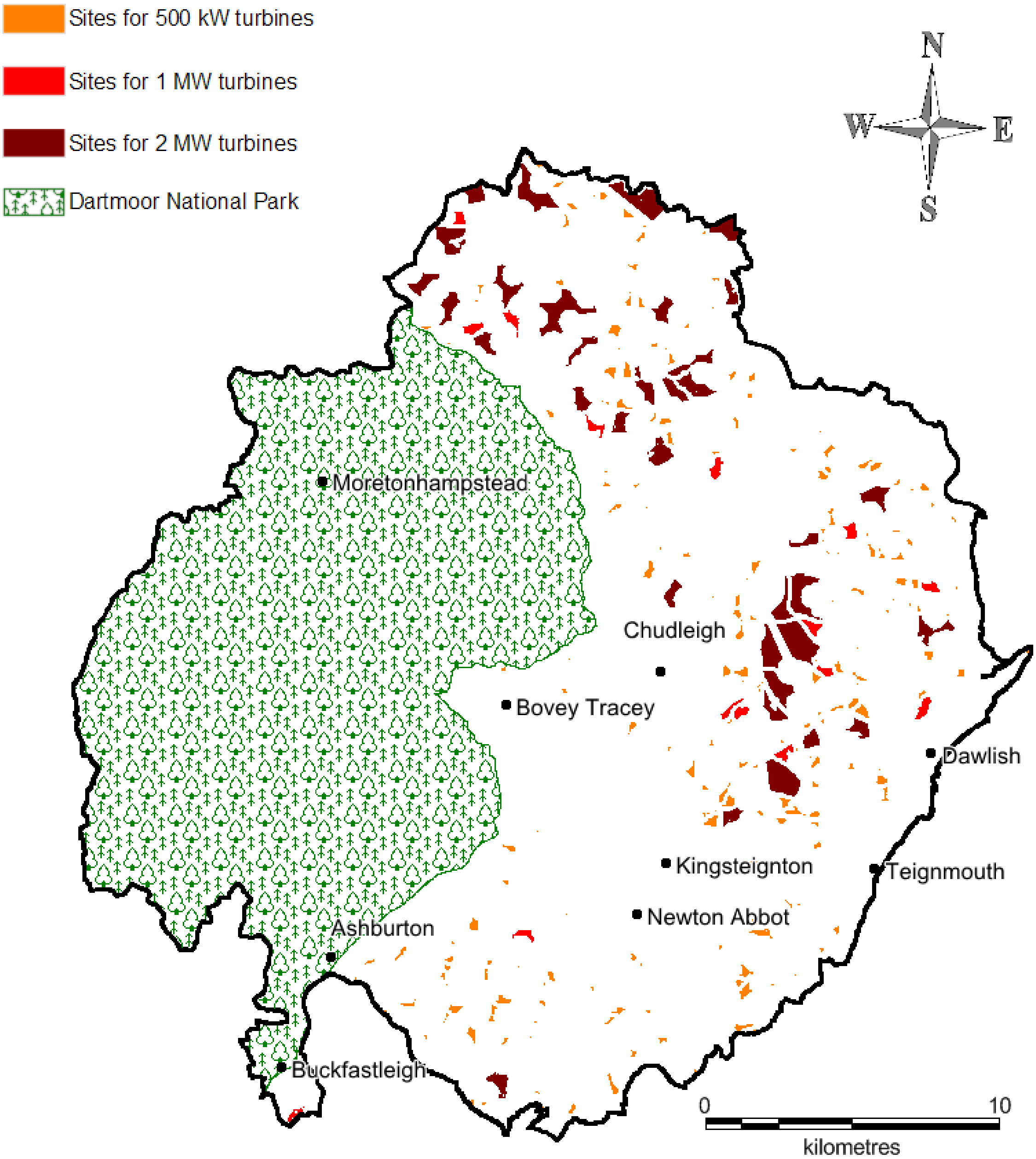

Figure 15: Scenario 3: Areas identified for onshore wind development with no constraint on the maximum distance from the WPD electricity distribution grid (the shading refers to the turbine sizes identified in the resource assessment), without woodland constraint applied

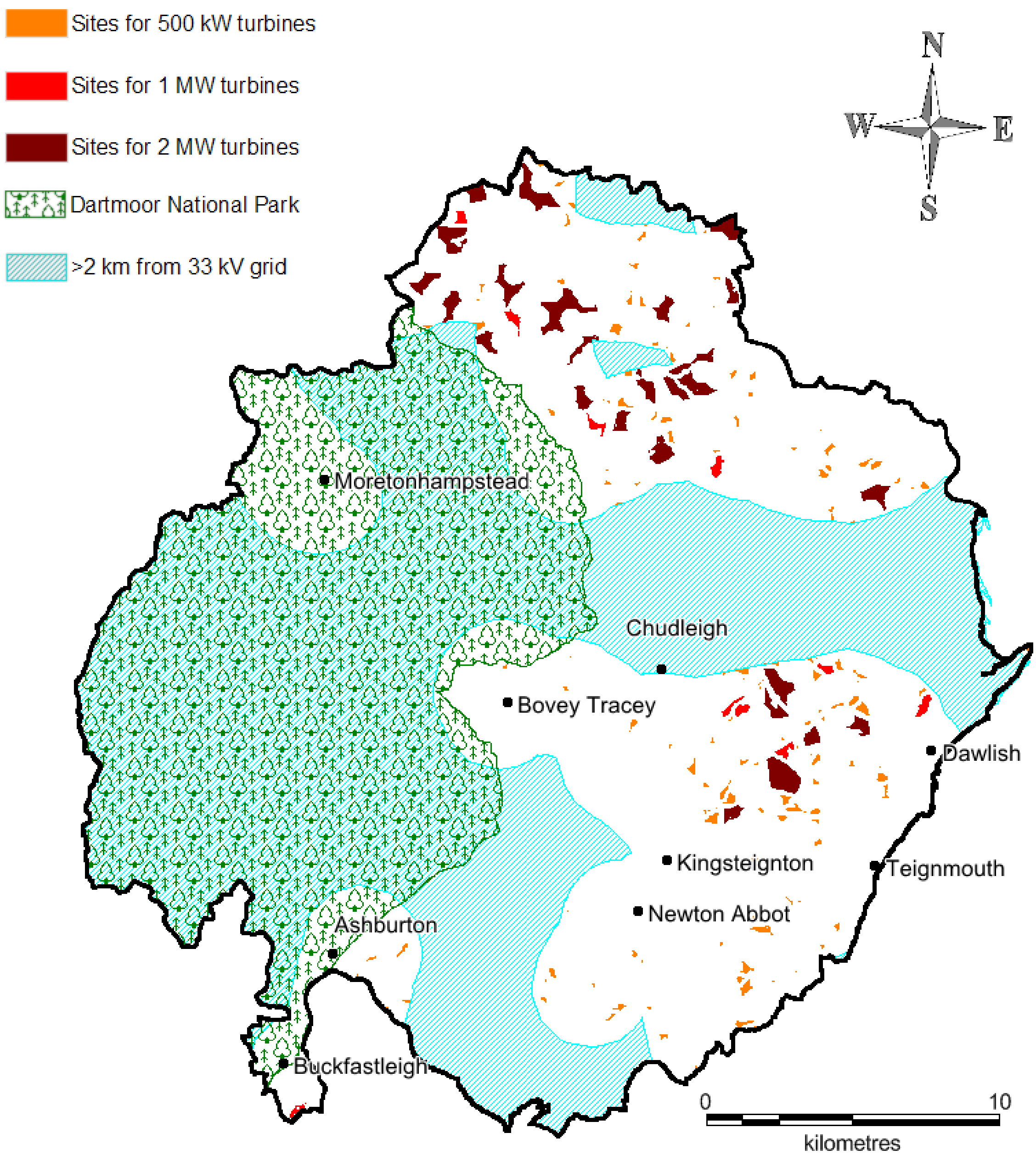

Figure 16: Scenario 4: Areas identified for onshore wind development with a 2 km constraint on the maximum distance from the WPD electricity distribution grid (the shading refers to the turbine sizes identified in the resource assessment), without woodland constraint applied

1.1.16 Resource assessment

The identified areas were used to estimate the potential installed capacity and annual output from onshore wind turbines, adopting the methodology of previous reports [44, 45]. In line with other studies [44], available parcels of land (sites) have been categorised by area. The study adopted a minimum site size of 250 m^2 and assumed an installed capacity of 9 MW per square kilometre for 2 MW turbines or larger, or 8 MW per square kilometre for 1 MW turbines. This equates to an area requirement of 0.222 km^2 per 2 MW (or larger) turbine, or 0.125 km^2 for a 1 MW turbine. Smaller sites (meeting the minimum threshold) were each assumed to support a single 500 kW turbine.

Taking the identified areas presented above forward to estimate the total resource, a density factor has been applied to restrict development and limit landscape impact. The factors applied were taken from similar studies [44]. A density factor of 50% has been applied to the single 500 kW turbines (i.e. only half of the sites will be utilised); developments using larger turbines (which could take the form of a cluster or wind farm) have a density factor of 80% applied.

A capacity factor of 28% was applied to account for the intermittency of wind when calculating the annual energy output. This is a typical figure used in other studies [44, 45]. These factors have been applied to arrive at the predicted resource figures below, but are not included in the GIS mapping presented above.

The resulting numbers of sites, installed capacities and annual electrical output are listed in Table 5 (the numbers of sites and turbines have been rounded to the nearest whole number).

Table 5: Estimated onshore wind resource in Teignbridge

Woodland Excluded	Grid proximity constraint	Number of sites (or turbines) (500 kW)	Number of sites (1 MW)	Number of sites (2 MW)	Land Area (km^2)	Number of 1 MW turbines	Number of 2 MW turbines	Total capacity (MW)	Annual Output (GW h)
Yes	No	179	10	11	10.0	10	14	127.5	312.7
Yes	Yes	117	6	10	7.7	6	12	88.5	217.1
No	No	114	12	28	17.6	12	46	161.0	394.9
No	Yes	74	8	21	12.0	8	31	107.0	262.4

In reality the resource is likely to lie somewhere between the values in Table 5 since proximity to the grid is not an absolute constraint (for example, a greater distance might not be a constraint for a larger wind farm, and the development of local grids and battery storage may also reduce the future importance of grid proximity). It is evident that removing the woodland constraint significantly increases the resource (by 21% with the grid constraint applied, and by 26% without the grid constraint). In practice, only a fraction of the additional area would be suitable for wind development without unacceptable ecological impacts.

1.1.17 Current resource use and remaining resource

Table 6 summarises wind development in Teignbridge as at 2019 [58].

Table 6: Current wind development (2019) in Teignbridge (source BEIS)

Number of sites	Capacity (MW)	Annual Output (GW h)
7	0.1	0.133

Current wind generation within Teignbridge represents a minute fraction of the identified resource. Note also that the existing sites have smaller installed turbine size than those considered in the resource assessment, averaging 14 kW per site.

Mapping and assessment of solar photovoltaic resource

The potential large scale PV resource in Teignbridge has been estimated using a process similar to that for onshore wind: by applying appropriate spatial constraints, applying a density factor to account for acceptable landscape impact, then estimating the installed capacity and annual energy output based on a typical installed capacity per unit area and a typical capacity factor. The constraints and electricity generation parameters were taken from similar previous assessments [44, 45].

Table 7 lists the spatial constraints applied to determine the PV resource. The percentage of Teignbridge excluded by applying each constraint is shown and indicate which constraints have the greatest effect in limiting the available area for PV. The parameters that individually exclude 10% or more of Teignbridge are:

1. proximity to the Western Power Distribution (WPD) 33 kV grid > 2 km (52%),
2. agricultural land classification grade 1 or 2 (12%),
3. roads within 25 m (15%),
4. woodland (18%), and

[58] "Renewable electricity by local authority" BEIS, September 2020, https://www.gov.uk/government/statistics/regional-renewable-statistics

5. national park (38%).

Table 7: Spatial constraints applied to determine the PV resource in Teignbridge

Parameter	Constraint	Source of Data	% of Teignbridge removed[47]
Transport & Communications			
Airfield	Exclude	DCC GIS	0%
Railway Line	> 25 m	Ordnance Survey OpenMap	0.4%
Road	> 25 m	Ordnance Survey OpenMap	14.7%
Built Environment & Heritage			
Building	> 25 m	Ordnance Survey OpenMap	9.5%
Greenspace[49]	Exclude	Ordnance Survey Greenspace	1.1%
Landfill Site	> 1 km from centroid[50]	Google Earth	0.4%
MOD Danger Area	Exclude	DCC GIS	0%
Quarry	Exclude	Google Earth	1.0%
Registered Park or Garden	Exclude	Historic England	1.9%
Scheduled Monument	Exclude	Historic England	1.0%
Natural Features			
Agricultural Land Classification	Exclude 1, 2[59]	Natural England	12.4%
Area of Outstanding Natural Beauty	Exclude	Natural England	0%
Heritage Coast	Exclude	Natural England	0%
Local Nature Reserve	Exclude	Natural England	0.2%
Marshland	Exclude	Ordnance Survey Landcover	0.0%
National Nature Reserve	Exclude	Natural England	0.8%
National Park	Exclude	Natural England	37.7%
RAMSAR Site	Exclude	Natural England	1.1%
Sand Dunes	Exclude	Ordnance Survey Landcover	0.1%
Site of Special Scientific Interest	Exclude	Natural England	7.3%
Slope	Exclude > 20° facing between east and west via north	Ordnance Survey OpenMap	1.2%
Special Area of Conservation	Exclude	Natural England	3.8%
Special Protection Area	Exclude	Natural England	1.1%
Tidal Water	Exclude	Ordnance Survey OpenMap	1.1%
Water	Exclude	Ordnance Survey OpenMap	0.6%
Woodland	Exclude	Ordnance Survey OpenMap	18.1%
World Heritage Site	Exclude	Historic England	0%
Technical Constraints			
WPD Grid connection (33 kV)	< 2 km	WPD	51.7%

Alternative scenarios were considered with or without the requirement for a 33 kV grid connection within 2 km. Future technological developments including battery storage, smart grids and electric vehicles may increase the feasibility of installing PV further downstream on the grid or autonomously.

1.1.18 Mapping

The data for each of the constraints was converted to GIS format where necessary and distance buffers applied. Any overlaps were eliminated and the objects subtracted from the total Teignbridge area to form layers with objects representing areas available for PV development. The area of each object was determined and objects smaller than a minimum size threshold of 1 ha [45] were eliminated. The resulting maps for the two scenarios are presented in Figure 17 and Figure 18. Ideally grade 3a agricultural land would be excluded, but the sub-classification of grade 3 is only available for very limited areas (those surveyed since 1988). The maps therefore indicate grade 3 agricultural land that has not been excluded by other constraints; only about one-half of this is likely to be grade 3b and therefore suitable for PV development.

[59] Ideally grade 3a would also be excluded, but grades 3a and 3b have only been distinguished in post-1988 mapping. Where grade 3a and 3b data are available, approximately half is grade 3a and half is grade 3b, and this has been considered later in the analysis.

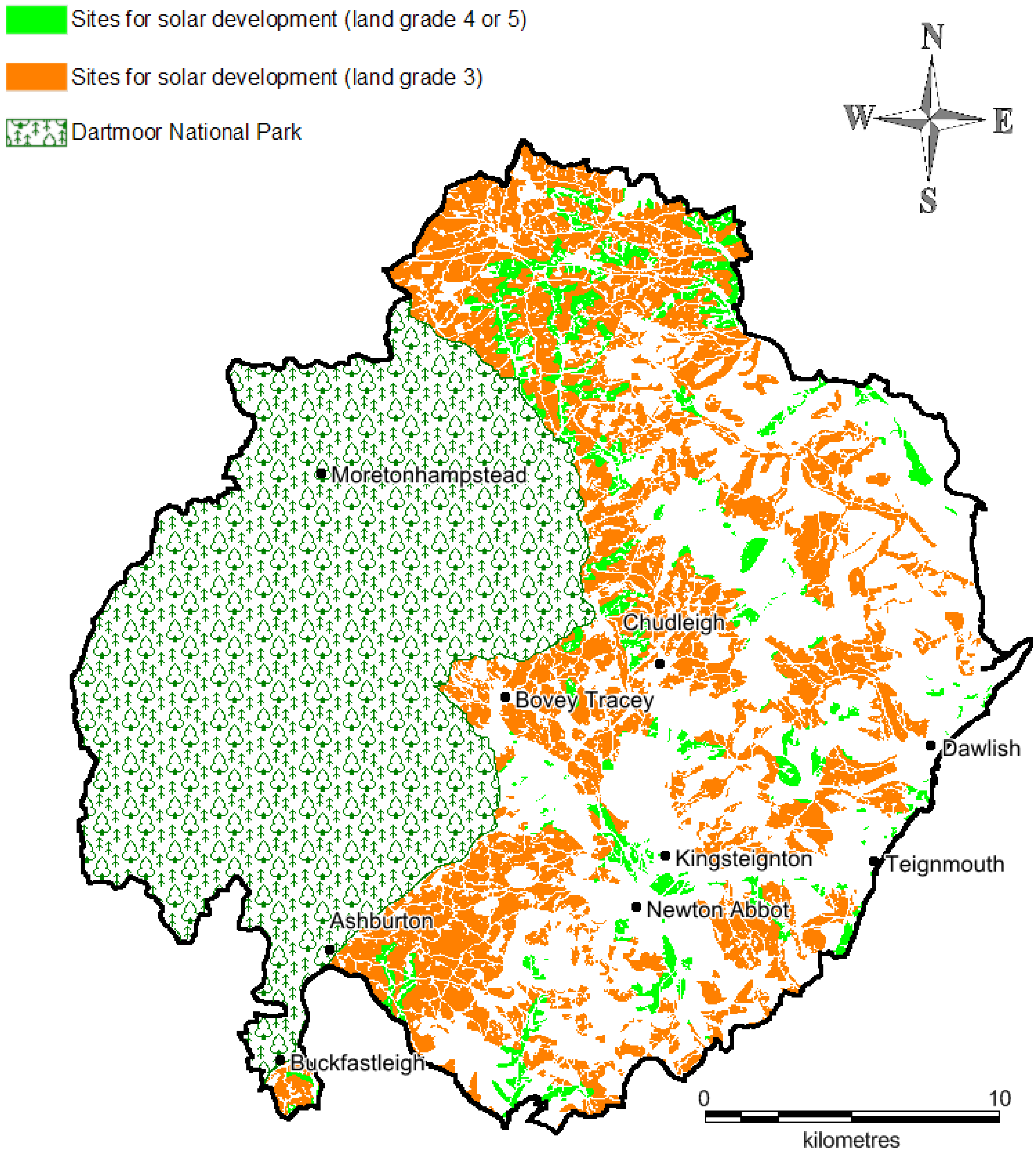

Figure 17: Areas identified for PV development with no constraint on the maximum distance from the WPD electricity distribution grid

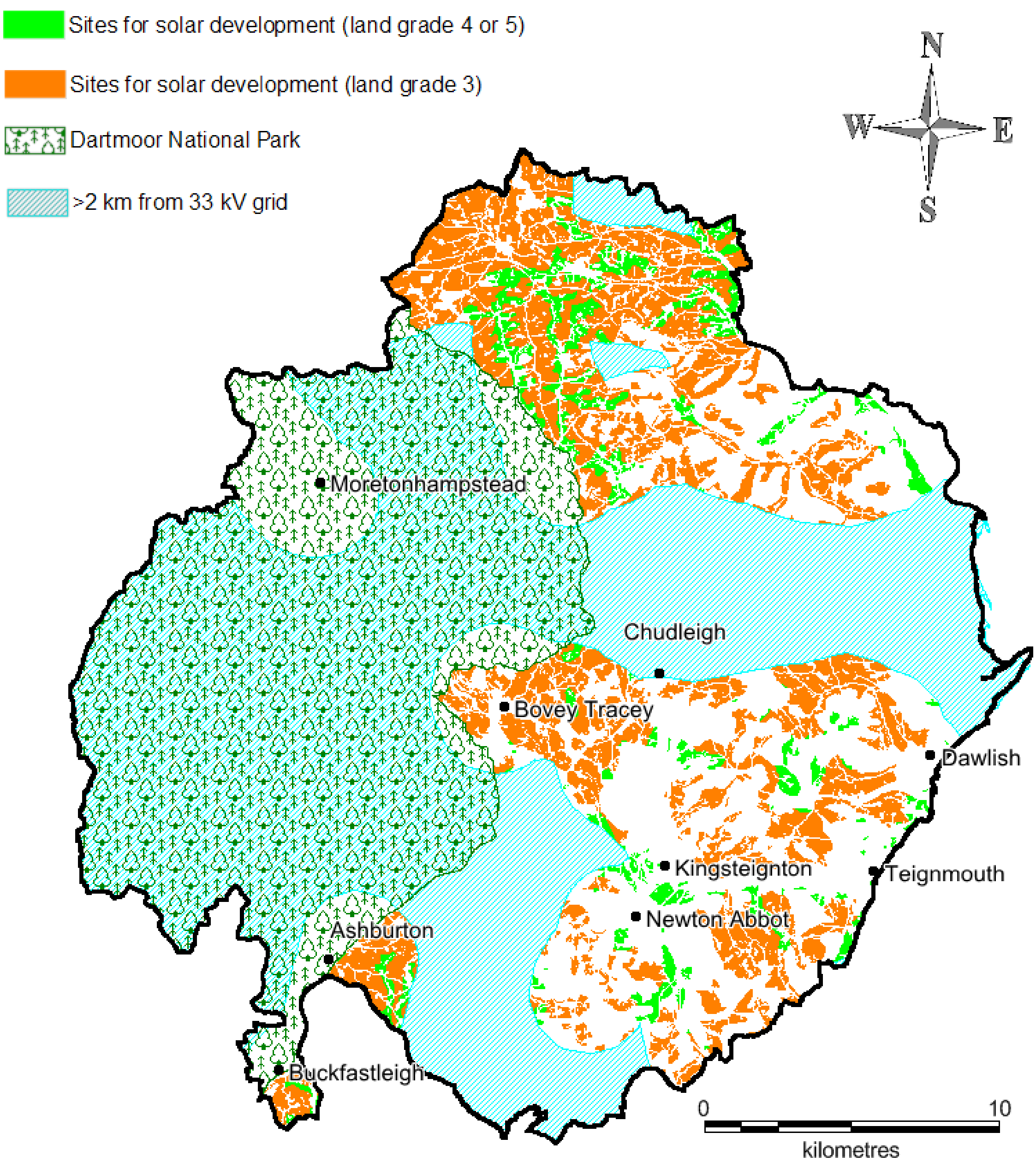

Figure 18: Areas identified for PV development with a 2 km constraint on the maximum distance from the WPD electricity distribution grid

1.1.19 Resource assessment

The identified areas were used to estimate the potential installed capacity and annual output from PV, adopting the methodology of previous reports [44,45]. In line with other studies[44], an installed capacity of 0.13 MW per acre (32.1 MW per square kilometre) was initially assumed. This was subsequently revised to 0.17 MW per acre (41.0 MW per square kilometre) on the basis of a review of installed capacity and gross land area of all PV farms over 4 MW in Devon.

A density factor of 25% has been applied to restrict development from that outlined above to limit landscape impact. This is taken from the Cornwall study [45] (other studies[44] referenced this value, but used a higher figure of 35% to account for PV being highly constrained by other factors such as green belt and flood risk; Teignbridge is broadly more similar in character to Cornwall). A capacity factor of 11.5% was applied to account for the intermittency of solar insolation when calculating the annual energy output. This figure was derived from the performance of PV installations in Teignbridge in 2019 [58]. A similar figure was used in other studies [44,]

[60]. These factors have been applied to arrive at the predicted resource figures below, but are not included in the GIS mapping presented above.

The resulting numbers of sites, areas, installed capacities and annual electrical output are listed in Table 8 (note: the number of sites resulting from the application of the density factor have been rounded to the nearest whole number). Clearly, there is a significant difference between the estimated outputs when constraints of distance to the WPD electricity distribution grid are applied. Therefore, to achieve higher outputs it will be necessary for sites remote from the grid to be developed in tandem with storage or direct supply.

Table 8: Estimated PV resource in Teignbridge

Grid proximity constraint applied	Number of sites	Area (km^2)	Total capacity (MW)	Annual Output (GW h)
No	186	42.8	1754.9	1768.0
Yes	134	29.3	1202.6	1211.5

Table 9 incorporates an adjustment to estimate the amount of Grade 3a agricultural land and exclude it from the available area. This is based on the percentage split between grades 3a and 3b where this survey data exists. Despite the estimation, these results are thought to represent a more realistic constrained resource.

Table 9: Estimated PV resource in Teignbridge: results adjusted to exclude Grade 3a agricultural land

Grid proximity constraint applied	Estimated percentage of Grade 3 land that is Grade 3a	Number of sites	Area (km^2)	Total capacity (MW)	Annual Output (GW h)
No	44%	117	26.9	1102.6	1110.8
Yes	44%	85	18.7	765.0	770.6

1.1.20 Current resource use and remaining resource

Table 10 summarises PV development in Teignbridge [58] as in 2019.

Table 10: Current (2019) PV development in Teignbridge (source BEIS)

Number of sites	Capacity (MW)	Annual Output (GW h)
3,603	35.0	35.1

Current total ground mounted and roof mounted PV generation in Teignbridge represents 2.9% of the grid-constrained resource (to agricultural land grades 3 and above) or 2.0% without the grid proximity constraint. These figures increase to 4.6% and 3.2% respectively if the resource is constrained to grades 3b and above. Table 11 shows the yet to be developed PV resource in Teignbridge and indicates a large unexploited potential. The number of existing sites includes roof-mounted panels and therefore the number of sites large-scale ground-mounted sites remaining cannot be calculated from these data.

Table 11: Unexploited PV potential within Teignbridge (constrained to agricultural land grades 3 and above)

Agricultural land grades excluded	Grid proximity constraint	Capacity (MW)	Annual Output (GW h)
1 and 2	No	1720	1733
	Yes	1168	1176
1, 2 and 3a	No	1068	1076
	Yes	730	736

[60] The REGEN North Somerset study applied a capacity factor but the value is not stated; back-calculation from the rounded capacity and output figures in the report gives a value of about 10%.

1.1.21 Detailed resource assessment of the Bovey Basin area

A more detailed examination of the Bovey Basin Strategy Area for solar PV development has been undertaken with less stringent constraints imposed. Refinements and changes from the Teignbridge-wide resource assessment included:

1. Areas of mineral workings were revised to the active extent of workings based on specific data provided in place of the approximate extent of workings previously taken from Google Earth. The extent of long term working areas was also provided, and has been applied as an optional constraint.
2. Landfill was not excluded. The only landfill site in the study area is the Heathfield landfill, which would appear to have limited remaining capacity and in the long term may be suitable for PV arrays.
3. The minimum distance constraint was relaxed from 25 m to 5 m[61] for the Newton Abbot to Heathfield railway line. This line is currently not in regular use, although future use for passenger and freight traffic is possible.
4. The minimum distance constraint was relaxed from 25 m to 12 m for roads. This was found to be sufficient to encompass the carriageway and verges. The planned new A382-A383 link road and Jetty Marsh II link road were included.
5. Areas allocated for employment or residential development in the Houghton Barton area were excluded.
6. The minimum distance constraint for buildings was reduced from 25 m to 10 m. However, new constraints were added based on the detailed examination of maps to exclude private gardens and yards around industrial, commercial and agricultural buildings.
7. Consideration was given to development on Grade 2 and 3 agricultural land.

The resultant areas excluded are listed in Table 12. Constraints that are not present within Teignbridge have been omitted (airfields, MOD danger areas, Areas of Outstanding Natural Beauty, Heritage Coast and World Heritage Sites). Constraints that each remove 5% of more of the study area are shown on Figure 19.

[61] Distance is either side of the formation centreline. Minimum clearance for a single railway line is 2.5 m.

Table 12: Spatial constraints applied to determine the PV resource in the Bovey Basin study area

Parameter	Constraint	% of Bovey Basin area removed
Transport & Communications		
Railway Line	> 5 m	0.3%
Road	> 12 m	7.2%
Planned Road	> 12 m	1.6%
Built Environment & Heritage		
Building	> 10 m	4.0%
Private Gardens and Yards	Exclude	5.8%
Allocated Residential Development Land	Exclude	0.3%
Allocated Employment Development Land	Exclude	0.3%
Greenspace[49]	Exclude	4.0%
Quarry (active workings)	Exclude	23.0%
Quarry (long term potential working areas)	Exclude (as an option)	11.8%
Registered Park or Garden	Exclude	7.7%
Scheduled Monument	Exclude	0.0%
Natural Features		
Agricultural Land Classification Grade 1	Exclude	0.3%
Agricultural Land Classification Grade 2	Exclude (as an option)	1.6%
Agricultural Land Classification Grade 3	Exclude (as an option)	52.5%
Local Nature Reserve	Exclude	3.0%
Marshland	Exclude	0%
National Nature Reserve	Exclude	0%
National Park	Exclude	0%
RAMSAR Site	Exclude	0%
Sand Dunes	Exclude	0%
Site of Special Scientific Interest	Exclude	7.6%
Slope	Exclude > 20° facing between east and west via north	0.3%
Special Area of Conservation	Exclude	0%
Special Protection Area	Exclude	0%
Tidal Water	Exclude	0.2%
Water	Exclude	2.9%
Woodland	Exclude	25.2%

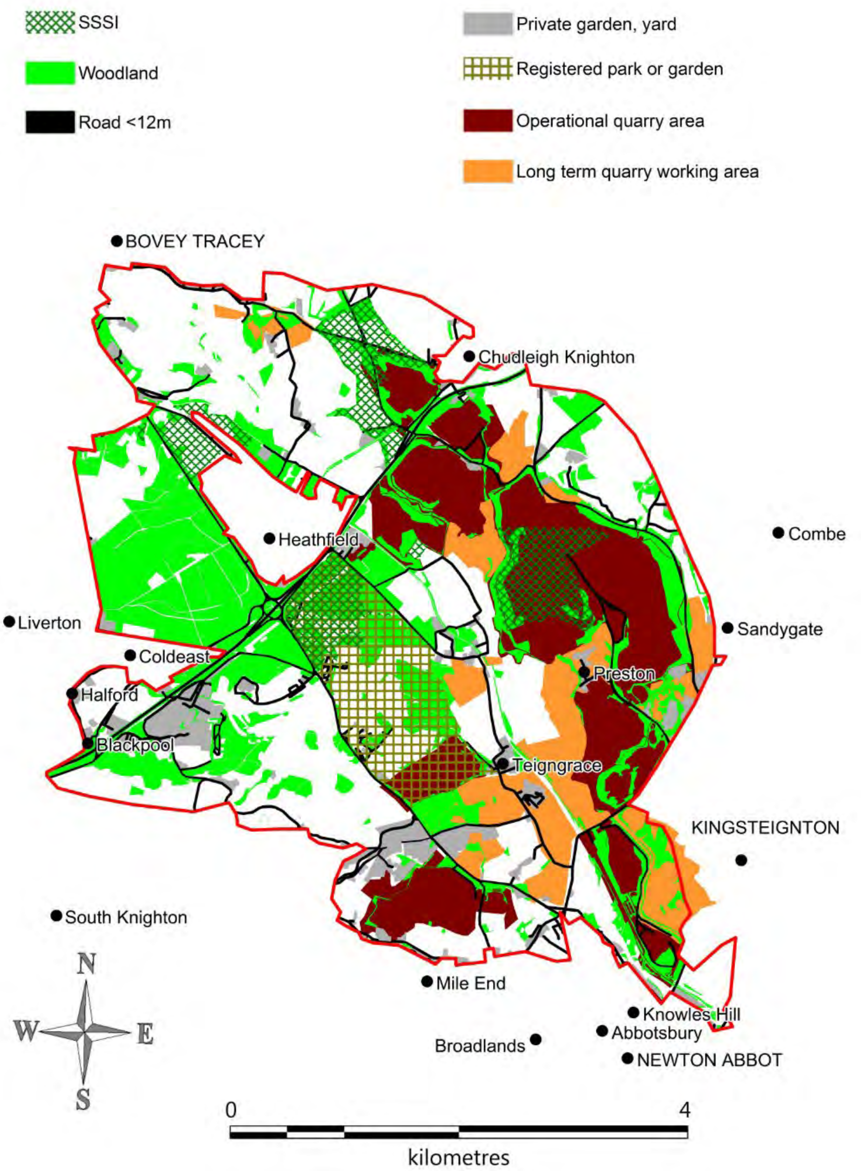

Figure 19. Constraints each removing at least 5% of the Bovey Basin study area

Table 13 lists the available areas and associated resource for various scenarios. Comparing results within the Bovey Basin study area to the Teignbridge-wide mapping for the equivalent scenario (no grid proximity constraint and no constraints on development on Grade 3 agricultural land or long-term quarry working areas) shows similar results, returning 0.1 km^2 of additional resource. Comparing the outputs, the greatest changes have been from the refinement of the extents of the quarry working areas.

Total capacity and annual output have been calculated without the application of a density factor. Development of only 25% of available sites was assumed in the Teignbridge-wide mapping, which would reduce the figures in Table 13 by 75%. Application of a density factor is less applicable to a study of a small area that has been selected for potential intense application of PV.

Table 13: Estimated PV resource in the Bovey Basin study area. The row in bold is the scenario used in the comparison with the Teignbridge-wide mapping

Grid proximity constraint applied	Long term quarry workings constraint applied	Highest agricultural land grade available for development	Number of sites	Area (km^2)	Total capacity (MW)	Annual Output (GW h)
No	No	2	57	8.5	350.1	352.7
No	**No**	**3**	**58**	**8.4**	**342.4**	**344.9**
No	No	4	35	2.3	92.8	93.5
No	Yes	2	53	6.8	279.5	281.6
No	Yes	3	53	6.7	274.2	276.2
No	Yes	4	29	1.5	63.3	63.8

Grid constraints have not been applied to this assessment. Figure 20 shows high voltage power distribution in the vicinity of the study area. The western part of the study area is more than 2 km from a Western Power 33 kV transmission line, but the entire study area is within 2 km of an 11 kV grid connection.

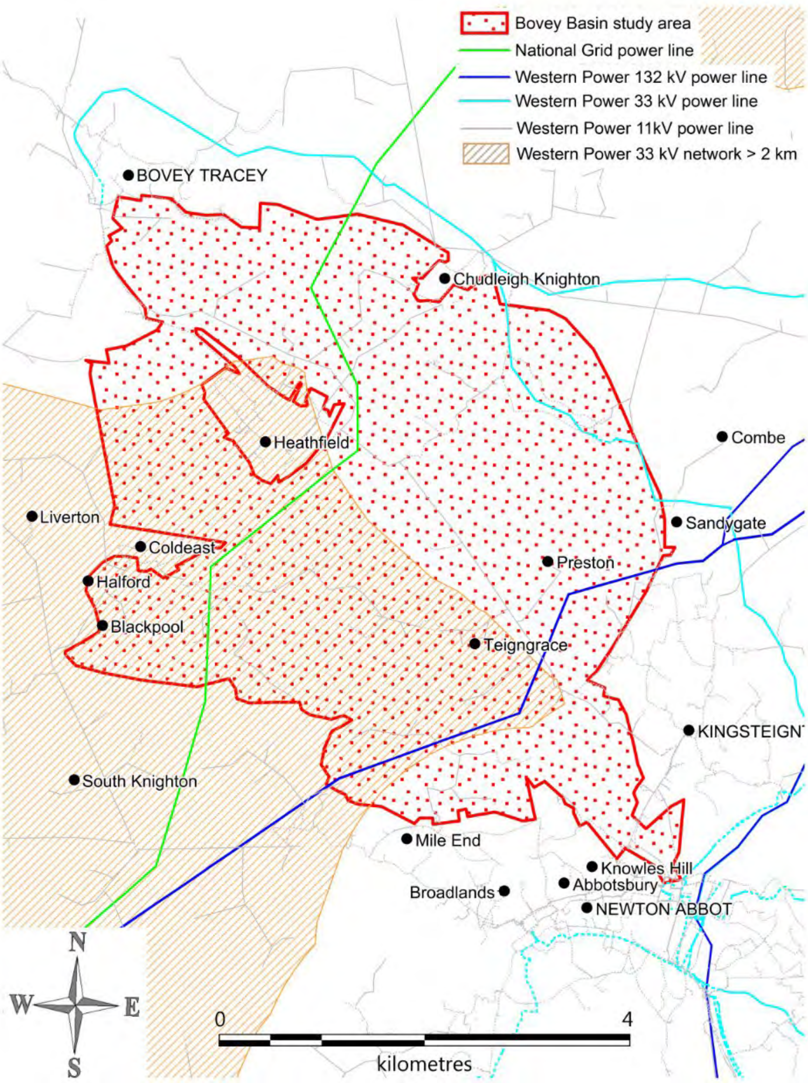

Figure 20. High voltage power distribution in the vicinity of the Bovey Basin study area. Dotted lines indicate underground cables

Figure 21 show the areas identified for potential PV development within the Bovey Basin study area.

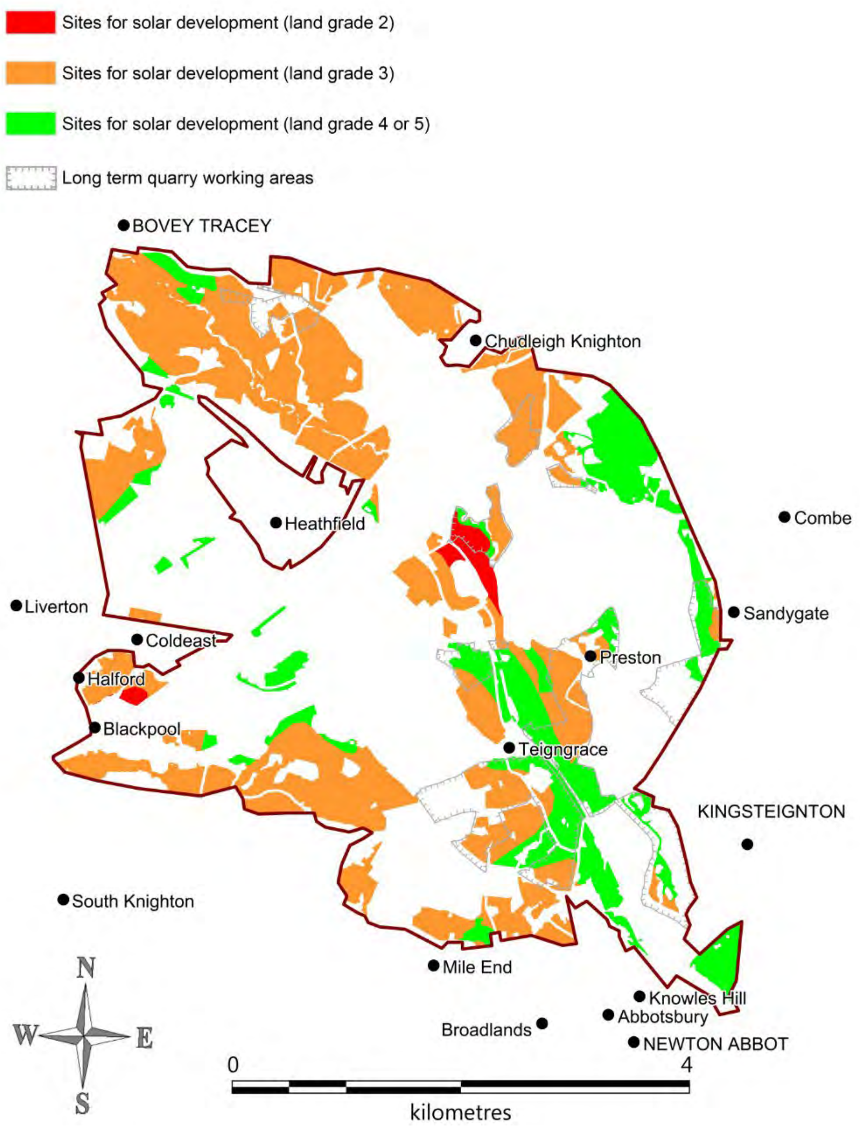

Figure 21: Areas identified for PV development within the Bovey Basin study area, shaded by agricultural land grade

The renewable energy resource in context

Total 2019 electricity consumption in Teignbridge (including DNP) was 468 GWh of which 244 GWh was domestic and 224 GWh non-domestic[62]. 7.5% of total consumption (35.2 GWh) is currently generated from large scale wind and PV in the part of the district excluding DNP. This compares with a near-grid onshore wind resource (excluding DNP and woodland) of 217 GWh and a near-grid PV resource of 771 GWh demonstrating that, while some wind and PV development will be mutually exclusive, the minimum total wind and PV resource identified (988 GWh) significantly exceeds the district's current annual electricity demand.

A new home meeting net zero regulated CO_2 emissions (CSH 5) is calculated to consume 2,093 kWh/annum[63]. When unregulated consumption is included (CSH6) consumption rises to 4,870 kWh/annum.

Table 14 shows the percentage either of wind or PV resource and the associated land areas (excluding DNP) over and above existing projects that would need to be identified to provide electricity for 1,000 and 10,000 new homes to meet demand from regulated consumption (CSH5) and regulated and unregulated consumption (CSH6).

Table 14: Land areas needed to be identified to power up to 10,000 new homes

New homes	Net zero	Consumption GWh	Wind capacity MW	Wind land area ha	PV capacity MW	PV land area ha
1,000	Regulated	2.093	0.9	10.7	2.1	5.1
1,000	Regulated and unregulated	4.870	2.0	24.8	4.8	11.8
10,000	Regulated	2,093	8.5	106.6	20.8	50.8
10,000	Regulated and unregulated	4,870	19.9	248.1	48.3	118.2

A typical electric vehicle (EV) uses 265 Wh/mile[64] which if it covers the average annual mileage of a UK car (6,607 miles in 2019[65]) would consume 1,751 kWh annually. Table 15 shows the percentage either of wind or PV resource and the associated land areas (excluding DNP) that would need to be identified to provide electricity for 1,000 and 10,000 EVs.

Table 15: Land areas needed to be identified to power up to 10,000 electric vehicles

Number of EVs	Consumption GWh	Wind capacity MW	Wind land area ha	PV capacity MW	PV land area ha
1,000	1.751	0.7	8.9	1.7	4.2
10,000	1,751	17.5	89.2	17.4	42.5

In Table 14 and Table 15 it is important to note that the resource percentages and land areas for each technology are those required to generate all the electricity use from this technology alone. Combinations of technologies are also possible.

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[62] Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/946419/Sub_national_electricity_consumption_statistics_2005-2019.xlsx

[63] Calculated on the basis of a Part L 2021 compliant home with and air source heat pump to meet FHS

[64] Nissan Leaf source : www.ev-database.uk

[65] Source: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/906056/nts0904.ods

The combined electricity demand of 10,000 regulated new homes and 10,000 EVs is estimated at some 38GWh increasing to 66GWh when unregulated home consumption is included. Resourcing 38GWh needs the identification of land of either 196ha for wind or 93ha for PV and 337ha for wind or 161ha for PV when unregulated consumption for homes is included.

Provided by wind alone, the generation of 38GWh would require 18% of the wind resource to be developed with 66GWh requiring 30%. If distributed evenly across the wind turbine sizes in Table 5, 18% would result in approximately two 2MW turbines, one 1MW turbine and twenty one 500kW turbines with 30% needing four 2MW turbines, two 1MW turbines and thirty six 500kW turbines. Alternatively, if provided by PV alone 5% of the PV resource would be developed to generate 48GWh and 9% to generate 66GWh resulting in approximately eight and thirteen 5MW PV farms respectively. Each 5MW PV farm would occupy approximately 12.2 ha.

Renewable energy storage

Storage of electricity produced from renewable energy generation needs to be seen in the context of the decarbonisation of the UK's electricity system (see Figure 10) and the evolution of future electricity demand. Decarbonisation of the grid is playing, and will continue to play, an important role in the decarbonisation of buildings and transport leading to a likely increase in demand. Local provision of the required electricity infrastructure, potentially including energy storage, will therefore be essential if a locality is to deliver low carbon development, and more especially provide for the decarbonisation of existing buildings and transport.

The current electricity use and the scale of additional use from new homes and additional EVs in Teignbridge (including DNP) is illustrated in Table 16 (figures from Section 0).

Table 16: Current electricity use compared to the additional use for 10,000 new homes and/or EVs in Teignbridge

Usage	Additional electricity use (GWh)	2019 domestic electricity use (GWh)	2019 domestic electricity use (%)	2019 total electricity use (GWh)	2019 total electricity use (%)
10,000 new homes	49	244	20%	468	10%
10,000 new EVs	18	244	7%	468	4%
10,000 new homes and EVs	66	244	27%	468	14%

Ten thousand new homes and EVs are estimated to increase current total electricity demand in Teignbridge by 14%.

Table 17 enables comparison with the longer term additional electricity demand it is estimated would arise from replacing the natural gas currently supplied in Teignbridge with electricity and all cars and vans registered in Teignbridge with EVs as the UK moves towards net zero GHG emissions in 2050.

Table 17: Estimates of electricity use replacing gas and petrol/diesel cars and vans in Teignbridge

Usage	Additional electricity use GWh	% of 2019 total elec. Use
Domestic gas[66]	148	32%
Non-domestic gas	53	11%
Total gas	201	43%
Cars[67]	133	28%
Vans[68]	72	15%
Total cars & vans[69]	205	44%
Heat plus cars & vans	406	87%

Replacing existing fossil fuel use with electricity requires six times more additional electricity supply than would be required to supply ten thousand new homes and electric cars. The changes to the electricity system that this implies goes far beyond providing electricity storage, with extensive distribution system upgrades being required at all voltage levels. For example retrofitting homes with electric heating and EV charging will need homes to be moved to a three phase electrical supply requiring entire localities to be re-cabled.

Figure 22 illustrates current and estimated electricity demand from existing users together with the illustrative demand from ten thousand new homes and EVs. This demand is compared to the minimum mapped renewable electricity resource.

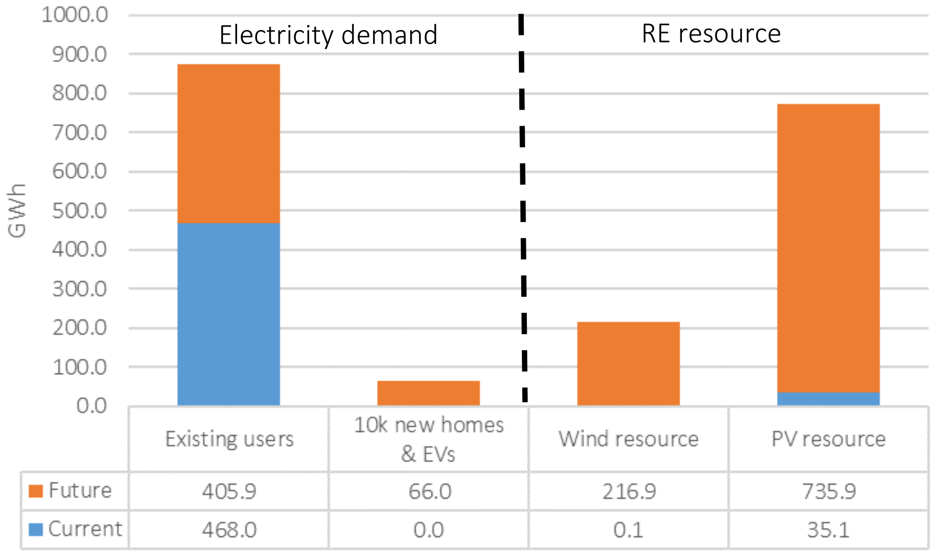

Figure 22: Estimates of current and future electricity demand compared to the renewable energy resource in Teignbridge

[66] Domestic and non-domestic based on gas use efficiency of 80% and electricity coefficient of performance of 3.0
[67] Based on average 2019 car use of 6,607 miles/year with Nissan Leaf (265 Wh/mile)
[68] Based on average van use of 13,000 miles/year (Source https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/801483/road-traffic-estimates-2018-vans.pdf) using Vauxhall Vivaro (405 Wh/mile Source www.ev-database.uk)
[69] Numbers of cars and vans in 2019 (427 ULEVS in Teignbridge in 2019 ignored) from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/882143/veh0105.ods

The graph shows that the magnitude of estimated future demand is matched by the resource available in the district (a total demand of 940 GWh compared to a total wind and PV resource of 988 GWh).

The extent of the local challenge of integrating new renewable energy generation in Teignbridge into the local and national electricity grid infrastructure, including energy storage, will depend on how much of the district's renewable energy resource is brought forward for development.

In the Sixth Carbon Budget the CCC provides guidance for local authorities[70] recommending that they should work with their Distribution Network Operators, neighbouring authorities and across their wider climate and energy partnerships to prepare local energy plans for their area. Teignbridge will need to work closely with WPD on these plans, part of which will concern the connection of renewable energy and the provision of electricity storage. Local policy should be developed in the context of the Teignbridge local energy plan.

The Government updated the planning regime for electricity storage in 2020[71]. Battery electricity storage projects no longer need to seek consent from the Secretary of State under the Nationally Significant Infrastructure Project (NSIP) regime in the Planning Act 2008. Previously projects over 50 MW capacity needed to seek NISP consent. All battery storage projects will therefore be consented by the local planning authority under the Town and Country Planning Act 1990, unless directed into the NSIP regime by the Secretary of State (e.g. following a request by the developer, LPA, an objector etc.) under section 35 of the Planning Act 2008.

The Government has committed to updating the national renewable and low carbon energy planning practice guidance to refer specifically to electricity storage. When published this guidance can be incorporated in Teignbridge's local energy plan and the policy that emerges from the energy planning process.

[70] "Local authorities and the sixth carbon budget", Committee on Climate Change, 2020 p96
[71] "Proposals regarding the planning system for electricity storage, Government response to October 2019 follow up consultation", BEIS, July 2020

Appendix I Review of Carbon Offsetting Approaches in London

The National Energy Foundation (NEF) has undertaken a thorough review[72] of the different approaches in London (consult for further detail). From this review, key outcomes of relevance to local plans include:

- Policy: Allowable solutions were introduced as they were expected to bridge the gap between on-site carbon reduction and achieving the Government's Zero Carbon Homes policy. As this policy was dropped there is uncertainty as to the ability of LPAs to stipulate Carbon Offset measures in local plans. Nonetheless, and underpinned by the London Plan's zero carbon requirement, boroughs in London have been (with varying degrees of success) collecting carbon offset payments from new development.
- Approaches: In London, 22 LPAs are collecting offsetting payments, 2 have imminent plans to do so, and 11 do not. The reasons the 11 that are not collecting gave included uncertainty on ZCH policy, the local plan being at an early stage in the review process, viability issues, preference for onsite measures, and lack of identified projects for offset funding. Fifteen of the 22 LPAs set the payment level at £1,800/tonne (i.e. based on the middle scenario presented by the ZCH of £60/tonne for 30 years [the lower and upper values set being £36 and £90 respectively, with the ZCH also having experimented with a value of £46/tonne]). Of the remaining 7 LPAs, 4 set values based on other values put forward by the ZCH, and 3 based values on local analysis of the cost of carbon reduction measures. Interestingly, these varied widely. In Islington there is a one off payment of £920/tonne, whilst in Lewisham and Westminster the values are much higher at £3,201 and £7,560 respectively (the former derived from Lewisham's own Cost of Carbon 2014 report, and the latter derived from a local assessment carried out by consultants on the cost of delivering a range of carbon saving measures in the Borough. In Westminster costs are high due to a large number of heritage buildings and designations making energy efficiency measures more expensive). Most LPAs have developed their own additional policy mechanisms to support their approach to offsetting, either through local plan policy and/or through Supplementary Planning Documents (SPDs). The requirements apply to all residential developments of over 10 dwellings or any non-residential development with an area greater than 1,000 m^2. These thresholds correspond to the definition of major development[73]. In addition to this, 3 out of the 22 LPAs (Enfield, Islington and Waltham Forest) apply a requirement to minor developments as well. Enfield apply the offsetting policy to minor works "where it is demonstrated that this is technically feasible and economically viable". Islington sets a flat rate of £1,500 per house or £1,000 per unit for minor works and is confident in its approach, however a Written Ministerial Statement in December 2014 stated that tariff-style contributions should not be sought for minor developments. Waltham Forest's local plan applies offsetting policy to all developments, but in practice compliance is only being applied to major developments.
- Funding and project selection: Twelve LPAs have set up a dedicated carbon offset fund, six administer the funds through their Section 106 (S106) processes, and four have not yet set up a fund, primarily because payments have not yet been received as developments have not yet commenced or reached the trigger point for payment. At the time of the report, Islington had far and away the highest current balance in the fund at £2.8 million with only two other LPAs having balances in excess of £200,000. Seven out of the 22 LPAs applying offsetting have spent funds on projects with Islington anticipating spending funds on projects imminently. The remaining 14 LPAs are experiencing a range of barriers to spending the offset fund. The most common barrier is the time taken waiting for payment trigger

[72] National Energy Foundation 2016, Review of Carbon Offsetting Approaches in London
[73] 2015, Statutory Instrument 595 Town and Country Planning, England

points to commence, or for payments to be pooled to a required threshold to be sufficient to deliver projects. The restrictions placed on pooling of S106 obligations by the CIL Regulations is a potential barrier to the setting up of offset schemes. For some LPAs it was found to be a major barrier, whilst for others it was not a hindrance, i.e. where the fund is not used to deliver infrastructure projects. The NEF acknowledge there is an absence of guidance on the matter.

- Monitoring and Reporting: Seven of the 22 LPAs do not currently have a list of projects for funding. The reasons are primarily due to a lack of funds to date; projects identified in S106 agreements or lack of internal resources and departmental awareness of the fund. The remaining LPAs either have published in-house lists or general project descriptions in SPDs, or have specific projects (e.g. Croydon – fuel poor home energy awareness scheme; Havering – PV on community run buildings; Islington – fuel poverty projects e.g. high rise solid wall insulation; Merton – Leisure Centre CHP and City Farm PV; Westminster – feasibility studies for district heating, and community and residential building retrofits). The majority of LPAs (13) calculate offset payments at the planning application stage. Merton has assessed two offset contributions following the committee approval stage. Five authorities revisit the energy assessment calculation, either following amendments to the application at the detailed design stage, or when planning conditions are discharged. Three authorities recalculate at the "as built" stage (note: "as built" refers to the calculated emissions when the building is handed over as opposed to the actual performance of the building in use).
- Case studies: The NEF report provides further details for five case study schemes (Ashford, Islington, Milton Keynes, Tower Hamlets, Southampton) of which three are outside London.

In addition, a number of management issues were identified in operational in London and beyond:

- Additionality: Funds must be directed towards projects that would not otherwise have happened. In some cases, the funds have been used in conjunction with other schemes (e.g. ECO), and in these cases the carbon claimed to be saved by the offset fund can only apply to the fraction of the overall funding derived from the offset fund.
- Offset amount, price and ratio: The payments in the three case study LPAs outside London ranged from £200 - £265/tonne which is significantly less than the most commonly used value of £1,800/tonne used in London. Those three LPAs have had the policy in place prior to the national ZCH work on allowable solutions, and it is claimed that the amount is based on the cost of actually delivering carbon reduction in those areas. It is not clear whether the measures identified are "quick wins", or if a 30 year multiplier has not been applied. However, these prices are now under review through the Local Plan process. The "offset ratio" (the ratio of the actual identified cost to save a tonne compared to the levied cost per tonne) is also a factor in London, with the Mayor's SPD stating that the ratio does not need to be 1:1 as the *"offset price set generally does not fully cover the cost of saving carbon dioxide in order to ensure the price is viable for development"* and that *"The benefit of the fund is in unlocking carbon dioxide saving measures. If a 1:1 ratio is set, only the simplest retrofitting measures are likely to be carried out. This would potentially leave the more complicated measures without adequate funding and could result in a property requiring further retrofit works in the future, resulting in further disturbance to the occupier".* In London, the approach to collection has been via S106 payments, ensuring that no projects are also on the CIL Regulation 123 list as this would constitute double charging.
- Viability: Development must still remain viable, after the charging for any carbon offsetting. The NEF concluded that whilst there has been some resistance, where LPAs have followed the London Plan SPG developers have been unlikely to challenge, due to the weight of evidence behind the plan. However, land values are significantly higher in London than in the south west and so this may be a factor.

- Management: Generally the collected funds are managed by the local council, though there are some example cases where this function has been outsourced.

Appendix II Planning for a Future White Paper and Changes to the Current Planning System

In announcing the Planning for a Future White Paper in August 2020 the Prime Minister stated that the current planning system is "a relic from the middle of the 20th – our outdated and ineffective planning system. Designed and built in 1947 it has, like any building of that age, been patched up here and there over the decades."

The White Paper includes proposal for:

- A deadline of December 2023 by which time all LPAs must have an up-to-date Local Plan to ensure communities have enough land available to meet local housing need.
- Simplified Local Plans would place land in three categories – growth areas "suitable for substantial development", renewal areas "suitable for some development" and protected areas. This would (the white paper says) halve the time to acquire planning permission on larger sites identified in plans. General development management policies would be set nationally, with Local Plans containing "clear rules" with design codes and site- and area-specific requirements.
- A single statutory "sustainable development" test with the abolition of current "unnecessary assessments and requirements that cause delay and challenge".
- While suggesting "democratising" the planning process by putting a new emphasis on engagement at the plan-making stage there are proposals to "streamline the opportunity for consultation at the planning application stage, because this adds delay to the process and allows a small minority of voices, some from the local area and often some not, to shape outcomes".
- Introducing binding top down housing targets on local planning authorities based on 300,000 new homes per year nationally.
- More homes built on brownfield sites, tree lined streets and continued protection of Green Belt.
- A national flat rate Infrastructure Levy to replace Section 106 planning agreements to "sweep away months of negotiation and the need to consider site viability" while "capturing a greater share of the uplift in land value that comes with development".
- Supporting efforts to combat climate change and facilitating "ambitious improvements in the energy efficiency standards for buildings", as part of the drive towards 2050 net zero greenhouse gas emissions.
- Supporting small and medium size developers.

The consultation on the White Paper closed in October 2020 and the Government's response is awaited.

The consultation on changes to the current planning system covers four main areas of policy:

- First homes. First Homes are one form of affordable housing. The consultation sets out proposals for setting developer contributions for First Homes which should seek to capture the same amount of value as would be captured under the LPA's existing published affordable housing policy within its Local Plan. A quarter of affordable housing on site should be First Homes and the consultation document offers two options for the remaining three quarters.
- Threshold for developer contributions. The consultation proposed to raise to 40 or 50 homes the threshold at which developer Section 106 contributions would be sought, for a time-limited period which would end "as the economy recovers from the impact of Covid-19".

- Permission in principle. The Housing and Planning Act 2016 introduced a new system of allowing the Secretary of State to grant planning "permission in principle". Currently major development is outside the scope of permission in principle, unless the site is entered in Part 2 of a brownfield land register. The consultation proposes extending permission in principle to cover major development. In-principle matters relate to the location, use, and amount of development on a site.
- Standard method for calculating housing need. The current standard method comprised three steps (setting the baseline, affordability adjustment and capping the level of increase). The consultation document set out proposals to amend it, to include as a new element a percentage of housing stock levels and an affordability adjustment. Another change was to be the removal of the cap on the level of increase, which (the consultation paper said) "artificially suppresses" identified housing need. The consultation document set out the detail of the two, amended steps – step 1 was setting the baseline and step 2 was adjusting for market signals – and provided the results of the new standard method, which was a national housing need of 337,000 on the basis of currently available data.

The Government has not yet published its response to other aspects of the review of the current planning system, but on 16 December 2020 published its response on local housing need, alongside a written ministerial statement confirming that it would not be proceeding with the changes set out in the consultation. Instead it amended the current standard method by adding a 35 per cent uplift to the post-cap number which it generates for Greater London and the local authorities containing the largest proportion of the other 19 most populated cities and urban centres in England.

Appendix III 2020 analysis of higher energy standards for new dwellings in the Greater Exeter area

In order to assess the impact of potential policies to reduce GHG emissions a calculation process was undertaken to determine emissions from alternative policies to the envisaged business as usual pathway.

The calculation process for new dwellings was based on the following approach, assumptions and data sources:

- Various specifications and associated costs for four different dwelling typologies (detached, semi-detached, 1 bed flat and 2 bed flat [ground, mid and top floor for each of the flat scenarios]) were published in a report by Currie and Brown[74] (the C&B report) and the Impact Assessment of the Future Home Standard consultation[75]. These were used to determine the baseline specifications for a Part L 2013 compliant dwelling and the subsequent incremental cost uplift of improving performance of the fabric and services.

- The typical housing mix within the GESP area has been estimated previously by examining typical layouts of developments in East Devon's West End (taken to be 40% detached, 53% semi-detached, and 7% apartments). Calculations were undertaken for each dwelling architype but area weighted to give a GESP "typical" dwelling with an internal floor area of 88 m^2.

- The C&B report was used to establish the heat loss (in W/K) of each of the principle fabric elements (based on the reported element areas and U-values) and air exchange paths (ventilation based on a fixed natural ventilation rate of 0.5 air changes per hour as stated in SAP 10 and an air permeability rate of 5 $m^3/h/m^2$ @ 50 Pa. These were used to apportion the reported delivered energy consumption (kWh/m^2) for space heating. Delivered energy consumption for domestic hot water (DHW) was reported by C&B whilst delivered energy consumption for auxiliary energy (pumps), lighting, cooking and electrical appliances were calculated using methods stated in SAP 10.

- The delivered energy consumption for each element and end use was converted to both primary energy and carbon emissions using the conversion factors in Table 12 of SAP 10. In the case of primary energy, for energy generated using PV it was assumed that 50% would be used on-site (and therefore avoids importing an equivalent amount from the grid), with the remaining 50% exported to the grid. Therefore a primary energy factor was calculated for PV generation as an average of the import and export primary energy factors (the potential effects of battery storage was not considered).

- It was assumed that the Government's preferred specification for Part L 2020 from their consultation was chosen ("Part L 2020 Option 2"). This corresponds to a 30% carbon reduction on a Part L 2013 dwelling and is achieved via moderate improvements in roof and window U-value, and 6.5 m^2 of connected PV facing south east to south west (. The exact specification of the Future Home Standard proposed for 2025 is not known at this stage, though it is stated that it will achieve a 75 – 80% carbon reduction over a Part L 2013 dwelling and that there is an intent to not connect to the gas grid. Modelling undertaken here has found that the "Part L 2020 Option 2" specification without any PV

[74] Currie and Brown 2019, A report for the Committee on Climate Change The costs and benefits of tighter standards for new buildings Final report

[75] The Future Homes Standard: changes to Part L and Part F of the Building Regulations for new dwellings, October 2019

though with an air source heat pump (ASHP) meets the FHS carbon reduction level, and so this was taken to be the specification for Part L 2025.

- The potential energy savings and financial costs of specifying better levels of performance (e.g. improved U-values, air tightness, mechanical ventilation with heat recovery [MVHR]) were calculated and two additional scenarios were created. Scenario A assumed floor, wall, roof and window U-values of 0.11, 0.13, 0.11 and 1.2 W/m^2/K respectively, an air permeability rate of 3 m^3/h/m^2 @ 50 Pa, improved thermal bridging, and MVHR. Scenario B was the same as scenario A but with a window U-value of 0.8 W/m^2.K and an air permeability rate of 1 m^3/h/m^2 @ 50 Pa (i.e. similar to the *Passivhaus* specification).

- The total potential PV generation on each of the dwelling architypes was calculated by estimating the available roof area and assuming that roof faced SE/SW with minimal shading. This was then used to determine the maximum potential amount of primary energy or carbon that could be offset from the different dwelling specifications.

- The calculated gas and electricity consumption for each potential dwelling specification (Part L 2013, Part L 2020, Part L 2025 [FHS], and two potential standards to test which were either net zero carbon or net zero primary energy (regulated energy only) were established. These were the theoretical outputs that would be obtained from SAP as opposed to in-use performance which is likely to be higher due to the "performance gap". It was assumed that Parts L 2020 and 2050 would be phased in over 5 years following the phase-in assumption in the Part L 2020 Impact Assessment, and that any GESP policy would be implemented in its entirety from 2023 onwards. These were used in combination with housing projections for the GESP period to estimate the business as usual (BAU) trajectory and the potential additional carbon reduction that might arise if a net zero carbon or net zero primary energy standard were to be set.

The results from the analysis of dwellings are shown in Table A 18 to Table A 20. For each of the proposed net zero primary energy and carbon standards these tables show the maximum potential reduction in either primary energy or carbon for either regulated or total (regulated plus unregulated) energy use, which is determined by the energy consumption, and the potential of roof mounted PV to offset this. A value of less than 100% implies that it is not possible to meet the standard. The accompanying costs (both per m2 of floor area or per dwelling) are given to either achieve the standard, or to get as close to it as possible (i.e. where it is not possible to meet the standard). These results highlight the following:

- The lowest cost way to achieve net zero carbon emissions from regulated uses would be to add PV to the Part L 2020 Option 2 with an ASHP. This would cost on average an additional £3,017 per dwelling over and above the envisaged building regulations of the day (i.e. of the Future Home Standard).
- A net zero primary energy target from regulated uses is harder/more expensive to achieve than a zero carbon target. This is because electricity generated by PV has a primary energy factor of approximately 0.5 compared to 1.5 for imported electricity, whereas the carbon intensity value of imported and generated electricity is the same. In addition, it is only possible to meet a zero net primary energy standard by uplifting the fabric and ventilation of the dwelling to the highest specification modelled (Option B). This would cost £6,714 per dwelling, and may in fact not be deliverable for certain configurations of flats.
- In none of the cases was it possible to meet standards that achieved net zero carbon or primary energy for regulated and unregulated combined.

Table A 18: The potential to meet net zero primary energy and carbon standards together with cost uplifts per unit of floor area or per dwelling, for the range of dwelling architypes, for the Part L Option 2 specification

Part L 2020 Option 2	Detached	Semi-Detached	1 bed flat – ground	1 bed flat – mid	1 bed flat – top	2 bed flat – ground	2 bed flat – mid	2 bed flat – top	Average Weighted House
Primary Energy									
Max possible reduction regulated	89%	82%	58%	58%	58%	114%	114%	114%	85%
Max possible reduction regulated + unregulated	38%	34%	24%	24%	24%	45%	45%	45%	36%
Zero primary energy regulated £/m^2	£38	£44	£58	£58	£58	£46	£46	£46	£42
Zero primary energy unregulated (or maximum possible) £/m^2	£50	£57	£70	£70	£70	£58	£58	£58	£55
Zero primary energy regulated £/dwelling	£4,441	£3,720	£2,887	£2,885	£2,879	£3,213	£3,209	£3,201	£3,962
Zero primary energy unregulated (or maximum possible) £/dwelling	£5,902	£4,772	£3,511	£3,508	£3,502	£4,088	£4,084	£4,075	£5,157
Carbon Emissions									
Max possible reduction regulated	134%	123%	71%	71%	72%	171%	171%	172%	127%
Max possible reduction regulated + unregulated	57%	51%	34%	34%	34%	68%	68%	68%	54%
Zero carbon regulated £/m^2	£28	£34	£51	£51	£51	£36	£36	£36	£32
Zero carbon unregulated (or maximum possible) £/m^2	£54	£63	£83	£83	£83	£66	£66	£66	£60
Zero carbon regulated £/dwelling	£3,328	£2,847	£2,545	£2,543	£2,538	£2,509	£2,507	£2,501	£3,017
Zero carbon unregulated (or maximum possible) £/dwelling	£6,354	£5,278	£4,162	£4,160	£4,155	£4,632	£4,629	£4,623	£5,648

Table A 19: The potential to meet net zero primary energy and carbon standards together with cost uplifts per unit of floor area or per dwelling, for the range of dwelling architypes, for the Option A

Option A	Detached	Semi-Detached	1 bed flat – ground	1 bed flat – mid	1 bed flat – top	2 bed flat – ground	2 bed flat – mid	2 bed flat – top	Average Weighted House
Primary Energy									
Max possible reduction regulated	100%	90%	61%	62%	61%	121%	123%	121%	94%
Max possible reduction regulated + unregulated	40%	36%	25%	25%	25%	47%	47%	47%	37%
Zero primary energy regulated £/m^2	£53	£63	£87	£82	£84	£65	£60	£62	£60
Zero primary energy unregulated (or maximum possible) £/m^2	£92	£106	£136	£130	£133	£111	£105	£107	£101
Zero primary energy regulated £/dwelling	£6,184	£5,328	£4,353	£4,082	£4,203	£4,567	£4,185	£4,356	£5,599
Zero primary energy unregulated (or maximum possible) £/dwelling	£10,721	£8,972	£6,778	£6,507	£6,628	£7,749	£7,367	£7,539	£9,543
Carbon Emissions									
Max possible reduction regulated	149%	135%	76%	77%	76%	182%	185%	182%	140%
Max possible reduction regulated + unregulated	59%	53%	35%	35%	35%	70%	70%	70%	56%
Zero carbon regulated £/m^2	£44	£54	£81	£75	£78	£56	£50	£53	£51
Zero carbon unregulated (or maximum possible) £/m^2	£70	£83	£113	£108	£110	£86	£81	£83	£79
Zero carbon regulated £/dwelling	£5,184	£4,532	£4,028	£3,760	£3,878	£3,907	£3,536	£3,697	£4,743
Zero carbon unregulated (or maximum possible) £/dwelling	£8,209	£6,963	£5,645	£5,377	£5,495	£6,029	£5,658	£5,819	£7,373

Table A 20: The potential to meet net zero primary energy and carbon standards together with cost uplifts per unit of floor area or per dwelling, for the range of dwelling architypes, for the Option B specification

Option B	Detached	Semi-Detached	1 bed flat – ground	1 bed flat – mid	1 bed flat – top	2 bed flat – ground	2 bed flat – mid	2 bed flat – top	Average Weighted House
Primary Energy									
Max possible reduction regulated	116%	101%	66%	67%	66%	132%	136%	132%	107%
Max possible reduction regulated + unregulated	42%	37%	26%	26%	26%	48%	49%	48%	39%
Zero primary energy regulated £/m²	£66	£73	£99	£94	£96	£78	£72	£75	£71
Zero primary energy unregulated (or maximum possible) £/m²	£104	£117	£148	£142	£145	£123	£117	£120	£113
Zero primary energy regulated £/dwelling	£7,690	£6,195	£4,972	£4,681	£4,822	£5,448	£5,035	£5,238	£6,714
Zero primary energy unregulated (or maximum possible) £/dwelling	£12,227	£9,840	£7,397	£7,106	£7,247	£8,630	£8,218	£8,420	£10,658
Carbon Emissions									
Max possible reduction regulated	173%	152%	82%	84%	82%	198%	205%	198%	160%
Max possible reduction regulated + unregulated	63%	56%	36%	36%	36%	72%	73%	72%	59%
Zero carbon regulated £/m²	£85	£65`	£93	£88	£90	£69	£63	£66	£63
Zero carbon unregulated (or maximum possible) £/m²	£84	£94	£126	£120	£123	£99	£94	£96	£91
Zero carbon regulated £/dwelling	£6,829	£5,487	£4,666	£4,382	£4,516	£4,841	£4,449	£4,630	£5,962
Zero carbon unregulated (or maximum possible) £/dwelling	£9,855	£7,918	£6,283	£5,999	£6,133	£6,963	£6,571	£6,753	£8,592

The impact of setting a zero carbon or zero primary energy standard for new dwellings in the GESP is shown in Figure A 23. This shows in shades of red this additional reduction. Whilst a zero primary energy standard would save more carbon by virtue of having more PV, the actual impact is small as over time the value of the carbon saved diminishes due to the reducing carbon intensity of the national electricity grid (in fact, the impact of a net zero primary energy standard is not visible to the human eye on the graph). Cumulative GHG savings from a zero carbon standard to 2050 are approximately 68,300 t CO_2e whilst a net zero primary energy standard would save a further 1,300 t CO_2e. As stated, the former would result in a cost uplift of approximately £3,000 per dwelling, whilst the latter would result in a £6,700 uplift. This means that for the dwellings that would be impacted by a policy in the GESP, the effective abatement cost would be approximately £2,500/t CO_2e for a net zero carbon standard, or £5,500/t CO_2e in the case of a net primary energy standard. These costs are high compared to – for example – the short-term traded carbon values[76], which in 2030 are approximately £80/t CO_2e under a medium scenario. The main reason for this is that over time as the electricity grid decarbonises, the carbon benefits of energy efficiency measures such as improved insulation or MVHR diminish, whilst the initial cost remains the same. The actual lifetime cost of carbon will be lower as the appraisal here has only considered the costs and benefits to 2050, though as the grid is taken to be almost decarbonised by this point and all energy use is electric, then this will not reduce the cost by much.

[76] BEIS 2019, Updated Short-Term Traded Carbon Values: Used for UK Policy Appraisal.

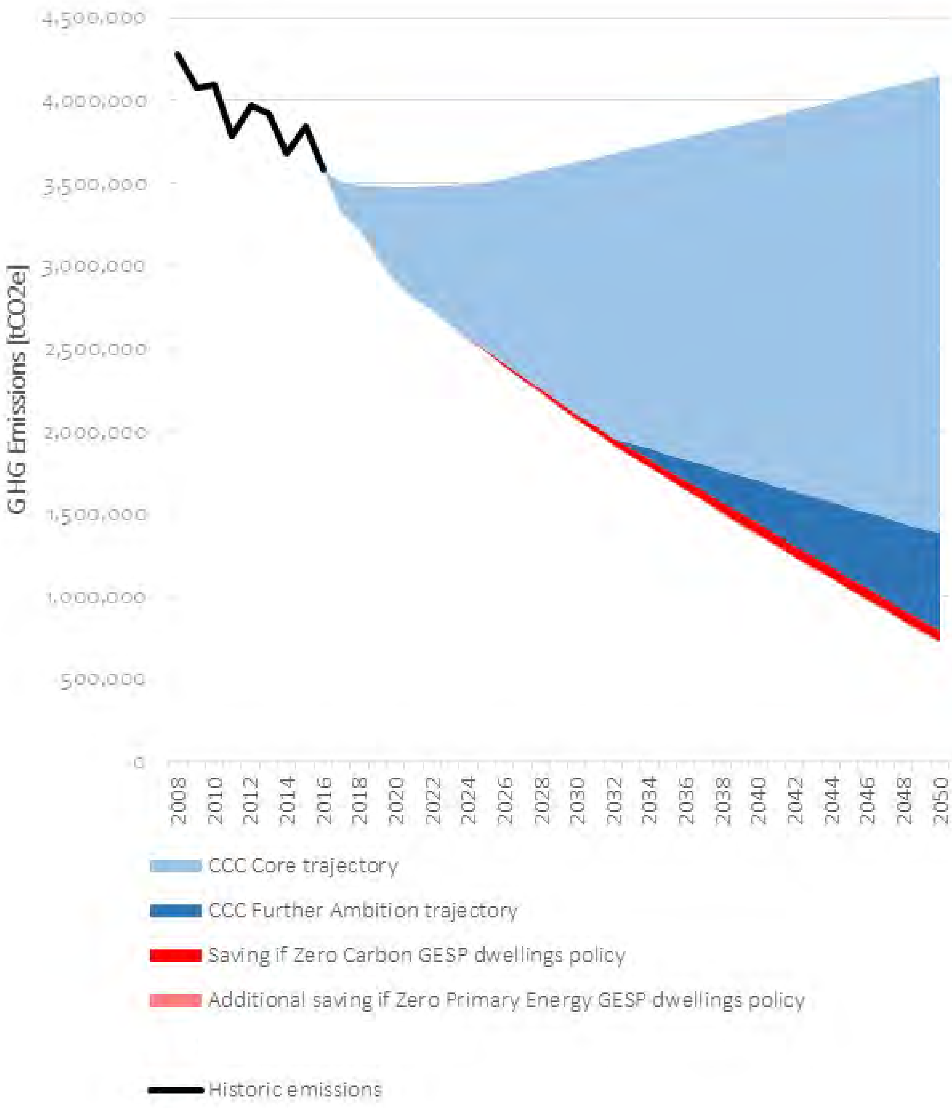

Figure A 23: The additional carbon reduction in the GESP area resulting from potentially setting net zero carbon and primary energy standards.

In summary, the analysis of new residential development has shown that if a standard of net zero carbon for regulated emissions were to be set in the GESP area, then the additional cost would be approximately £3,000 per dwelling. This would be achieved by adding PV to a FHS compliant home, which has been taken to have the same specification as the proposed Part L 2020 Option 2, but with an ASHP in place of a gas boiler. Setting a net zero primary energy target for regulated emissions is more challenging, and calculations have shown that to achieve this would require Passivhaus levels of energy reduction, in order to offset the balance of energy demand with the potential of PV generated electricity within available roof areas. This option costs £6,714 per dwelling, and may in fact not be deliverable for certain configurations of flats. In none of the cases was it possible to meet standards that achieved net zero carbon or primary energy for regulated and unregulated combined. When the magnitude of implementing such policies are viewed in the context of total GHG emissions in the GESP area, the cumulative GHG savings from a zero carbon standard to 2050 are approximately 68,300 t CO_2e whilst a net zero primary energy standard would save a further 1,300 t CO_2e. The effective abatement cost would be approximately £2,500/tCO_2e saved for a net zero carbon standard, or £5,500/t CO_2e in the case of a net primary energy standard.

Appendix IV Identification of heat loads

Identification of Heat Loads for the Greater Exeter Strategic Plan

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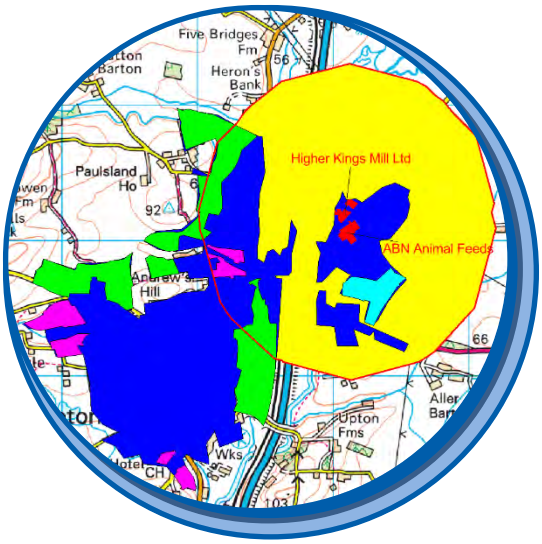
Internal Document 929 Version 4

April 2017



Report Name:	Identification of Heat Loads for the Greater Exeter Strategic Plan
Author(s):	T.A.Mitchell
Report Number:	Internal Document 929
Publication Date:	April 2017

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Ver. No.	*Comments*	*Approved By*	*Date*
1	Initial draft	-	-
2	Incorporated comments from Eleanor Ward	-	-
3	Incorporated comments from Howard Smith and review/addition of industrial sites	A. Norton	21/04/17
4	Extent of gas grid added		

Management Summary

This report considers the location of large users of electricity and heat, and planned new developments that would present opportunities for matching heat supply and demand, or otherwise incentivise the formation of a district heating network. A number of potential heat sources and electricity and heat loads have been identified from planning policy reports, publically available energy consumption data and local knowledge. It is recommended that the results form part of the GESP development location discussions, and that the potential which local energy demand and supply present are discussed and evaluated in progressive levels of detail as the GESP is developed. It is important that this initial data is not used without further analysis, evaluation and interpretation.

1.Introduction

This report considers the juxtaposition of large users of electricity and heat, and planned new developments that would present opportunities for matching heat supply and demand, or incentivise the formation of a district heating network through, for example, the direct supply of electricity from CHP. This energy perspective is important for the Greater Exeter Strategic Plan (GESP), which seeks to optimally locate new development. Localised opportunities are most likely to arise through heat networks which provide suitable loads for solar thermal, biomass, heat pump, combined heat and power technologies (using gas, biomass or waste) and waste heat.

2.Methodology

1. **Identify existing large electricity and heat users:**
    a. There is limited statistical information published on non-domestic energy consumptions. To avoid identifying individual users the statistics issued by the Department for Business, Energy and Industrial Strategy (BEIS) for non-domestic consumers are aggregated at middle level super output area (MSOA). The population of each MSOA is at least 5000 and nationally averages 7200. For each MSOA, the total, mean and median consumption are provided along with the number of meters. Data are available for electricity[77] and mains gas[78]. The most recent data available are for 2015.
    b. The MSOA data can give a high level indication of areas of interest since if there are a small number of large consumers in an MSOA, this will disproportionately inflate the mean compared to the median. As a first step, the mean was divided by the median; a larger result suggests that consumption within the MSOA is dominated by a few large consumers, however this does not indicate the magnitude of consumption. As a refinement, the amount of energy consumed by large consumers was estimated from the formula $n \times (\bar{e} - \tilde{e})$, where n is the number of meters, $\bar{e}$ is the mean consumption per meter and $\tilde{e}$ is the median consumption per meter. This formulation is based on the assumption that the difference between the mean and median is attributable to large consumers, the number of which is very small compared to the total number of consumers. Particular note was made of results exceeding the thresholds of 0.5 MW_e and 2 MW_{th}, which equate to annual consumption of 4.38 GW h for electricity and 17.52 GW h for gas.
    c. The results of this analysis were plotted both as absolute values and rank orders of results, using the MAPINFO geographical information system (GIS) software.
    d. The Department of Energy and Climate Change (DECC)/Centre for Sustainable Energy (CSE) National Heat Map[79] was also examined. Some known locations of high heat demand were identified, but a large number of spurious sites were also indicated and given that the underlying data are about seven years old it was not used in the analysis.

[77] **Lower and Middle Super Output Areas electricity consumption.** BEIS, 2017. https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption . Accessed 2/3/2017.
[78] **Sub-national gas consumption data.** BEIS, 2016. https://www.gov.uk/government/collections/sub-national-gas-consumption-data . Accessed 2/3/2017.
[79] **National Heat Map.** DECC, 2012. https://www.cse.org.uk/projects/view/1183. Accessed 21/3/2017.

e. Further registers of industrial processes were examined: the Environment Agency Operational Risk Appraisal database[80], the National Atmospheric Emissions Inventory register of large point sources[81] and the EU Emissions Trading Scheme National Allocation Tables[82].
f. MSOAs flagged at stage 1b as having potentially high consumption attributable to large heat users, and the significant industrial processes identified in stage 1e were examined more closely on Ordnance Survey and Google mapping. Confirmed sites were plotted along with 1 km radius buffer zones.

2. **Identify existing and planned heat networks and heat sources:**
Recent and planned heat networks (e.g. those serving Cranbrook, Monkerton and Exeter City Centre) are well known. The FAB Link high voltage interconnector to France is a potential source of heat to the east of Exeter. Current and future waste disposal facilities with (or with potential for) energy recovery were identified from the DCC Waste Local Plan[83] Within the GESP area, these include the existing Exeter energy recovery facility, planned gasification and pyrolysis plants at Hill Barton adjacent to the A3052 to the east of Exeter, and potential sites in the Tiverton eastern extension and at Heathfield.
3. **Review local plans:**
Current development sites in the GESP were mapped and co-plotted to identify synergies between the identified heat loads and sources and the heat demands and supply of potential new development.

3.Results

Figure 1 and Figure 2 indicate the mean non-domestic consumption of electricity and gas per meter within the GESP area. The method for estimating consumption due to large users described above yields Figure 3 and Figure 4. For electricity, the most significant areas are around Exeter (city centre, Alphington, Clyst Heath, and to the north) and the industrial and commercial area to the north of Newton Abbot. For gas, the significant areas are more evident and include Clyst Heath, Alphington, Tiverton, Cullompton, north of Newton Abbot and Crediton. Areas which are partially or wholly off gas grid are evident from the low or zero gas consumption. This is shown in greater detail based on postcode-level domestic gas consumption data[84] in Figure 5.

[80] **OPRA.** Environment Agency, 2015. https://data.gov.uk/dataset/opra. Accessed 10/4/2017.
[81] **Emissions from NAEI large point sources.** National Atmospheric Emissions Inventory, 2014. http://naei.defra.gov.uk/data/map-large-source. Accessed 19/4/2017.
[82] **Participating in the EU ETS.** Department for Business, Energy & Industrial Strategy, 2016. https://www.gov.uk/guidance/participating-in-the-eu-ets. Accessed 4/4/2017.
[83] **Devon Waste Local Plan 2011 – 2031.** DCC, 2014. https://new.devon.gov.uk/planning/planning-policies/minerals-and-waste-policy/devon-waste-plan . Accessed 21/3/2017.
[84] **Postcode level gas estimates: 2015 (experimental).** BEIS, 2017. https://www.gov.uk/government/statistics/postcode-level-gas-estimates-2015-experimental. Accessed 24/4/2017.

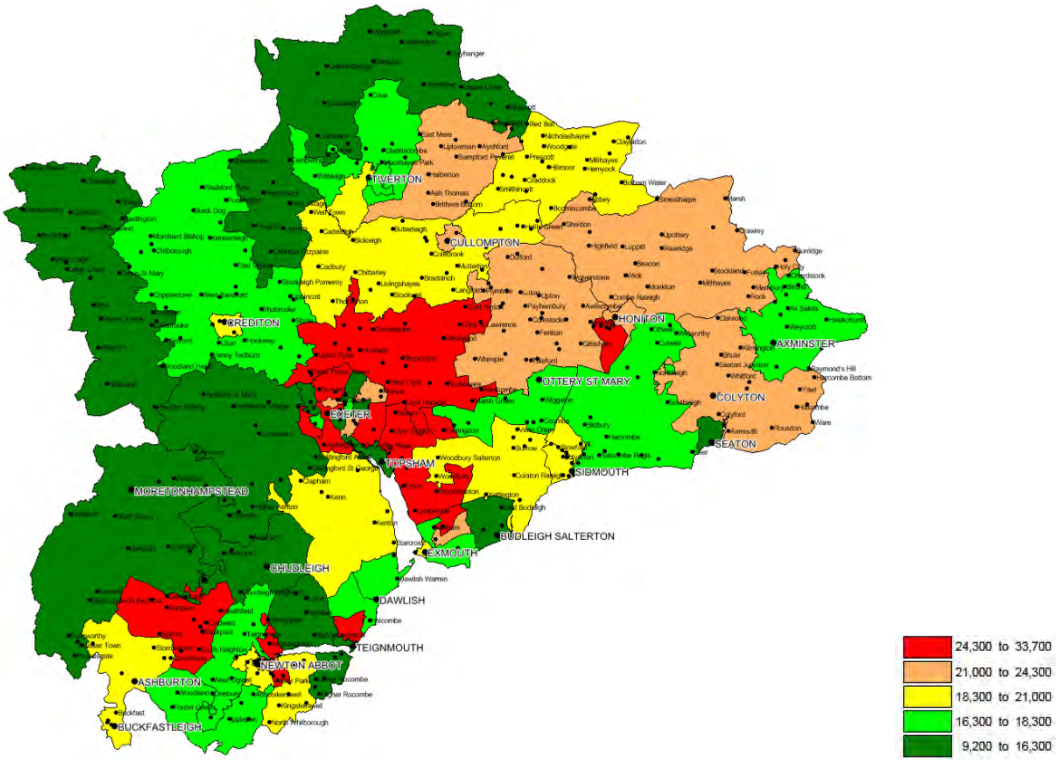

Figure 1. Mean electricity consumption in each MSOA (in kW h per meter per annum).

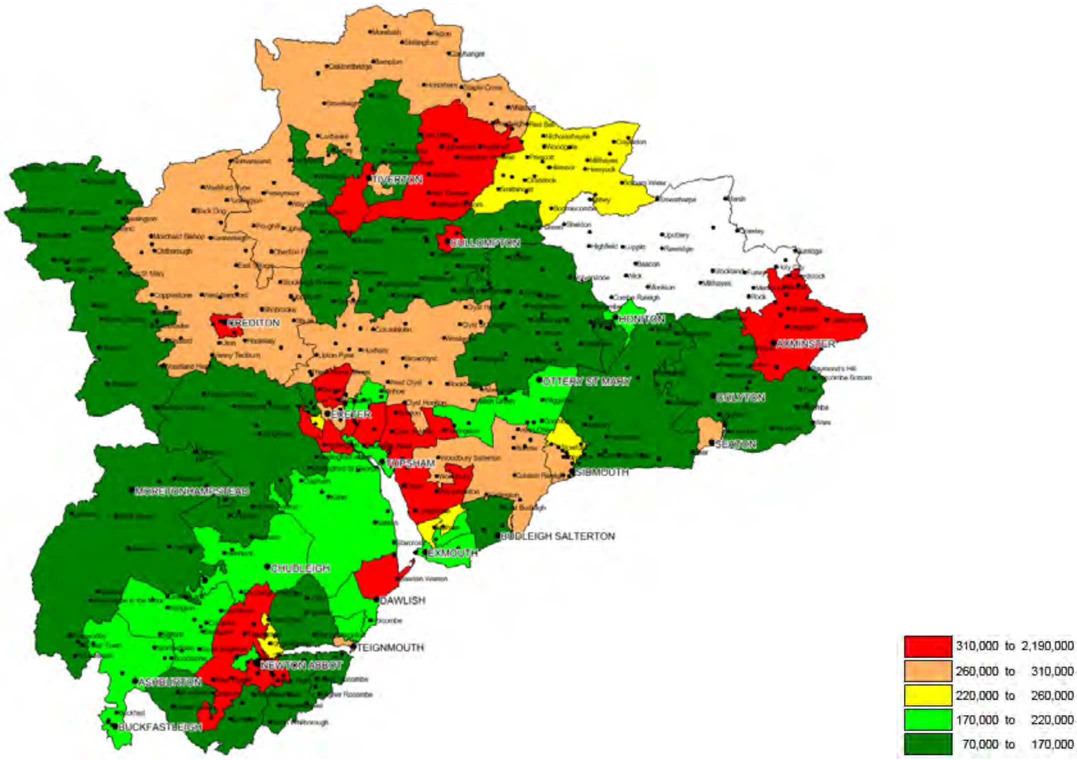

Figure 2. Mean gas consumption in each MSOA (in kW h per meter per annum). No data are available for the MSOA centred on Rawridge; it is assumed that mains gas consumption is negligible in this rural area.

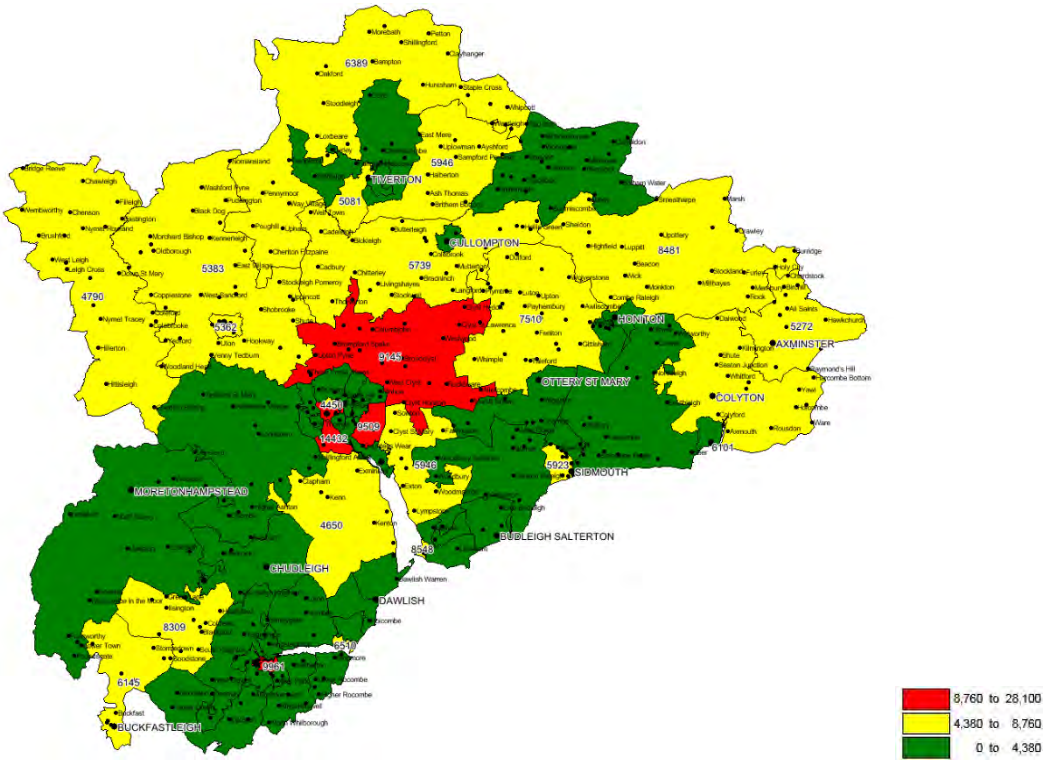

Figure 3. Estimated electricity consumed by large consumers in each MSOA (in MW h per MSOA per annum). Consumption estimates are indicated numerically where they exceed the 4.38 GW h threshold.

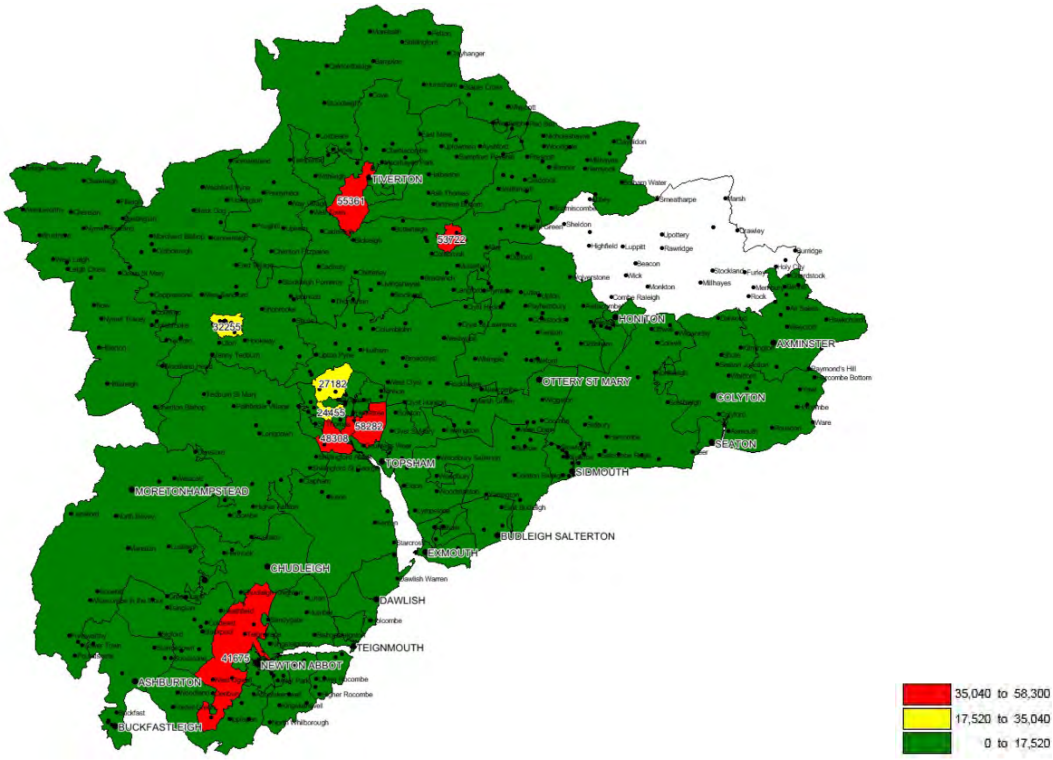

Figure 4 Estimated gas consumed by large consumers in each MSOA (in MW h per MSOA per annum). Consumption estimates are indicated numerically where they exceed the 17.52 GW h threshold. No data are available for the MSOA centred on Rawridge; it is assumed that mains gas consumption is negligible in this rural area.

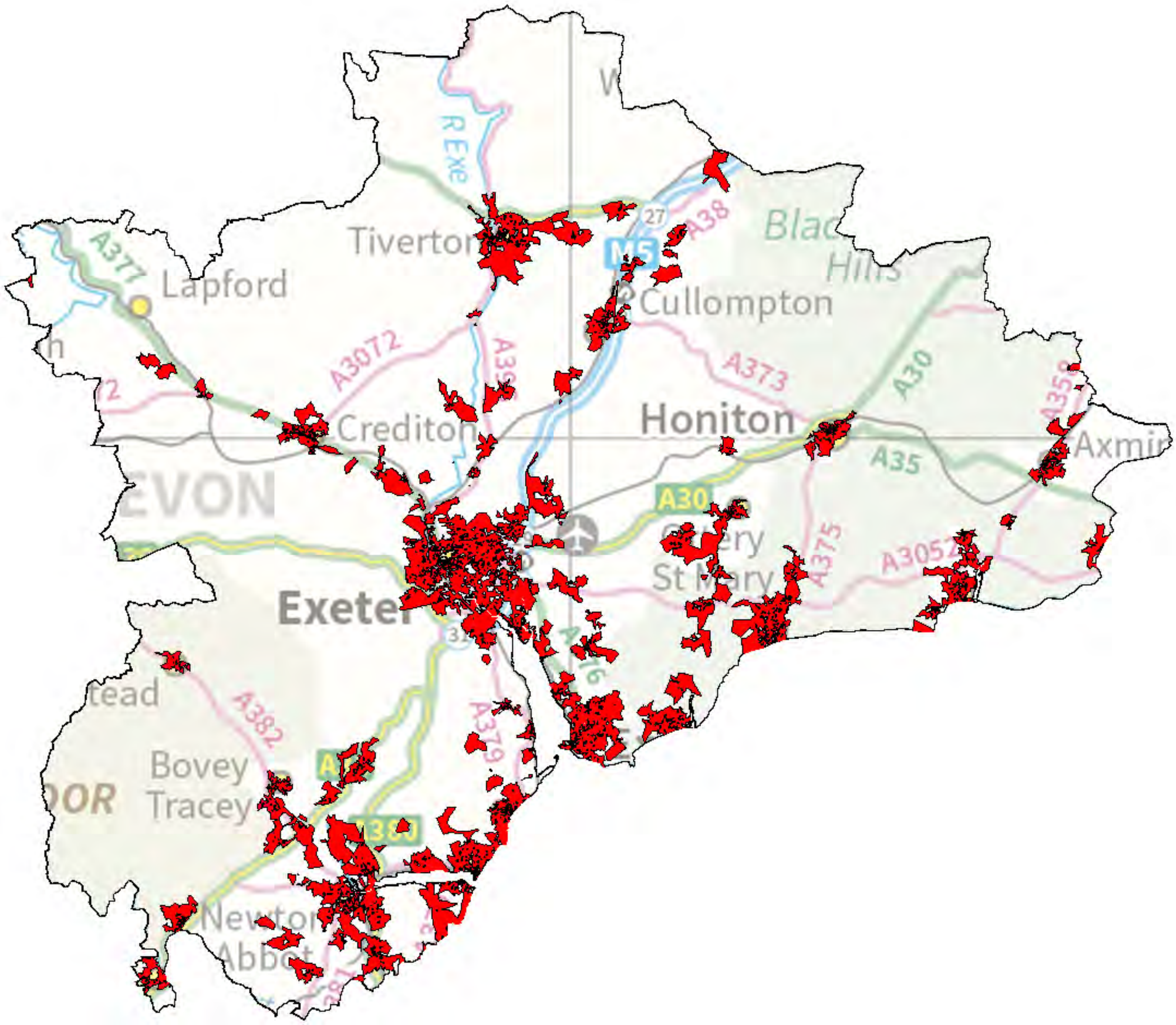

Figure 5 Extent of the mains gas network, based on postcodes containing at least one gas meter.

Examination of the areas indicating large consumers of electricity and gas has led to Table 1

Table 1 List of identified large heat users. Those in italics may not meet the minimum consumption criteria.

<table>
<tr><th>Site Name</th><th>Location</th><th>MSOA Large Gas Estimate (MW h p.a.)</th><th>MSOA Large Electricity Estimate (MW h p.a.)</th></tr>
<tr><td>Alcoa Howmet</td><td rowspan="2">Sowton</td><td rowspan="2">58,282</td><td rowspan="2">9,509[85]</td></tr>
<tr><td>Met Office</td></tr>
<tr><td>Heathcoat Fabrics</td><td rowspan="2">Tiverton</td><td rowspan="2">55,361</td><td rowspan="2">5,081</td></tr>
<tr><td>Aston Manor Brewery</td></tr>
<tr><td>Higher Kings Papermill</td><td rowspan="2">Cullompton</td><td rowspan="2">53,722</td><td rowspan="2">4,084</td></tr>
<tr><td>ABN Animal Feed</td></tr>
<tr><td>RD&E Hospital</td><td>Wonford</td><td>49,101</td><td>1,473</td></tr>
<tr><td>SW Metal Finishing</td><td>Marsh Barton</td><td>48,308</td><td>14,432</td></tr>
<tr><td>Seale Hayne</td><td rowspan="4">Howton Barton</td><td rowspan="4">41,675</td><td rowspan="4">1,339</td></tr>
<tr><td>Ringslade Clay Works</td></tr>
<tr><td>Preston Manor Clay Works</td></tr>
<tr><td>East Gold Marshes Clay Works</td></tr>
<tr><td>Crediton Dairy</td><td rowspan="2">Crediton</td><td rowspan="2">32,255</td><td rowspan="2">5,362</td></tr>
<tr><td>South West Galvanizers</td></tr>
<tr><td>University of Exeter (Streatham)</td><td>Duryard</td><td>27,182</td><td>1,669</td></tr>
<tr><td>Berendsen Laundry</td><td>Newton Abbot</td><td>15,636</td><td>2,601</td></tr>
<tr><td>Axminster Carpets</td><td>Axminster</td><td>9,153</td><td>5,272</td></tr>
<tr><td>Aggregate Industries UK</td><td>Westleigh</td><td>8,654</td><td>5,946</td></tr>
<tr><td>Centrax Gas Turbines</td><td>Newton Abbot</td><td>3,304</td><td>1,770</td></tr>
<tr><td>Met Office Supercomputer (new)</td><td>Monkerton</td><td>2,120[86]</td><td>9,145[86]</td></tr>
<tr><td>Langdon Hospital</td><td>Dawlish</td><td>2,118</td><td>2,863</td></tr>
<tr><td>Powderkeg Brewery</td><td>Greendale Barton</td><td>1,811</td><td>3,710</td></tr>
<tr><td>British Ceramic Tile</td><td>Heathfield</td><td>1,252</td><td>8,309</td></tr>
<tr><td>Goonvean Fibres</td><td>Honiton</td><td>927</td><td>4,135</td></tr>
<tr><td>Uffculme Feed Mill</td><td>Uffculme</td><td>530</td><td>4,098</td></tr>
<tr><td>Devon Valley Mill</td><td>Hele</td><td>447</td><td>5,739</td></tr>
</table>

In Figure 6, the large users identified above and heat generation sites are overlaid onto local plan base maps showing areas allocated for development. Most notably, regions shaded yellow are within 1 km of identified heat loads or heat sources, but are not currently allocated for development.

[85] The actual value for Alcoa Howmet alone is likely to be considerably higher based on data previously provided by the business.

[86] The Met Office supercomputer is a new installation and is not reflected in the consumption estimates, which date from 2015.

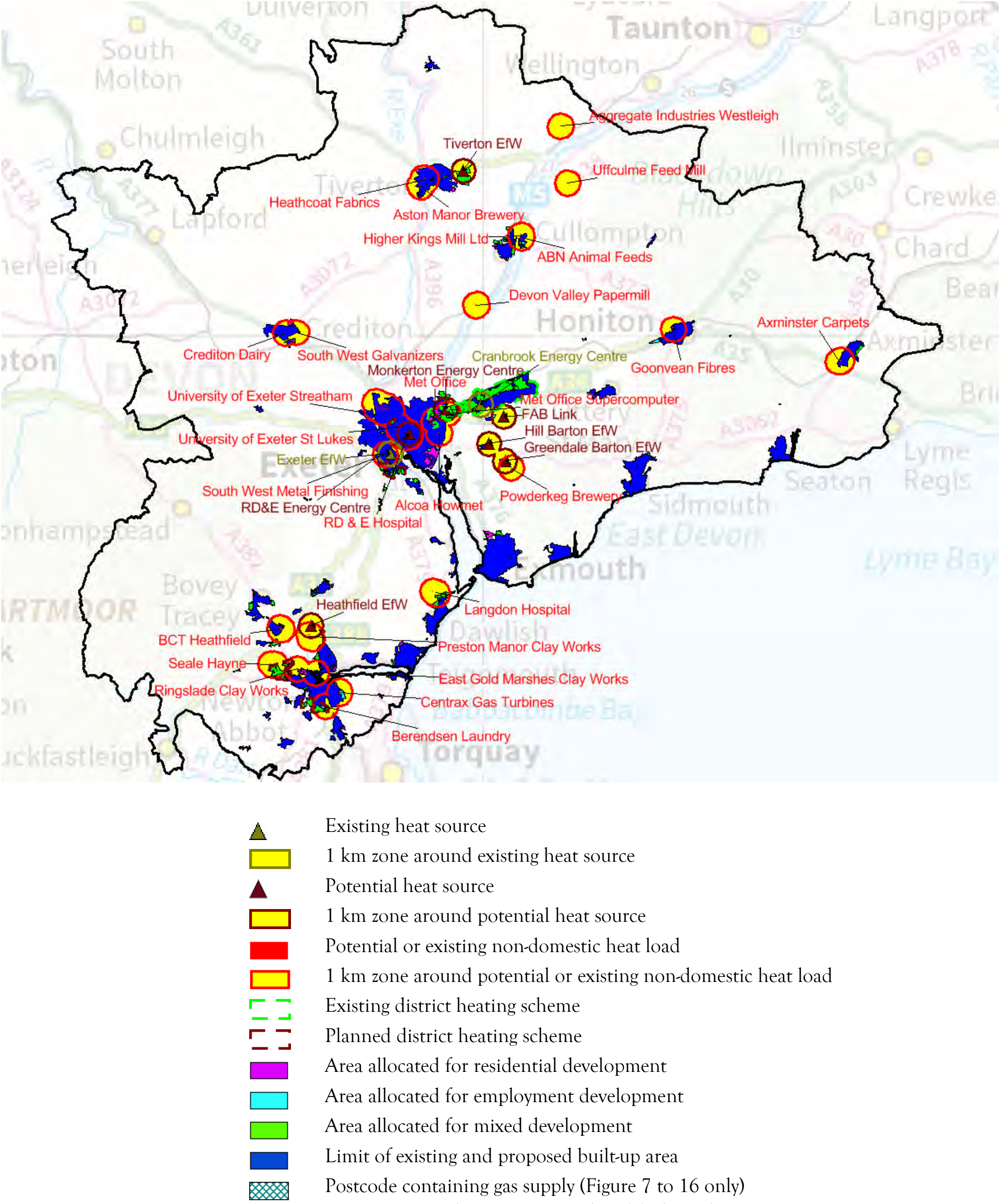

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Figure 6. Identified sites with heat loads or heat generation potential, with existing allocated areas for development.

Figure 7 to 16 indicate individual areas in greater detail. Note the extent of the gas grid may be overestimated due to the size of postcode areas[87].

[87] The data are mapped for individual postcodes, e.g. EX2 4SB.

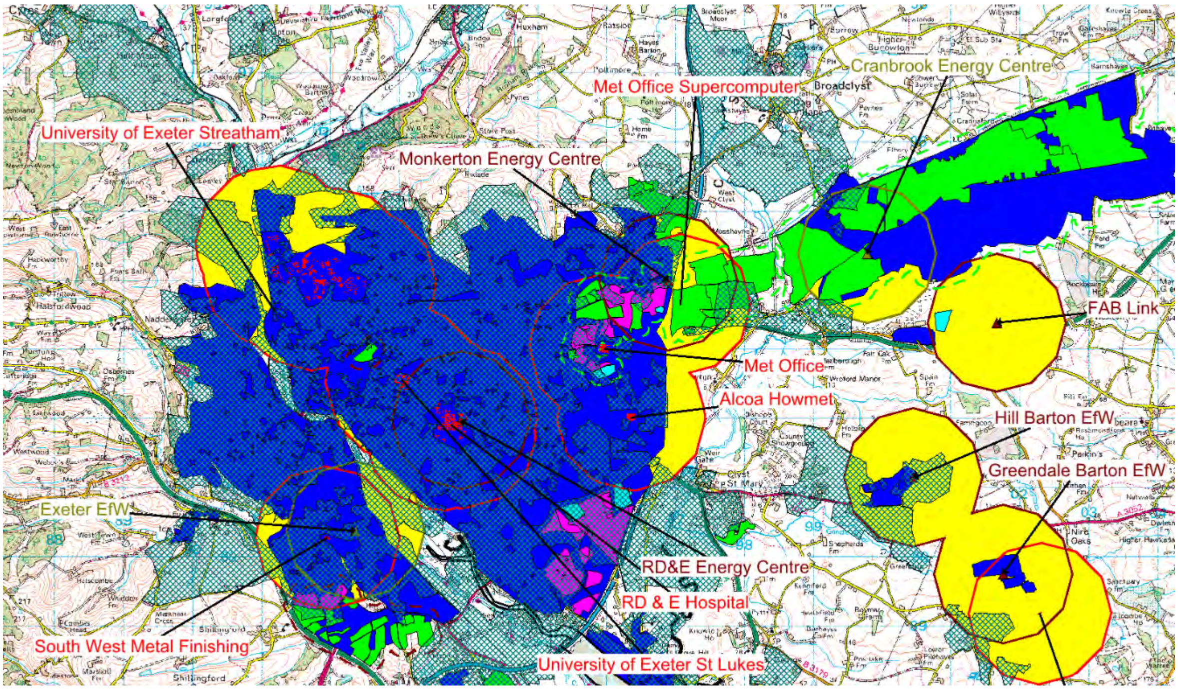

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Figure 7. Identified sites with heat loads or heat generation potential in Exeter, with existing allocated areas for development (for legend see Figure 6).

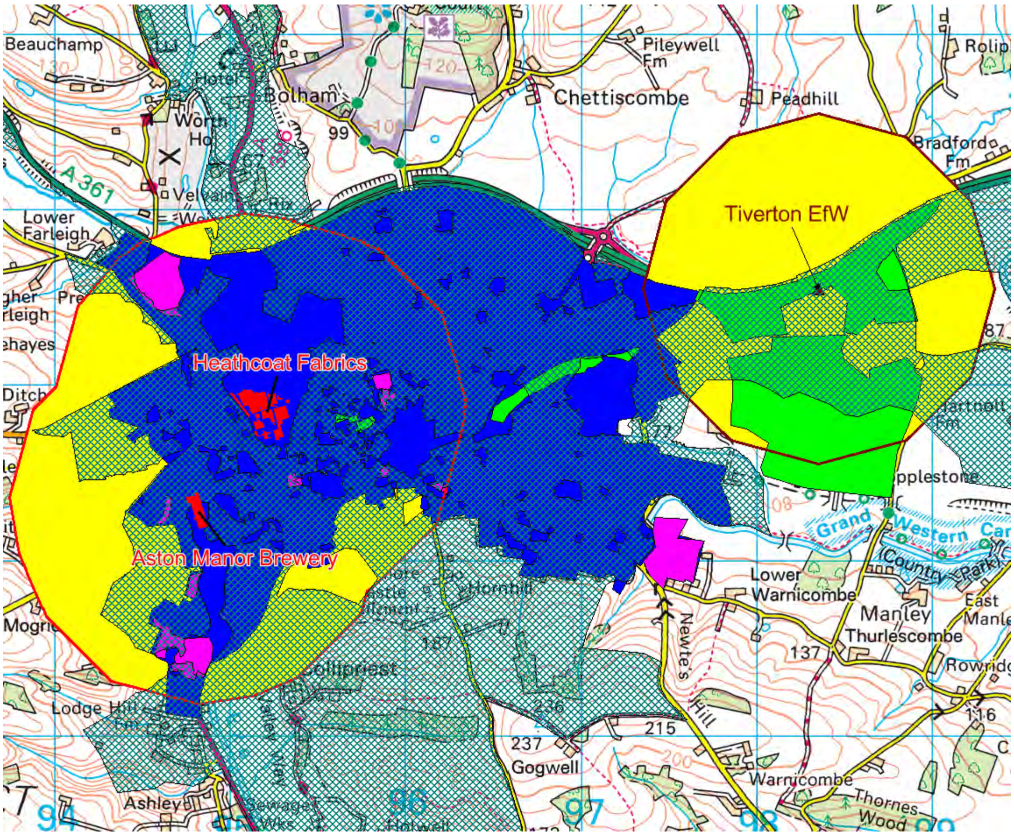

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Figure 8. Identified sites with heat loads or heat generation potential in Tiverton, with existing allocated areas for development (for legend see Figure 6).

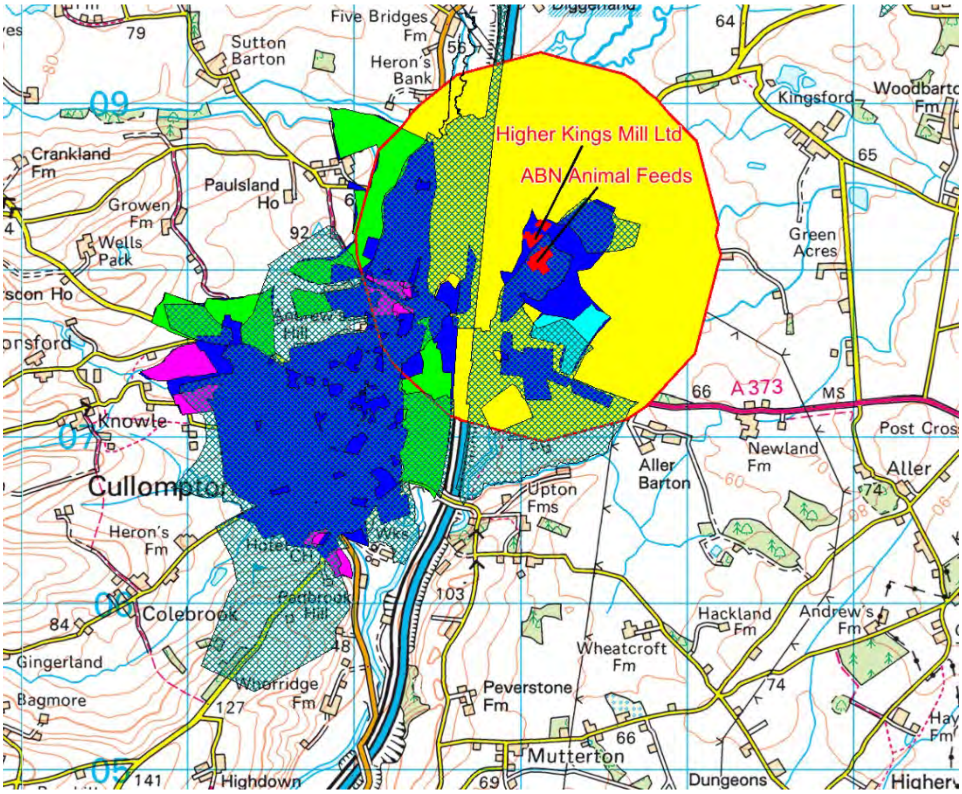

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Figure 9. Identified sites with heat loads or heat generation potential in Cullompton, with existing allocated areas for development (for legend see Figure 6).

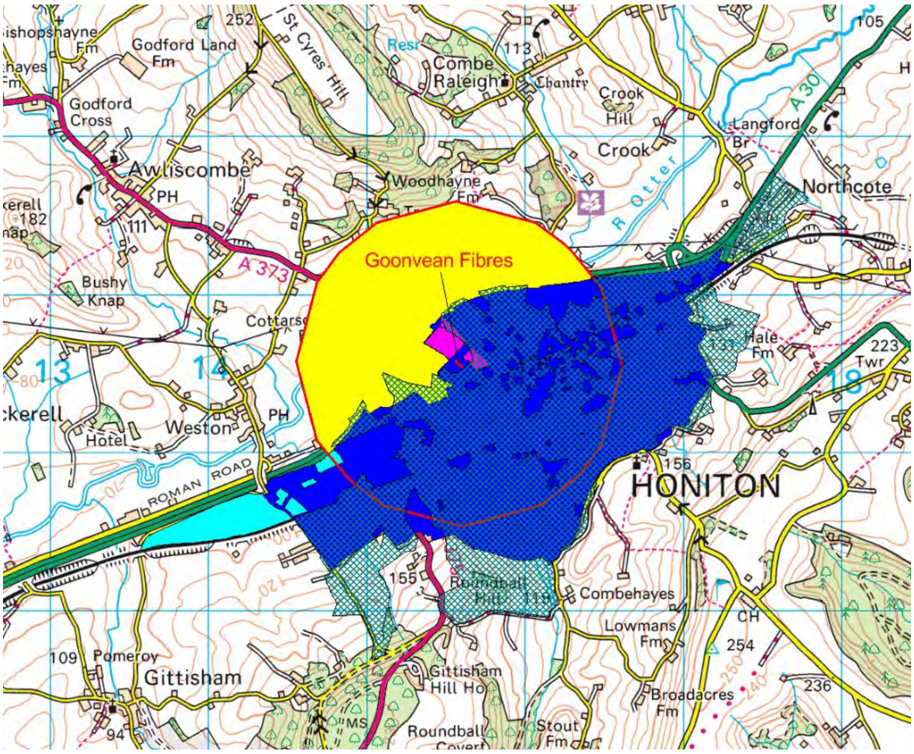

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Figure 10. Identified sites with heat loads or heat generation potential in Honiton, with existing allocated areas for development (for legend see Figure 6).

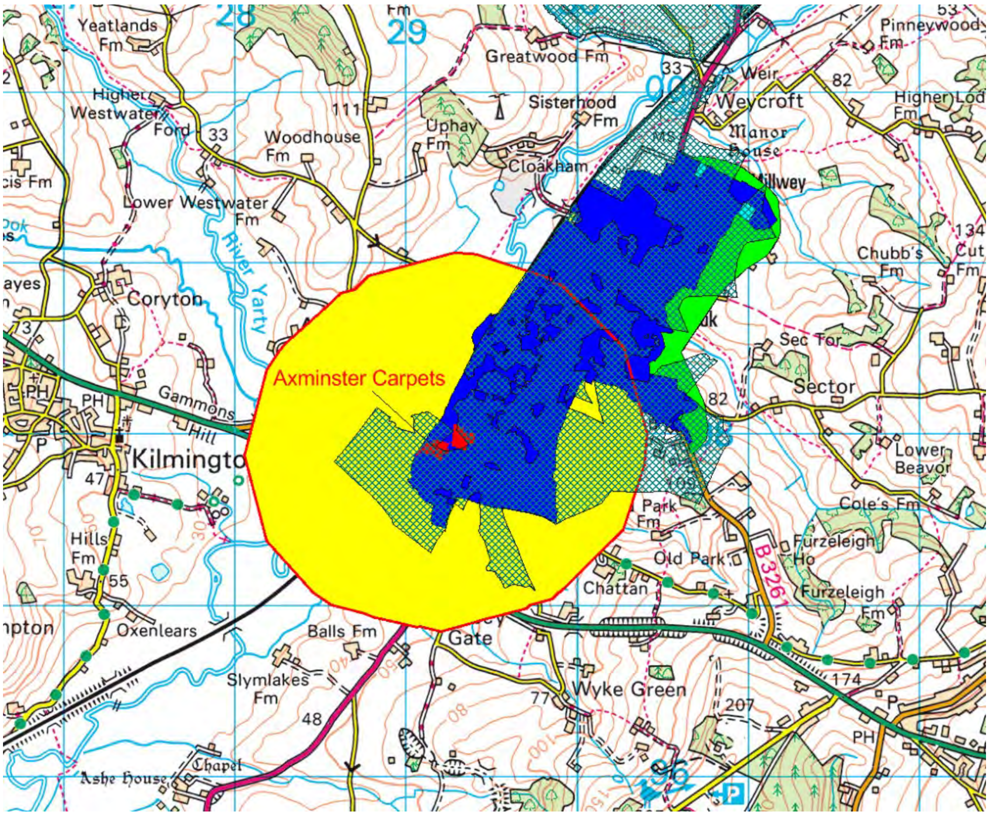

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Figure 11. Identified sites with heat loads or heat generation potential in Axminster, with existing allocated areas for development (for legend see Figure 6).

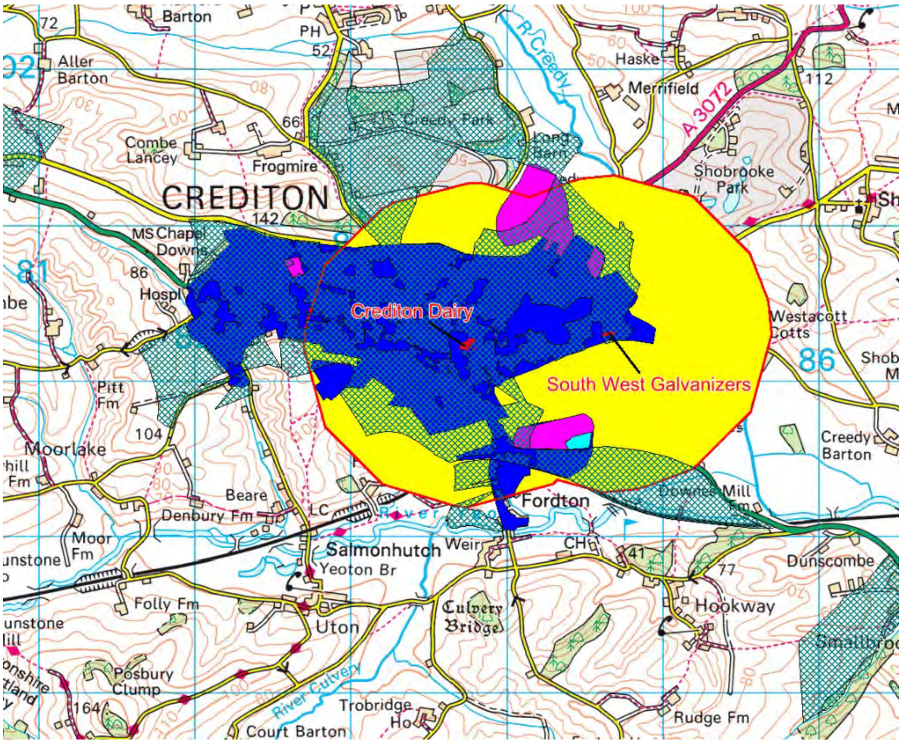

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Figure 12 Identified sites with heat loads or heat generation potential in Crediton, with existing allocated areas for development (for legend see Figure 6).

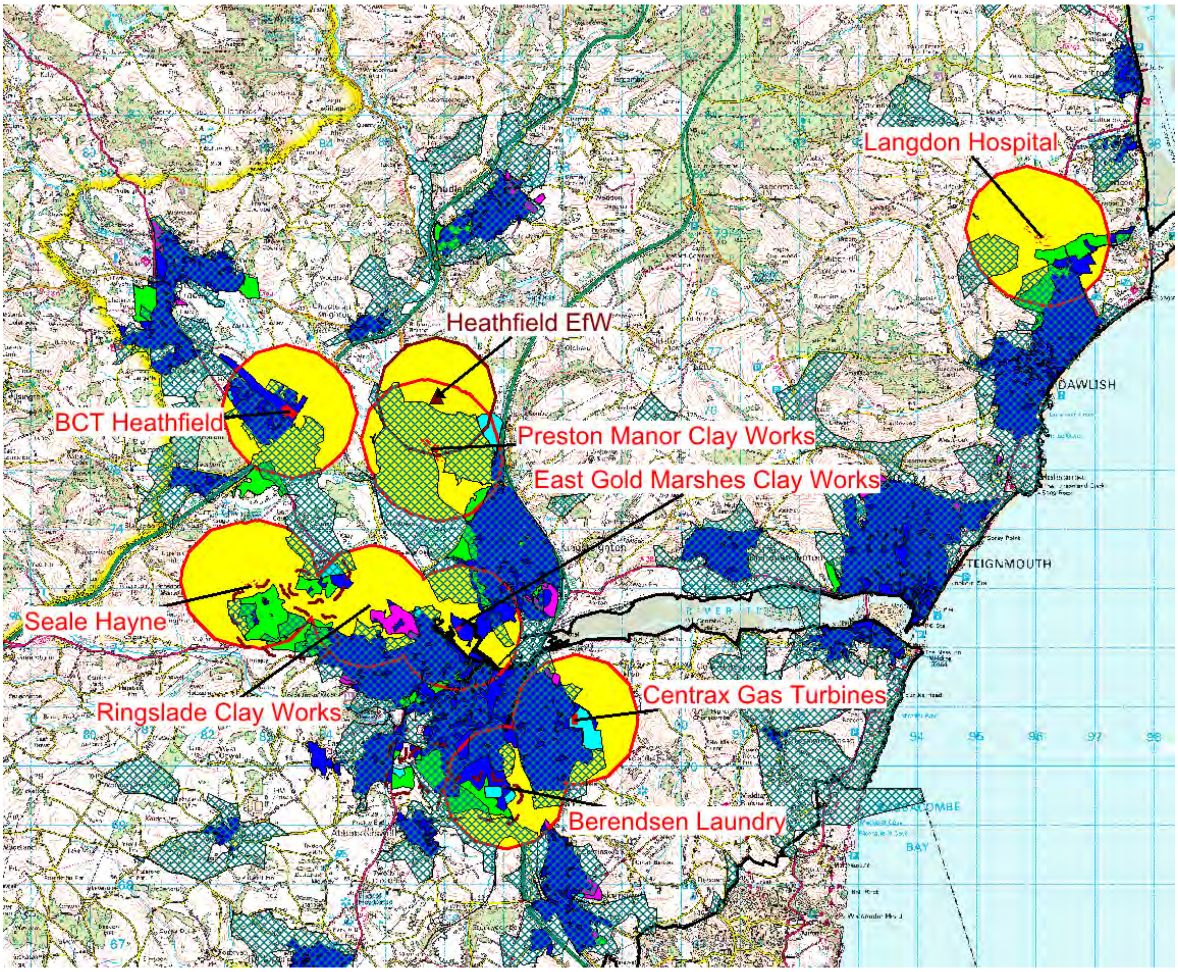

Figure 13. Identified sites with heat loads or heat generation potential in Newton Abbot and Dawlish, with existing allocated areas for development (for legend see Figure 6).

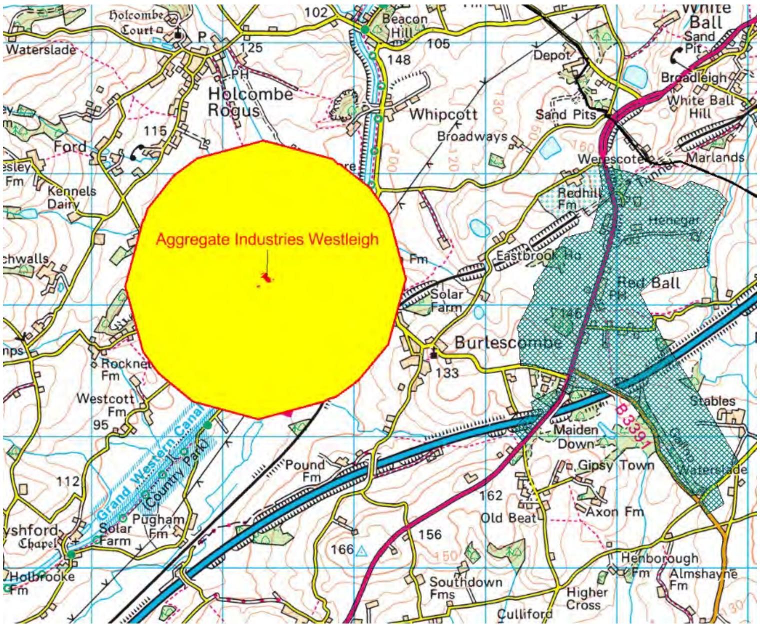

Figure 14. Identified sites with heat loads or heat generation potential north of Tiverton, with existing allocated areas for development (for legend see Figure 6).

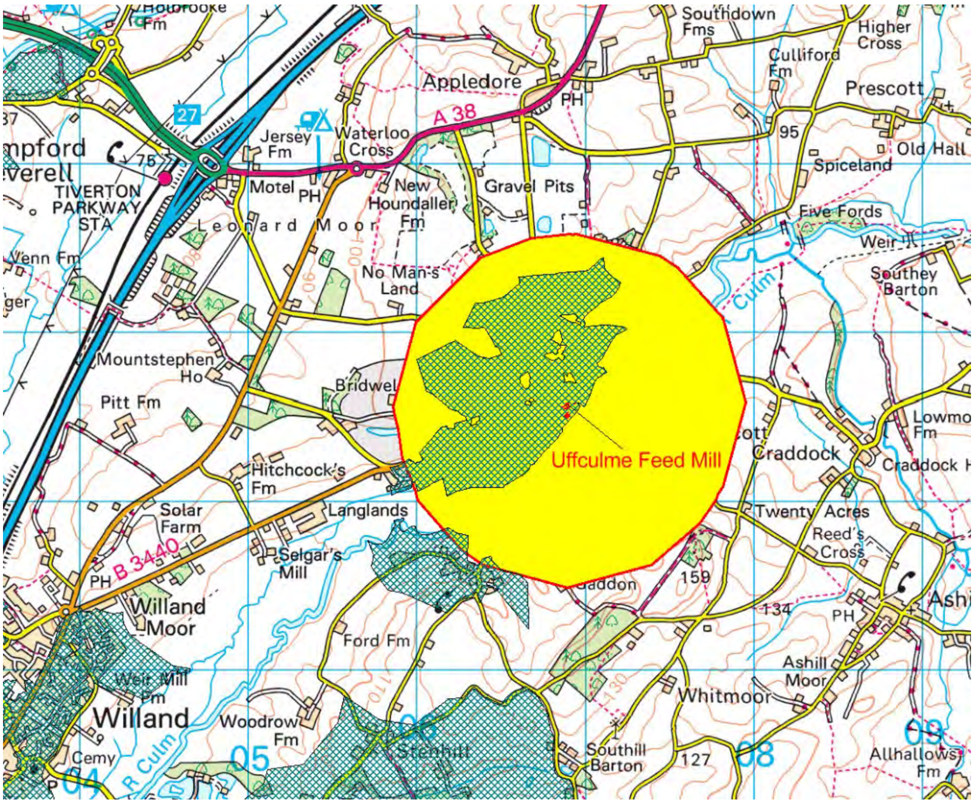

Figure 15.. Identified sites with heat loads or heat generation potential in Uffculme, with existing allocated areas for development (for legend see Figure 6).

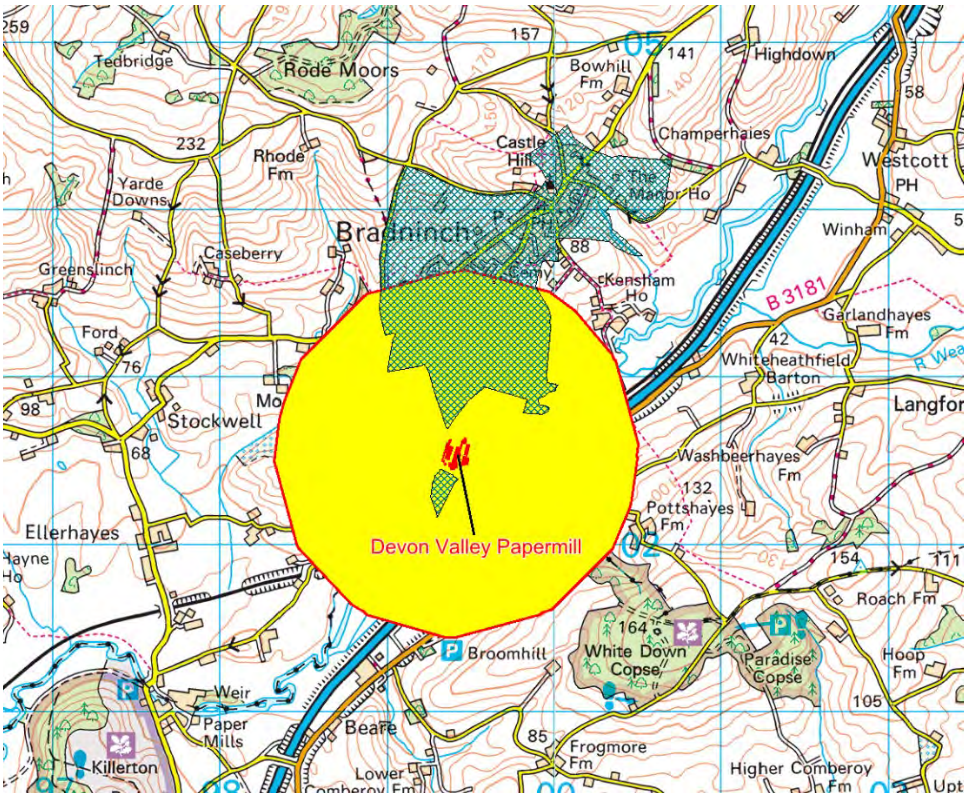

Figure 16.. Identified sites with heat loads or heat generation potential in Hele and Bradninch, with existing allocated areas for development (for legend see Figure 6).

4. Conclusions

A number of potential heat sources and heat loads have been identified from planning policy reports, publically available energy consumption data and local knowledge. It is recommended that the results form part of the GESP development location discussions, and that the potential which local energy demand and supply present are discussed and evaluated in progressive levels of detail as the GESP is developed. It is important that this initial data is not used without further analysis, evaluation and interpretation.