SOUTH WEST DEVON COMMUNITY ENERGY PARTNERSHIP

South West Devon Strategic Energy Study

The Evidence Base – Technical Appendix

May 2013

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Technical Appendix to South West Devon Strategic Energy Study: The Evidence Base

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Appendix to Scientist's Report 144

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EXECUTIVE SUMMARY

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1. Statistics and Area Definitions

1.1. Statistics and Output Areas

Super Output Areas were designed to improve the reporting of small area statistics and are built up from groups of Output Areas. Statistics for Lower Layer Super Output Areas and Middle Layer Super Output Areas were originally released in 2004 for England and Wales[i]. There are two main output area types used within this report:

LSOA (lower super output area): 1,000 to 3,000 people, 400 to 1,200 households.
MSOA (middle super output area): 5,000 to 15,000 people, 2,000 to 6,000 households.

1.2. Defining Dartmoor for Energy Baseline

The study area comprises the districts of South Hams and West Devon, and Dartmoor National Park. Data is generally readily available at a district level. Dartmoor posed a challenge the as data sources required further analysis to establish energy use within Dartmoor. Previous work by Devon County Council has classified Dartmoor according to parish (see image below)[ii]. In our study, we undertook a more refined exercise using GIS to correlate area boundaries for LSOAs and the national park with postcode points. This enabled us to obtain the number of post codes within each LSOA which fell within the Dartmoor boundary. From this we could establish a percentage of homes in the LSOA within Dartmoor, which we then applied to the LSOA gas and electricity data as a proxy. The breakdown of Dartmoor by proportion of postcodes is as follows:

- West Devon – 41.8%
- Teignbridge – 41.0%
- South Hams – 16.8%
- Mid Devon – 0.4% (six postcodes)

The Mid Devon result was due to a small area of one of the LSOA areas (at Cheriton Cross, nr. Cheriton Bishop) being just within the boundary. The domestic energy use from that area was used within this study. Non-domestic energy use for Mid Devon was ignored as a visual inspection of the area using Google Earth revealed that there was no likely significant source of non-domestic energy use.

Non-domestic and transport data and energy consumption from fuels other than electricity and gas for domestic sector are derived from modelled data from NAEI. These have been aggregated to district level, though not for Dartmoor National Park. A similar exercise was undertaken with GIS, this time overlaying the 1 x 1 km grid squares with the boundary of the national park. For each grid square, the percentage by area within the national park (and also within each district) was calculated, and this was taken forward as a means of building up the total energy consumption within the National Park boundary.

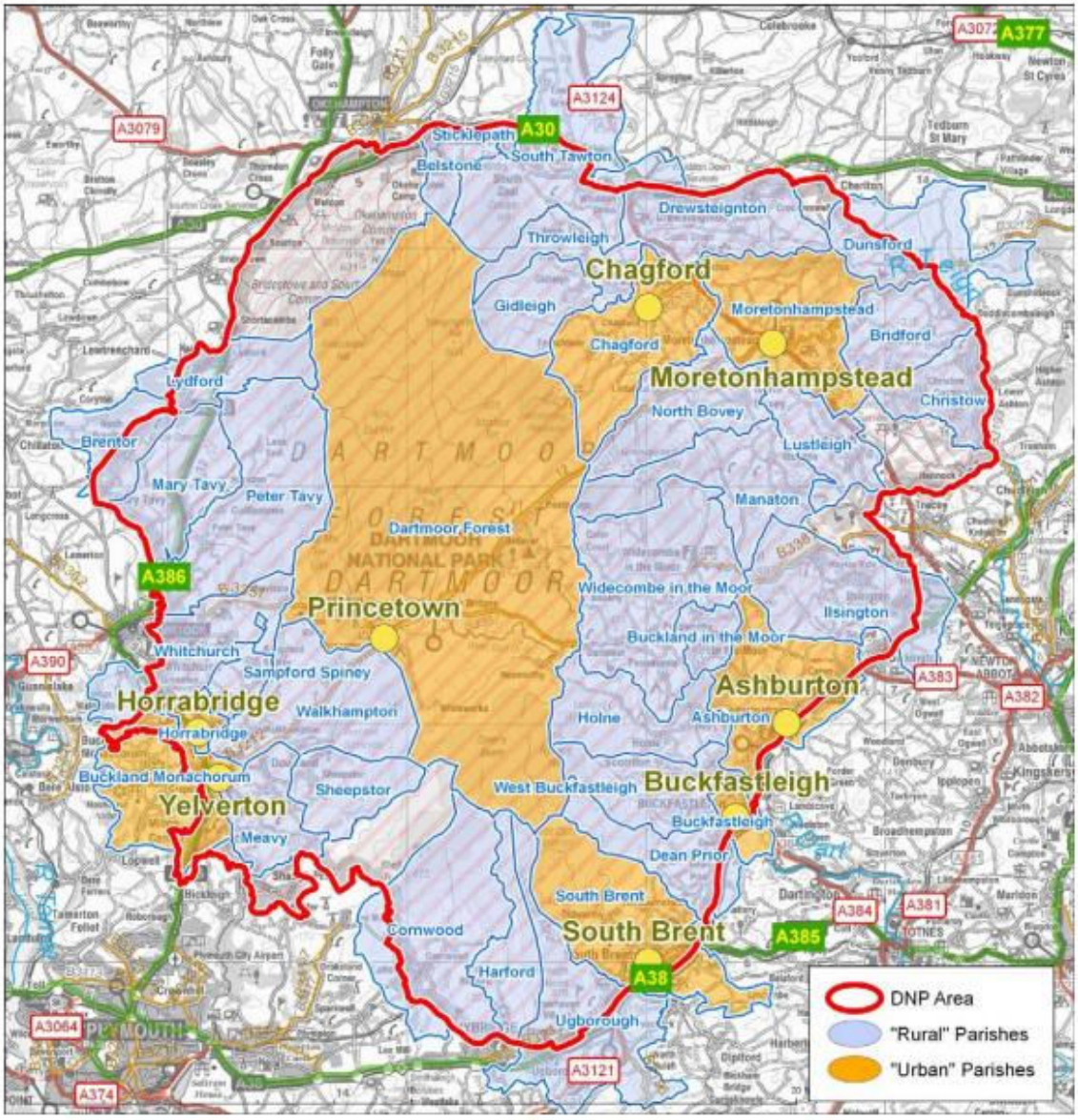
[i] http://www.ons.gov.uk/ons/guide-method/geography/beginner-s-guide/census/super-output-areas--soas-/index.html
[ii] http://www.devon.gov.uk/dnpbaselineprofile.pdf

Area Definition

The National Park area has been defined as aggregations of parishes, wards, lower super output areas (LSOAs) and postcode sectors. To be included each area had to have 40% or more of its residential delivery points (RDPs, an approximation of residential addresses) inside the National Park boundary.

The following 38 parishes are included:

Ashburton	Belstone	Brentor	Bridford
Buckfastleigh	Buckland in the Moor	Buckland Monachorum	Chagford
Christow	Cornwood	Dartmoor Forest	Dean Prior
Drewsteignton	Dunsford	Gidleigh	Harford
Holne	Horrabridge	Ilsington	Lustleigh
Lydford	Manaton	Mary Tavy	Meavy
Moretonhampstead	North Bovey	Peter Tavy	Sampford Spiney
Sheepstor	South Brent	South Tawton	Sticklepath
Throwleigh	Ugborough	Walkhampton	West Buckfastleigh
Whitchurch	Widecombe in the Moor		

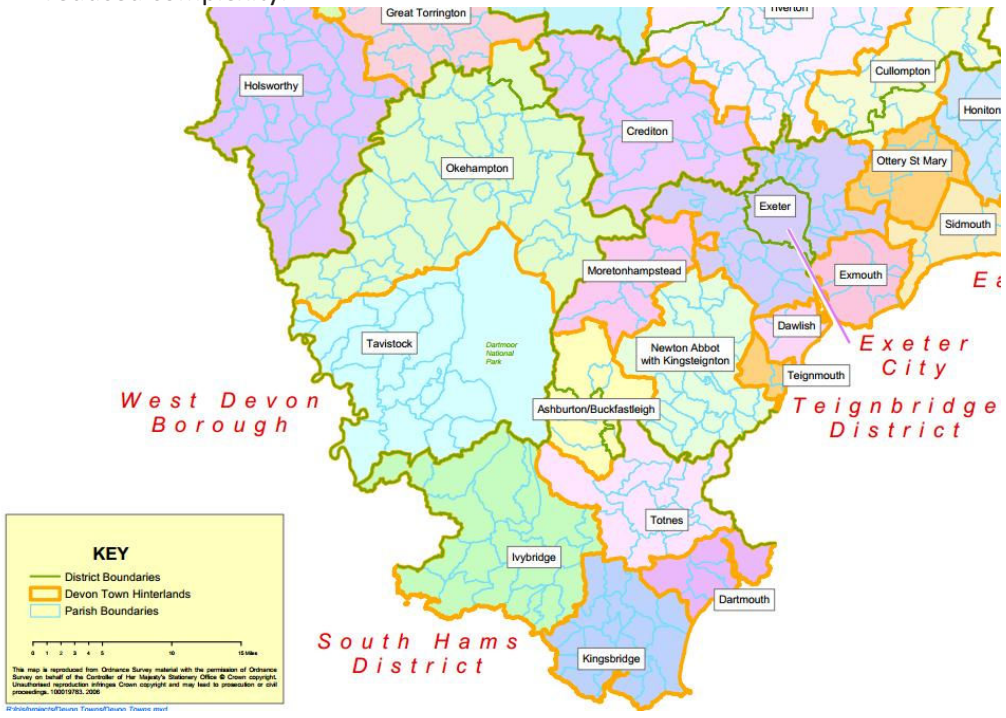


2. POPULATION DATA

2.1. POPULATION DATA

Population data for the study area was taken from data produced by Devon County Council[iii]. Data is derived from the Patient and Practitioner Services Agency and is based on GP registration. Population data is available by district, ward and parish split by age band. In addition, DCC have undertaken further analysis of 29 Devon Towns which includes major urban areas and their hinterlands. These are shown in the map below. The following of these towns were applicable to the study area:

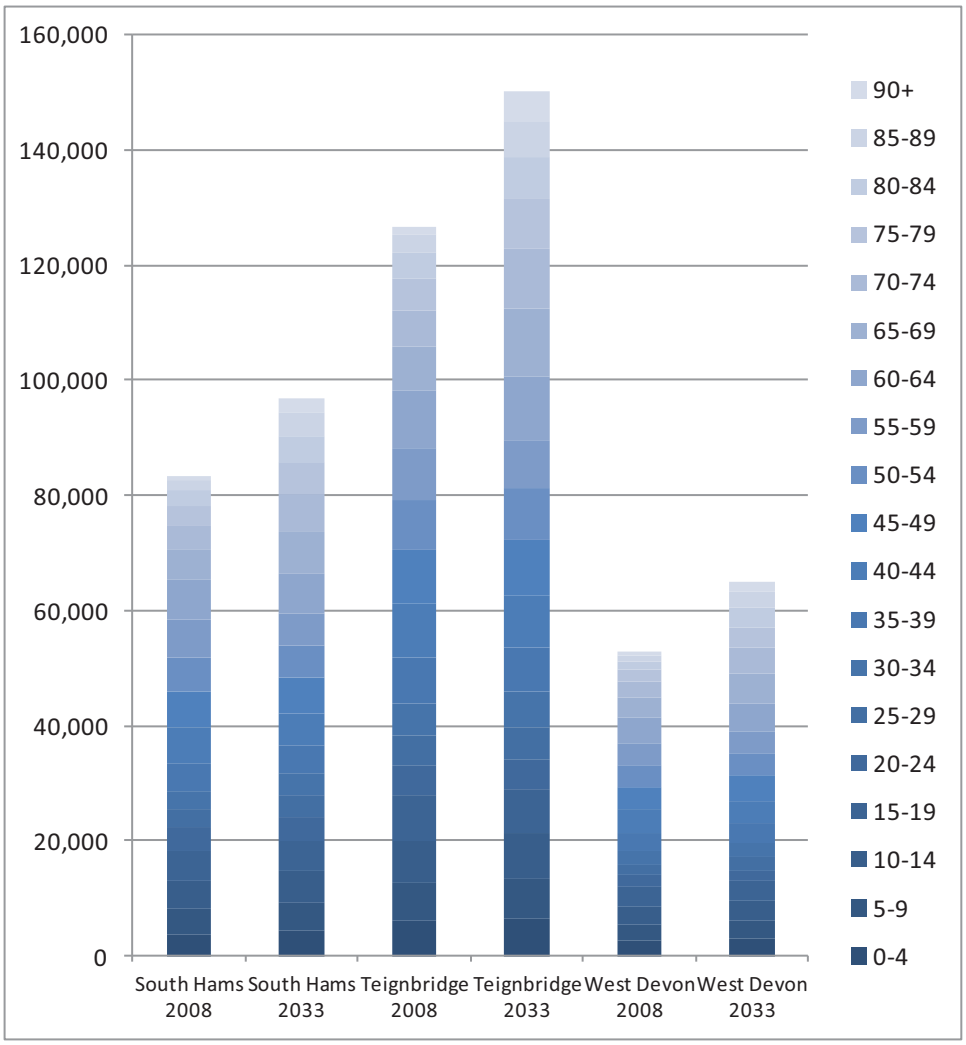
- South Hams:
  - Ivybridge
  - Kingsbridge
  - Dartmouth
  - Totnes
  - Ashburton/Buckfastleigh: The four parishes of Holne, West Buckfastleigh, Buckfastleigh and Dean Prior (the remaining three parishes of Widecombe in the Moor, Buckland in the Moor and Ashburton are in Teignbridge).
- West Devon:
  - Okehampton
  - Tavistock
- Dartmoor National Park:
  - Dartmoor overlaps a number of the "Devon Town" catchments. DCC have produced an additional profile of Dartmoor National Park and so that was used within this study.
  - The 38 parishes from the previous section were taken to represent the Dartmoor National Park area. It should be noted that these parishes do not completely coincide with the boundary, and so in using the population data with energy data from LSOA level data, a small element of error will be introduced. This is seen as a small price to pay for the reduced complexity.



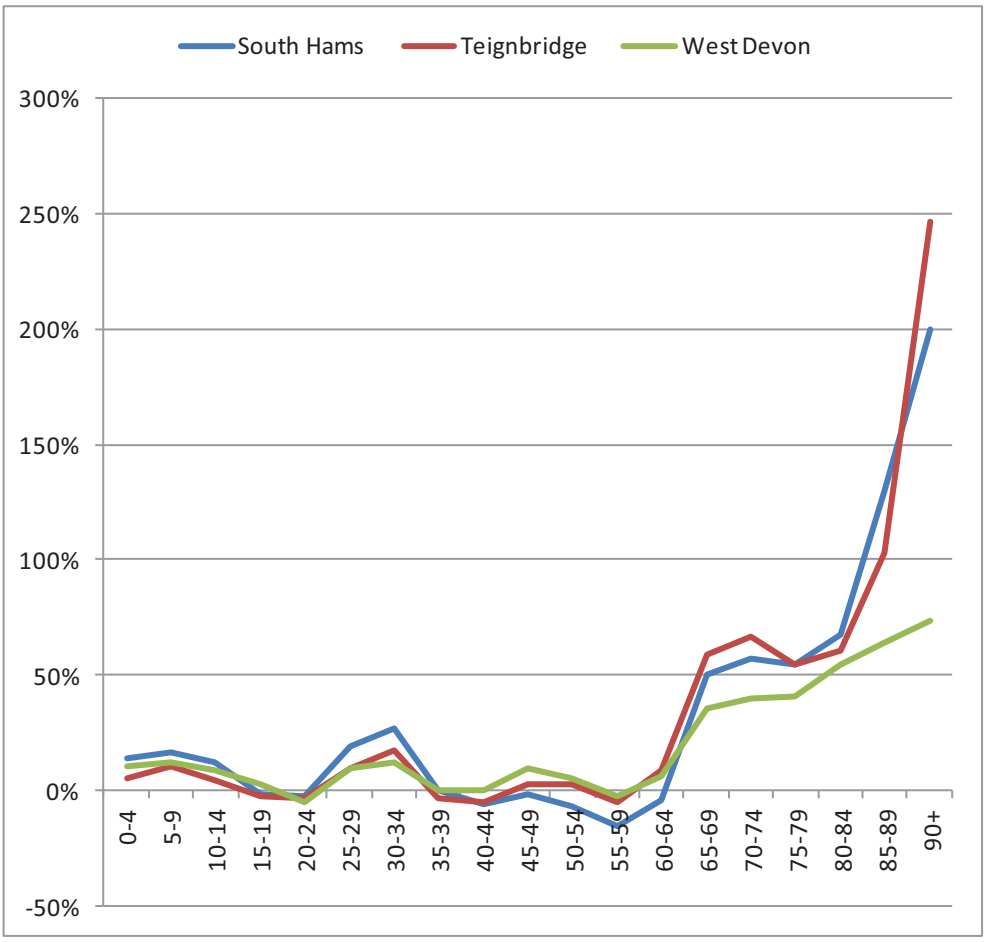
[iii] DCC Population estimates and projections 2012 http://www.devon.gov.uk/peoplepopestimates

2.2. POPULATION CHANGE

Projections for population change have been produced by the ONS and DCC[iv]. These are given by district and age band. The data for the three districts within the study area were analysed. The results are shown in the two graphs below. From the first graph we can see that the populations in each district rise over 25 years. The overall increase in population is 16% in South Hams and 19% in each of Teignbridge and West Devon. It is likely that a greater proportion of this growth in Teignbridge will be due to new development outside of Dartmoor. We can also see that the growth is greater amongst older people. This is shown more clearly in the second graph. There is mild growth (under 5%) in the age bracket 0-64. There is a much larger rise in older people. **Now, those over 65 account for just over 1 in 5 of the population. In 20 years time it this will rise to 1 in 3**.



[iv] DCC Population Estimates and Projections http://www.devon.gov.uk/peoplepopprojection


South Hams
Teignbridge
West Devon
300%
250%
200%
150%
100%
50%
0%
-50%
0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
85-89
90+

3. ESTABLISHING THE ENERGY BASELINE

The baseline energy consumption for the SW Devon area was established through the combination of a number of data sources. A broad method for our approach was as follows:

- Carbon dioxide emissions (tonnes) at a 1 x 1 km resolution were downloaded from NAEI. The latest data available was from 2009. The data is broken down into sub-classifications for buildings, and a single road transport value
- The private sector stock condition surveys from each of South Hams, Teignbridge and West Devon were taken and the split of carbon emissions by main heating fuel was established. This was sued to disaggregate "other" fuel use as stated in the NAEI for domestic and non-domestic into more detailed subdivisions e.g. split oil and LPG, or coal from manufactured fuels. It was assumed that private sector housing was representative of all housing in the districts, though it is likely that the social housing will have more efficient heating systems.
- Energy consumption data was taken from DECC for each district from 2005 to 2010. The 2010 was taken forward as being the most recent. This was used together with the Defra Carbon Conversion factors to establish carbon emissions by fuel, and within NAEI categories "Indother" and "domoilesol" the % of different sub-levels of fuel. This was needed in order to sub-divide the NAEI data into more detailed end uses.
- Transport energy consumption data was taken from DECC as above. A quick observation of the time series revealed that since 2005 freight fuel consumption has remained broadly constant, whilst personal vehicle fuel use has dropped, driven mainly by a reduction in petrol fuel use which has more than offset the more modest rise in diesel fuel use.
- For each of South Hams, Teignbridge and South Hams, the amount of fuel used (thousands of tonnes of fuel) was calculated by fuel type (petrol or diesel). These were then converted to carbon dioxide (ktCO2e) based on the most recent Defra fuel factors. The proportion of emissions by fuel type was then established. This ranged from between 40-42% petrol for each of the three districts (compared to 48-52% petrol in 2005). This information was then used in conjunction with the NAEI 1 x 1 km carbon data. The carbon emissions for each grid square were then converted into fuel volume (litres) and energy (kWh) based on the split of petrol to diesel. This data could then be used to compare energy with other sectors (i.e. domestic and non-domestic) or prices.
- An exercise was undertaken using GIS. Each grid-square was overlaid with the boundaries for each district authority and the national park. The % of each grid square that fell within each authority was calculated and taken forward. For building based emissions, location of postcodes was used to determine the extent to which a grid square fell within a specific district. For transport, major roads were used as the determining factor. Manual checks were made for the major trunk roads to ensure that the road was correctly allocated to each specific area. The output from this exercise were two series of adjustment factors (one for buildings, one for road transport) which was used to apportion energy use within each grid square to the appropriate area. It is important to note that this may mask factors that occur at a finer resolution.
- For each 1 x 1 km grid square, the carbon emissions were apportioned to each authority and then converted into energy using the Defra emission factors and the other data sources mentioned above. Dartmoor was calculated in itself, and the fraction of Dartmoor that falls outside of South Hams or West Devon.
- The energy use (GWh) for each sector and district were summed and compared to the original DECC district energy data. Differences of generally in the order of +/- 10% were observed. There were some larger differences where the values were very small e.g. industrial coal, though these are not expected to significantly alter the results.
- Scaling factors for each district and fuel were established in order to map the bottom-up NAEI data (from 2009) onto the DECC data (2010). The underlying assumption is that the spatial distribution remains constant, which is a fair assumption in the absence of more detailed information.

- The scaling factors were applied to each grid square and checked to ensure they summed to the DECC data. There was a small discrepancy of approximately 1% as bioenergy and waste from the DECC data could not be allocated in any meaningful way. It is not expected that this will significantly alter the results.
- The final energy breakdown by sector and fuel was established for each district and the study area as a whole. As a final step, the transport fuel (petrol and diesel) data was disaggregated into transport mode as per the DECC transport data. It was not possible to apportion the vehicle mode to the grid square due to lack of additional information, though it is likely the HGV and LGV would have a strong bias towards the major trunk roads e.g. A30 and A38.

4. ENERGY PRICES

4.1. CURRENT PRICES

An exercise was undertaken to establish current energy prices for a range of fuels and sectors. Where possible, information was taken from DECC. This information is readily available for domestic electricity and gas, transport fuel, and non-domestic fuel. This data was supplemented by data from the Solid Fuel Technology Institute for a range of solid fuel types, and also for Economy 7 electricity. DECC data at MLSOA resolution was used to establish average consumption per electricity and gas meter (for both normal and half hourly electricity meters). This was used to establish a mean area-wide electricity tariff. From this, it was found that for the study area:

- There are 11,041 non-domestic electricity meters each averaging 16 MWh consumption per annum (42% of total non-domestic electricity consumption)
- There are 280 non-domestic electricity meters each averaging 865 MWh consumption per annum (58% of total non-domestic electricity consumption)
- There are 394 non-domestic gas meters each averaging 913 MWh consumption per annum

Similarly, LLSOA data was used to establish the proportion of electricity through E7 meters and regular meters. The fraction of E7 energy at on and off peak was then estimated using results from the EST *Powering the Nation* field study of domestic electricity consumption. From this, for electrically heated homes it was estimated that 48% of electricity consumption was on-peak. Given that 64% of all energy consumption is through regular meters, this means that approximately 81% of domestic electricity is at an on-peak rate, and the remaining 19% at an off-peak rate.

A summary of current fuel costs and assumptions made are as follows:

Domestic	***£ per...***	***Unit***	***Source***
Natural gas	£0.045	kWh	DECC based on Plymouth average unit rate (inc. standing charge) for average property
Electricity peak	£0.150	kWh	DECC based on Plymouth average unit rate (inc. standing charge) for average property
Electricity E7	£0.062	kWh	Solid Fuel Technology Institute
Electricity area average	£0.135	kWh	Based on calculated consumption in area (by LSOA) of regular and E7 consumption and area weighting of both tariffs and analysis of fraction of E7 energy used on-peak.
Heating oil	£0.054	kWh	Solid Fuel Technology Institute
LPG bulk	£0.082	kWh	Solid Fuel Technology Institute
LPG bottle	£0.121	kWh	Solid Fuel Technology Institute
Average LPG	£0.102	kWh	unable to determine local split e.g. Bottle likely to be used in park homes, tanks elsewhere
Wood logs	£0.047	kWh	Solid Fuel Technology Institute
Wood pellets	£0.039	kWh	Solid Fuel Technology Institute
Bituminous coal	£0.040	kWh	Solid Fuel Technology Institute
Anthracite	£0.044	kWh	Solid Fuel Technology Institute

Non-Domestic	*£ per...*	*Unit*	*Source*
Electricity	£0.108	kWh	DECC weighted average of "very small" and "small/medium" electricity based on average metered non-domestic electricity normal and half hourly consumption in study area
Gas	£0.029	kWh	DECC small gas user based on average metered non-domestic gas consumption in study area
Coal	£2.860	GJ	DECC mean industrial user based on all available 2012 quarterly data
Heavy Fuel Oil	£631.633	tonne	DECC median industrial user based on all available 2012 quarterly data
Gas oil	£808.867	tonne	DECC median industrial user based on all available 2012 quarterly data
Coal	£0.010	kWh	converted from above based on Defra conversion factors
Heavy Fuel Oil	£0.053	kWh	converted from above based on Defra conversion factors
Gas oil	£0.064	kWh	converted from above based on Defra conversion factors

Transport	*£ per...*	*Unit*	*Source*
Petrol	£1.354	litre	DECC based on average price all months in 2012
Diesel	£1.418	litre	DECC based on average price all months in 2012
Burning oil	£0.059	litre	DECC based on average price all months in 2012
Gas oil	£0.071	litre	DECC based on average price all months in 2012
Therefore...			
Petrol	£0.141	kWh	Based on Defra conversion factors
Diesel	£0.134	kWh	Based on Defra conversion factors
Burning oil	£0.006	kWh	Based on Defra conversion factors
Gas oil	£0.006	kWh	Based on Defra conversion factors

These prices were applied to the estimated energy consumption data to establish fuel costs at an area and sub-area resolution.

4.2. FUTURE PRICES

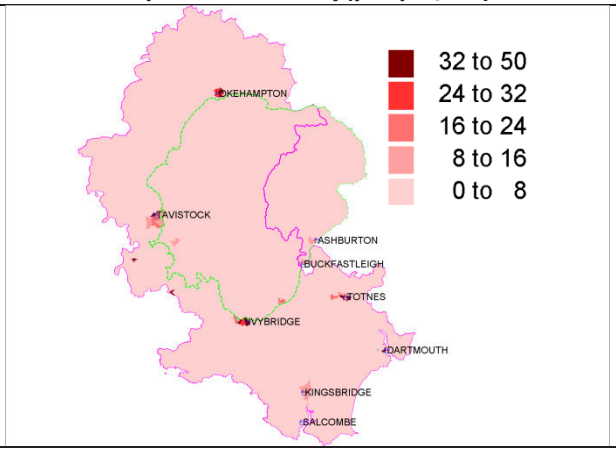
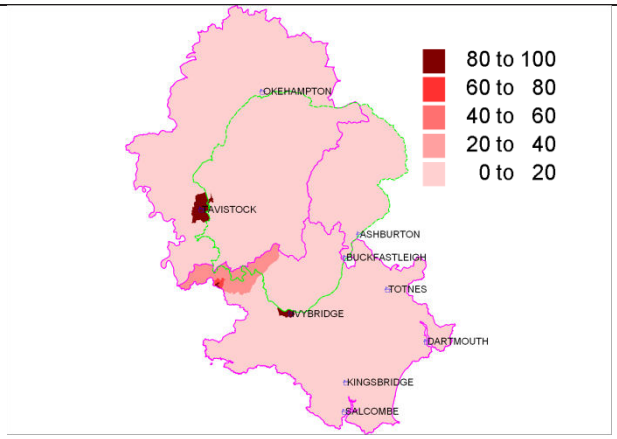
These were based on future prices from DECC as shown in the accompanying spreadsheets.

5. GIS Mapping Outputs

An exercise was undertaken using GIS to map out a series of key indicators for the area. These were based mainly on data from the 2011 Census, from DECC and CLG and from the NAEI. These are shown in the following sections.

5.1. People and Place

Population Density Indicators

Population Density(people/Ha)	*% Urban*
	

What is the map showing?

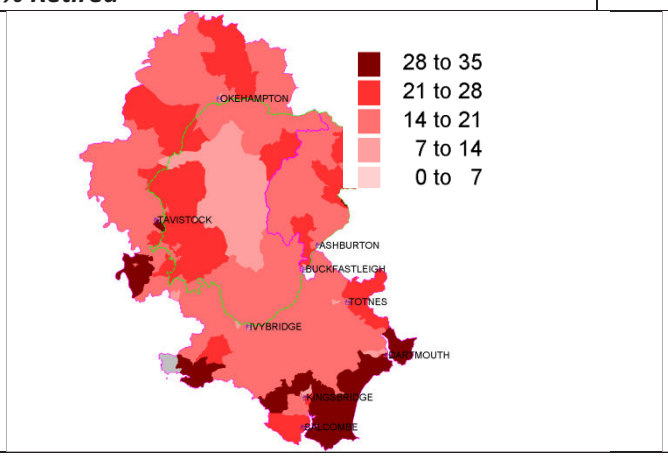
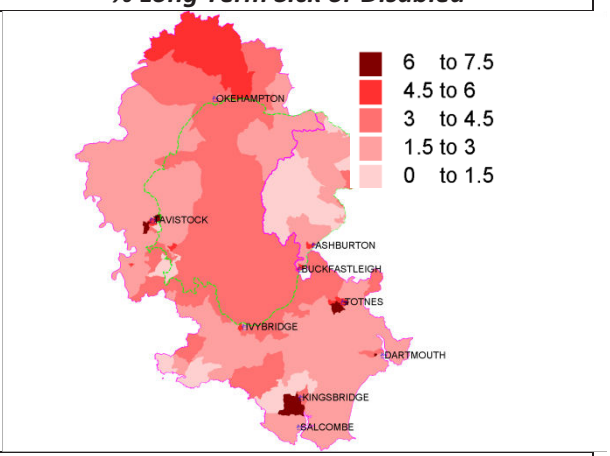
The area is mainly rural, with the exception of the principle towns.

How can I use this map?

The rural nature of the area helps explain specific outcomes, for example high transport energy consumption.

Source: 2011 Census and HECA

Economic Activity

% Retired	*% Long Term Sick or Disabled*
	

What is the map showing?

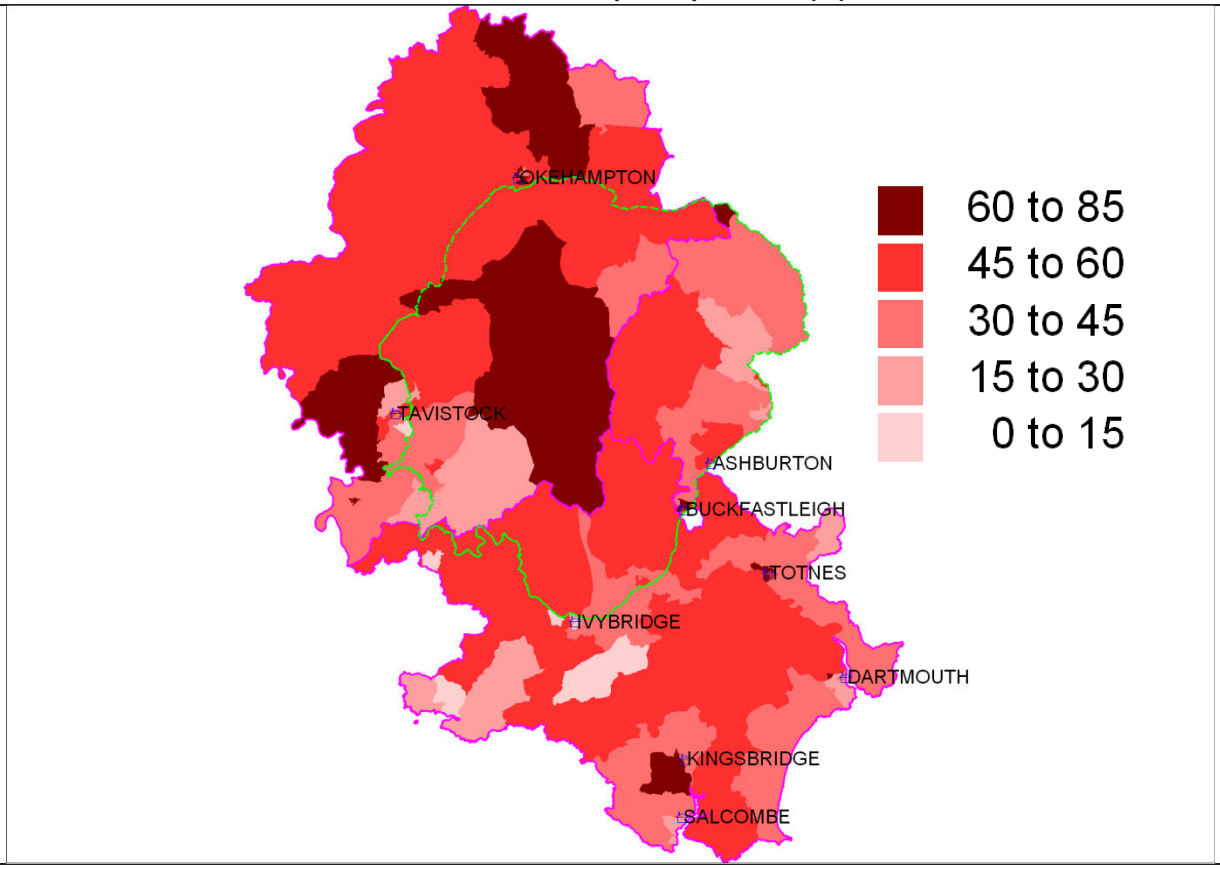
There is a high proportion of retired people in the whole area, and in particular on the coast in the South Hams between Salcombe and Dartmouth.

How can I use this map?

The elderly and long term sick or disabled are likely to be more vulnerable to the impacts of poorly insulated buildings, and so these areas should be targeted for improvements to dwellings.

Source: 2011 Census

Index of Multiple Deprivation (%)



What is the map showing?

There is a mixed picture for IMD, with higher levels generally found in rural areas, with some more affluent parts of Dartmoor having low values.

How can I use this map?

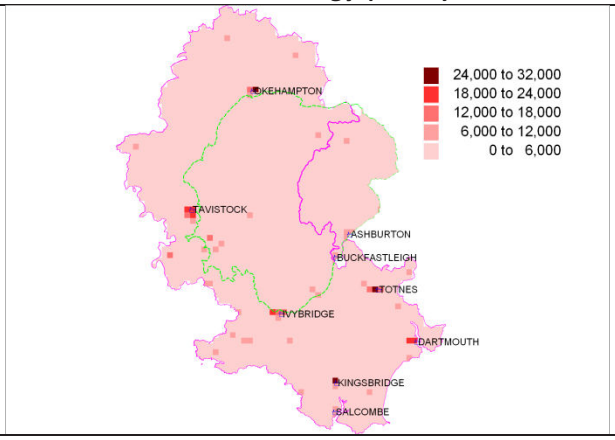
IMD % is based on the ranking of IMD with 100% being most deprived and 0% being least. It is a function of measures of deprivation such as income, health, education and access to services.

Source: CLG

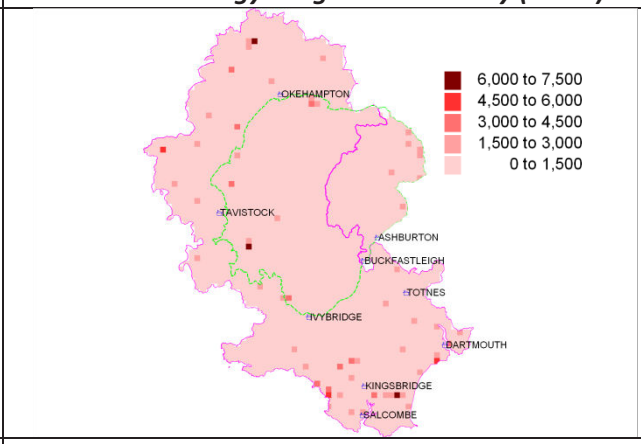
5.2. ENERGY

NAEI 1 x 1 km data

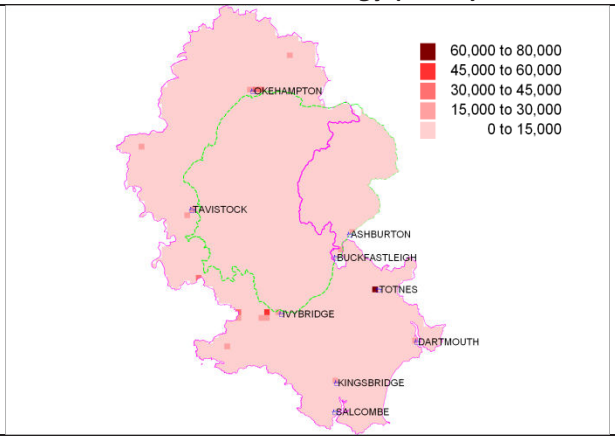
Domestic Energy (MWh)



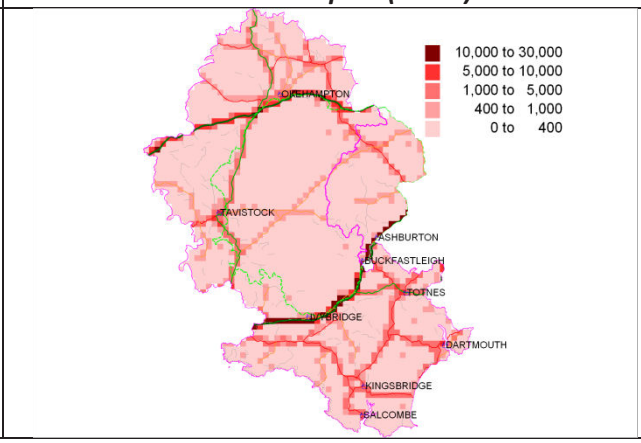
Domestic Energy ex. gas or electricity (MWh)



Non-domestic Energy (MWh)



Road Transport (MWh)



What is the map showing?

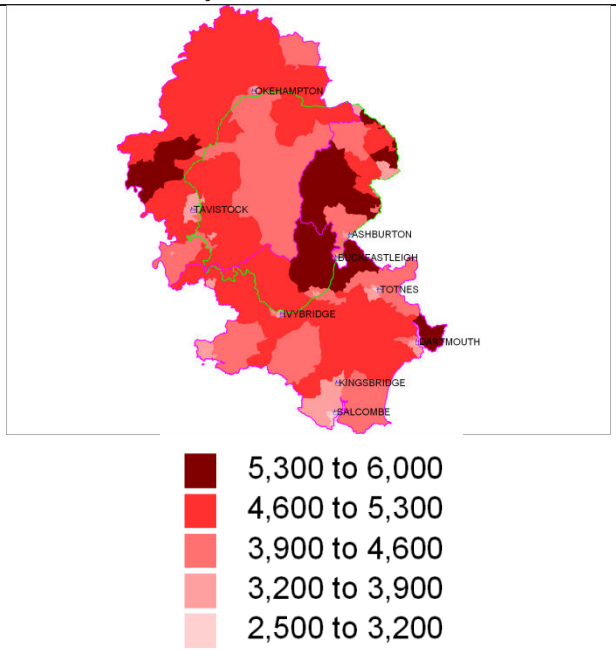
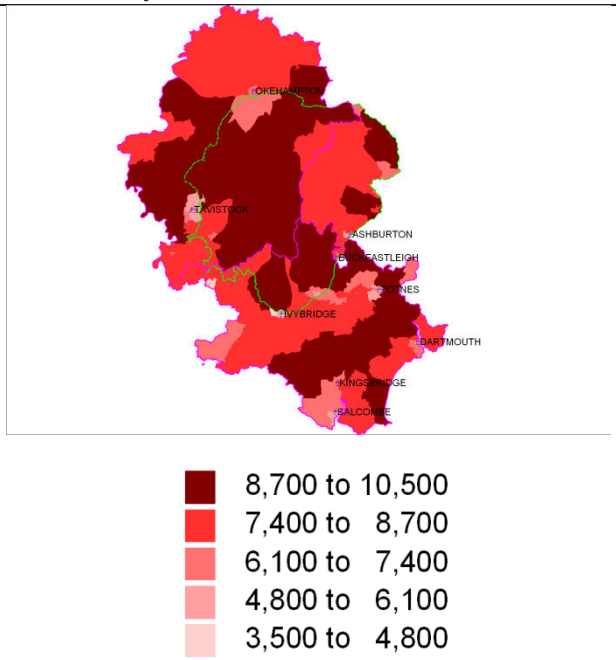
The data is based on a statistical approach. Domestic energy use intensity is obviously centred on the main towns. There are concentrations of non-gas or electricity(probably oil) around smaller villages in the area. Non-domestic energy use is concentrated at Totnes, Okehampton, Tavistock, Ivybridge, Lee Mill Industrial estate, and activity on the fringes of Plymouth that fall within the study area. As expected, road energy intensity is highest on the main trunk roads (A30 and A38) with the remaining A roads also being significant.

How can I use this map?

The domestic maps highlight the most intense areas that would benefit from targeting. Non-domestic energy use will likely require specific identification of the most intensive users.

Source: NAEI

Average electricity consumption per meter for normal and E7 meter

Normal Electricity Meters	*E7 Electricity Meters*
	

What is the map showing?

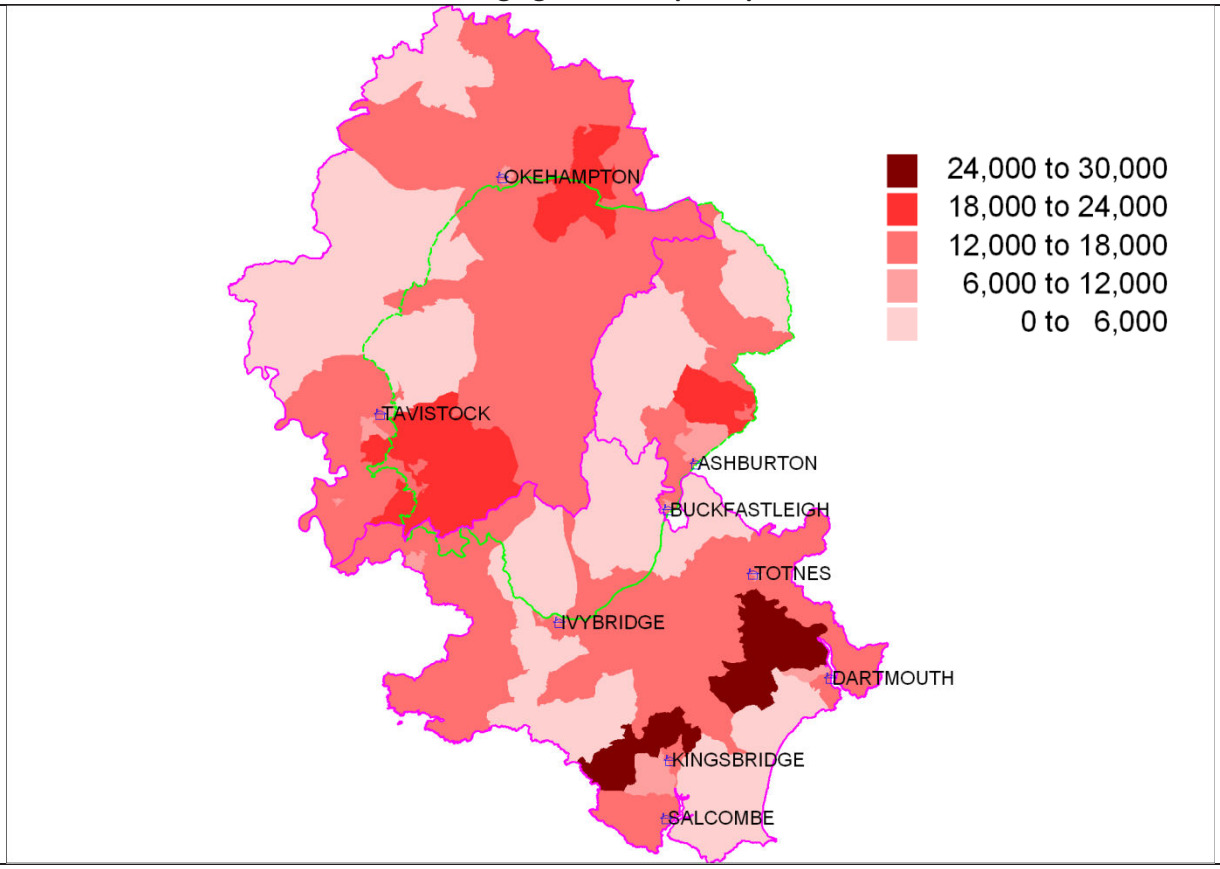
Homes with E7 meters (and therefore probably heated using off-peak electricity) use more electricity. Electricity use per meter is also higher in rural areas and particularly in Dartmoor. This is likely to be because of larger property sizes ,and in the case of E7 less efficient traditional buildings heated using electricity.

How can I use this map?

Space heating using off peak electricity is expensive and often less effective than other means of heating. There is a need to specifically target electrically heated gomes, especially on Dartmoor and in the more rural parts of West Devon and South Hams. This should involve both improving the efficiency of homes, and switching heating systems to either wood pellet boilers or heat pumps, which would require installing a wet heating system.

Source: DECC

Average gas consumption per meter



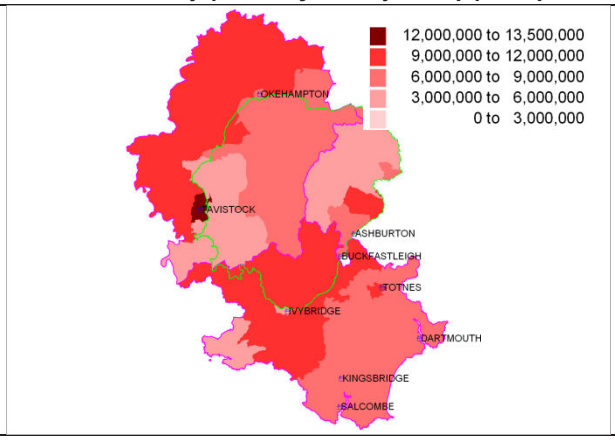
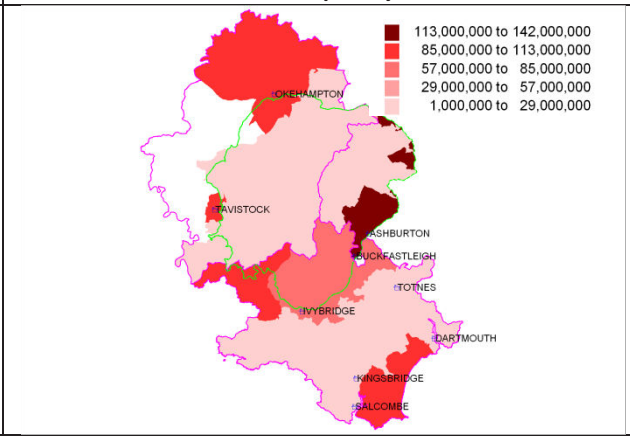
What is the map showing?

There is very high gas consumption per meter in the areas of South Hams surrounding Kingsbridge and Dartmouth, and to a slightly lesser extent surrounding Tavistock and Okehampton.

How can I use this map?

High gas consumption per meter is a function of the size of property, its efficiency (insulation) and behaviour (e.g. comfort preferences). High use could potentially be targeted by improving insulation and targeting behaviour e.g. reducing thermostat temperatures or fitting controls to ensure that infrequently heated rooms are not heated to the same extent as the remainder of a property.

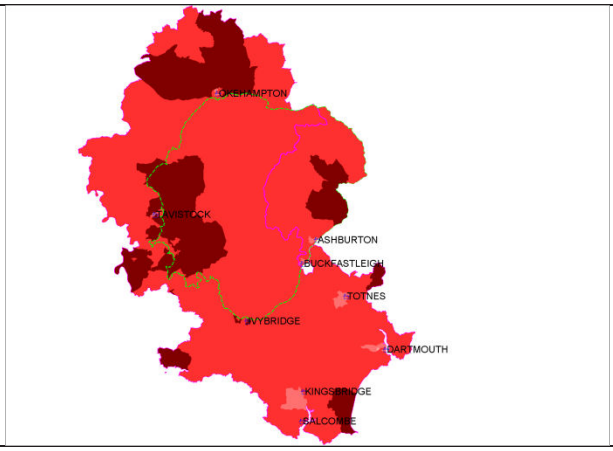
Source: DECC

Non-Domestic Gas and Electricity Consumption (excluding half hour electricity users)	
Electricity (ex. Half hourly sites) (kWh)	***Gas (kWh)***
	
What is the map showing? The MSOA data indicates areas of peak gas consumption are around Ashburton/Buckfastleigh area, and the relatively low consumption across most of the area due to being off the gas grid. Electricity use is highest at Tavistock, though the data does not include half hourly meters which are responsible for 58% of all non-domestic electricity in the area	
How can I use this map? Due to data being available at MSOA level the data is of limited value. Nonetheless, targeting small business electricity use in Tavistock should be prioritised.	
Source: DECC	

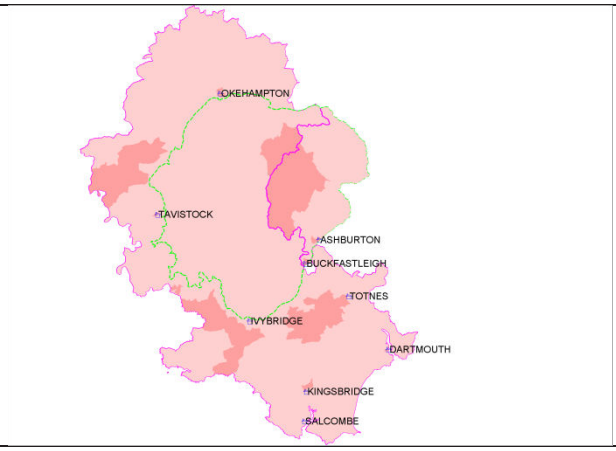
5.3. HOUSING

Tenure (0-100 scale)

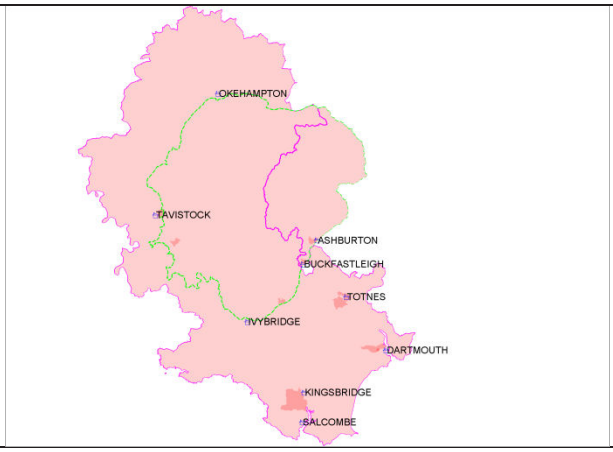
Owned

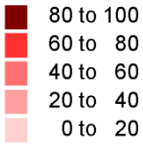


Private Rented



Social Rented





What is the map showing?

Most people in the area own their homes, either outright or with a mortgage.

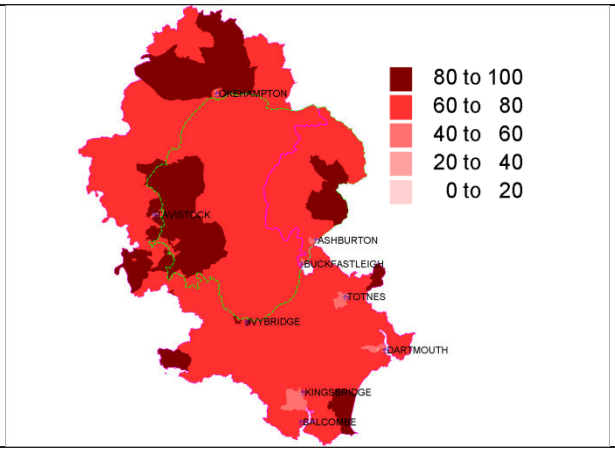
How can I use this map?

The opportunities to implement improvements to properties are strongly dependant on the tenure.

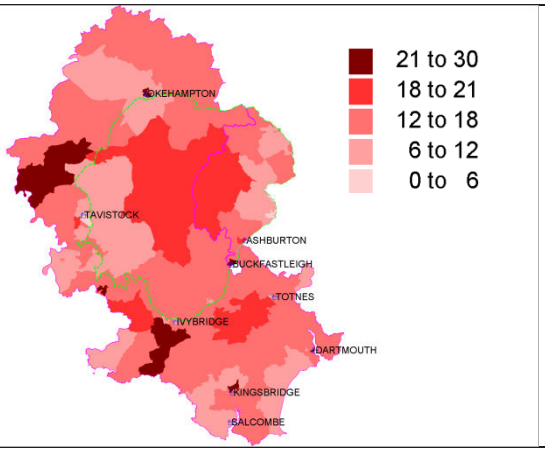
Source: 2011 Census

Tenure (Variable scale)

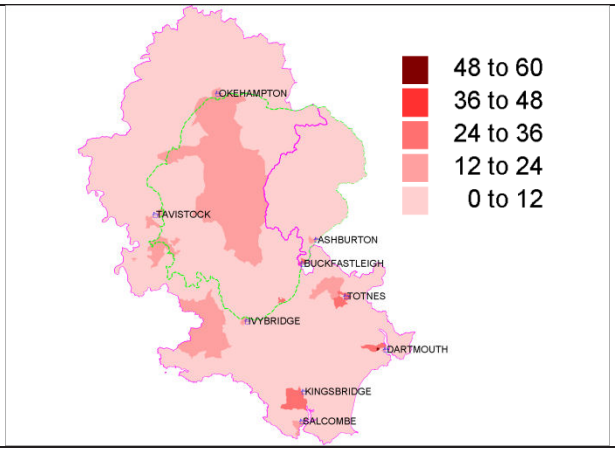
Owned



Private Rented



Social Rented



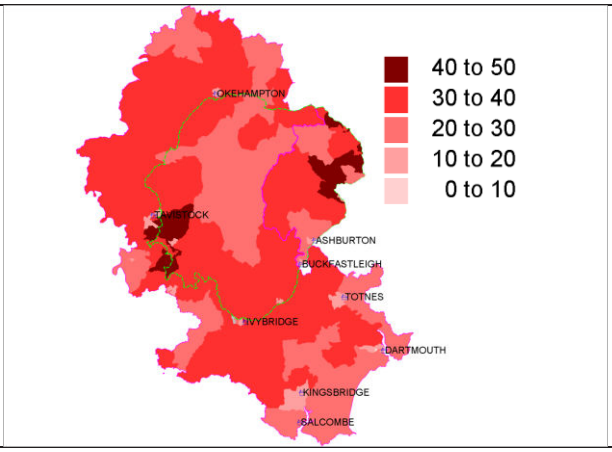
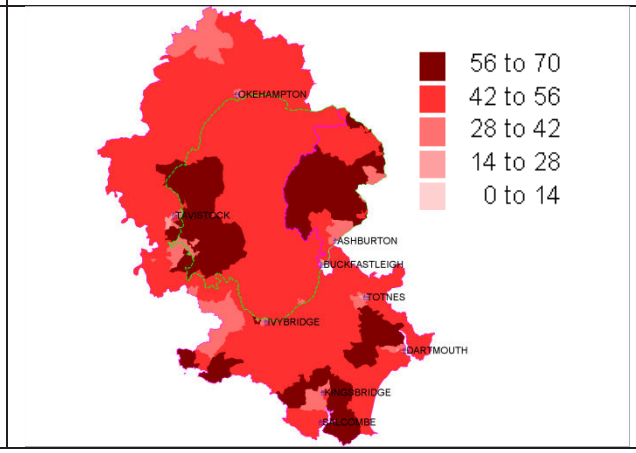
What is the map showing?

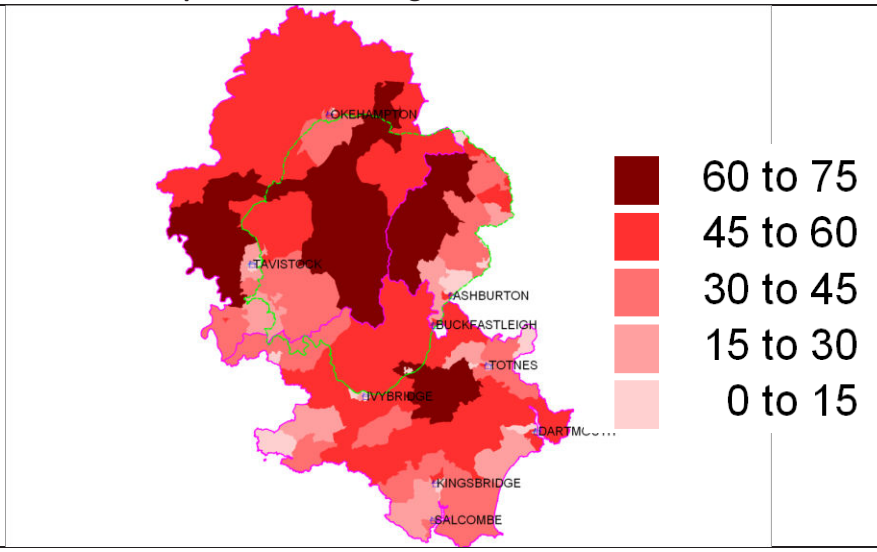
With variable scales the specific patterns of tenure can be seen. For example, the highest proportion of rented properties are found to the north of Tavistock and between Ivybridge and Plymouth. Social housing concentrations are highest around the urban centres.

How can I use this map?

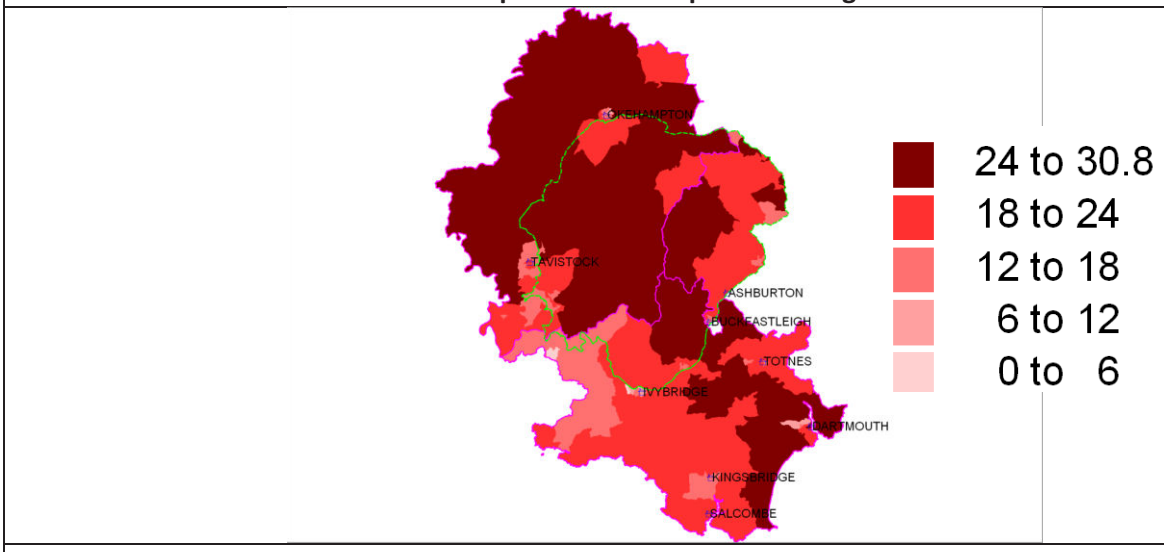
Specific advice and promotion can be targeted to different areas depending on the house type and likely measures that will apply.

Source: 2011 Census

Indicators of property size and occupant density	
Proportion of dwellings with 4 or more bedrooms	**Proportion of dwellings with occupancy rating of 2 or more**
	
What is the map showing? There is a high proportion of large homes on the east and west edges of Dartmoor, around Tavistock and Bovey Tracey. In general a large proportion of the SW Devon area has large properties. These closely correspond to homes with potential "spare" rooms. In some areas well over half of properties have at least two spare bedrooms.	
How can I use this map? Larger properties are more likely to use more energy. Therefore targeting areas with large homes might have a greater impact as fewer individual projects will be needed. An occupancy rating of +2 implies that theoretically there are two spare bedrooms. Therefore these homes could be targeted to implement measures such as controlling heat to infrequently used spaces.	
Source: 2011 Census	

Proportion of dwellings with solid walls

What is the map showing? The area has a high proportion of homes with solid walls. This is especially true in the rural areas, though is also significant in historic urban areas such as Dartmouth.
How can I use this map? Solid wall properties are "hard to treat" and require either internal or external insulation. This could be funded through ECO. Conversely, cavity walled properties can me more simply insulated and these should be prioritised where they have not been already filled.
Source: CSE

Proportion of fuel poor dwellings



What is the map showing?

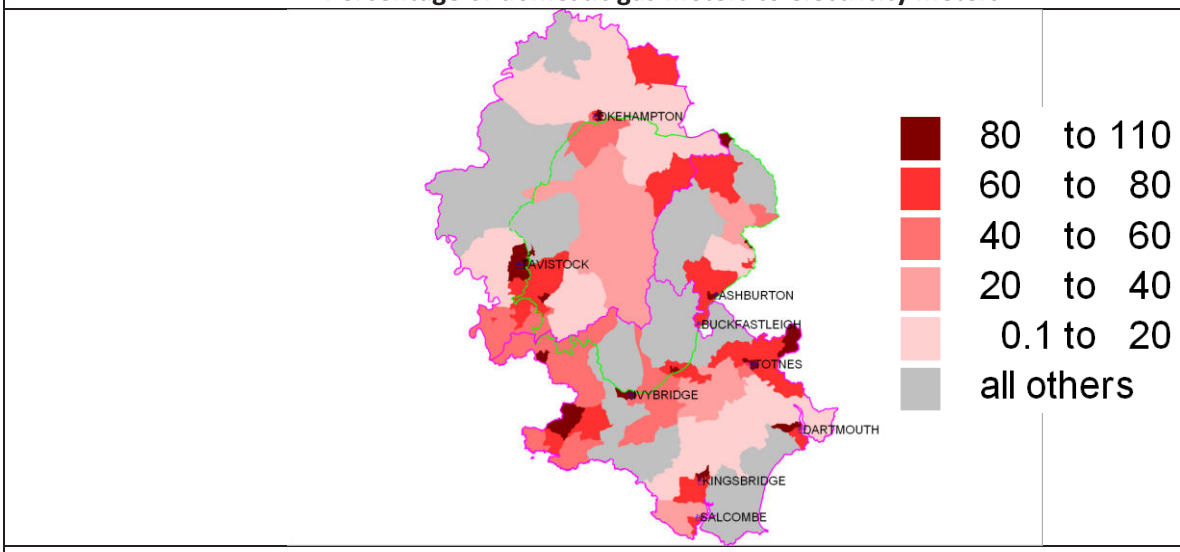
There are high proportions of fuel poverty across the area, though especially in Dartmoor and the rural areas around Okehampton and Dartmouth. This is strongly driven by being off-gas, as well as by inefficiency of homes (e.g. uninsulated solid walls).

How can I use this map?

Areas of high fuel poverty should be targeted. Specifically, ECO funding should be promoted to people in those areas.

Source: HECA

Percentage of domestic gas meters to electricity meters



What is the map showing?

There are high proportions of gas to electricity meters around all the major urban areas within SW Devon, indicating that the main towns are generally heated using gas as a fuel. In the rural areas, most homes would be heated using oil, solid fuels or electricity.

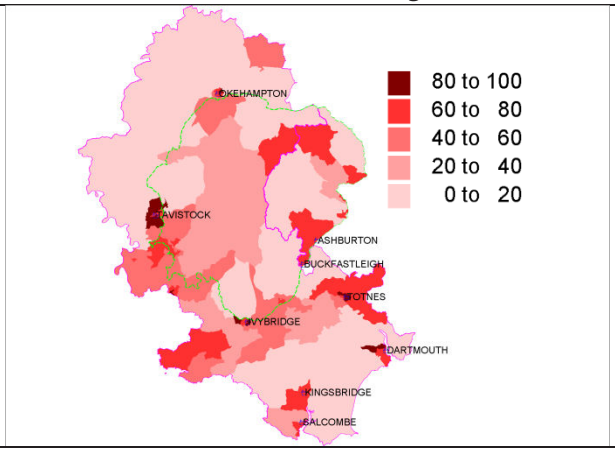
How can I use this map?

Although gas is a fossil fuel, it is cheaper and has a lower carbon intensity than other forms of fossil fuel heating. Prioritising switching to renewable heat and improving the efficiency of rural homes should be prioritised.

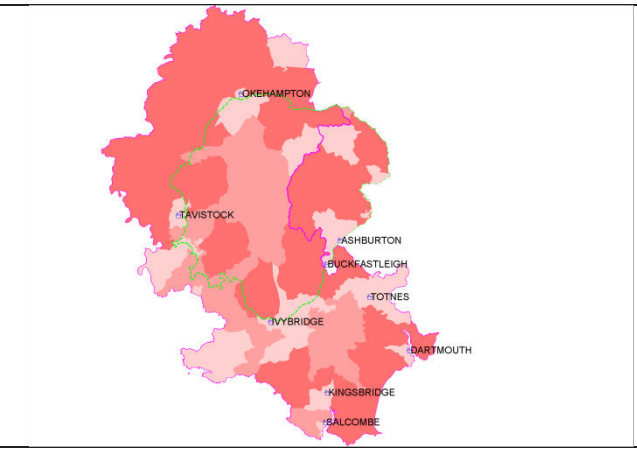
Source: DECC

Proportion of heating type (0-100 scale)

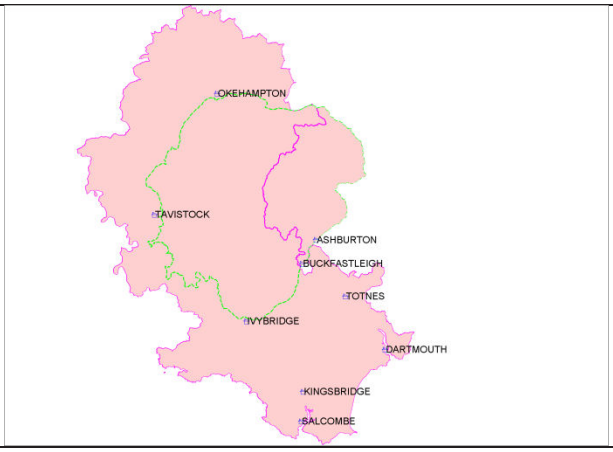
Gas central heating



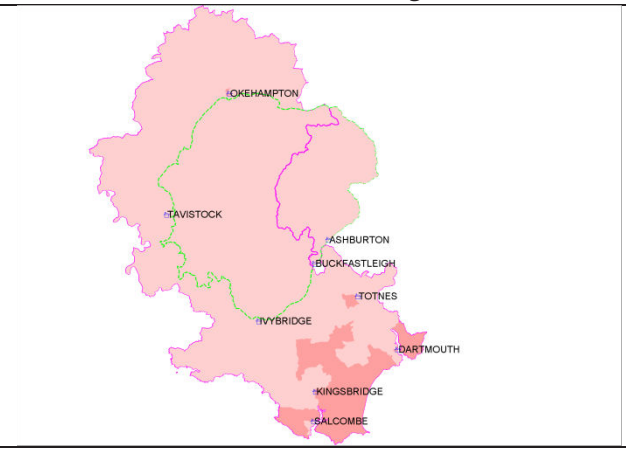
Oil



Solid Fuel



Electric Heating



What is the map showing?

There is a relatively high proportion of gas centrally heated homes around the major urban centres. Outside of these however, there is a high proportion of homes heated using oil. The highest concentration of electric heating occurs in the South Hams.

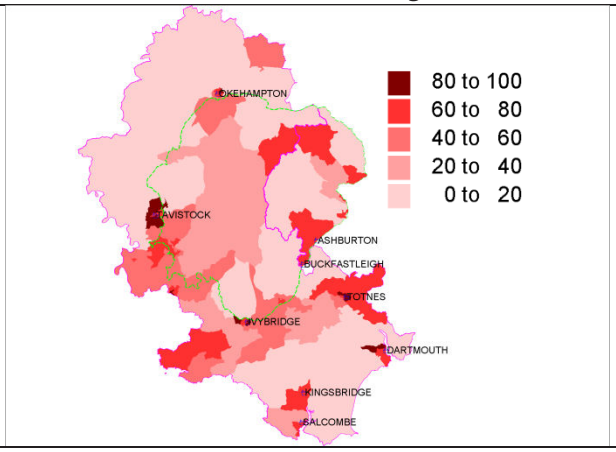
How can I use this map?

Although gas is a fossil fuel, it is cheaper and has a lower carbon intensity than other forms of fossil fuel heating. Prioritising switching to renewable heat and improving the efficiency of rural homes should be prioritised.

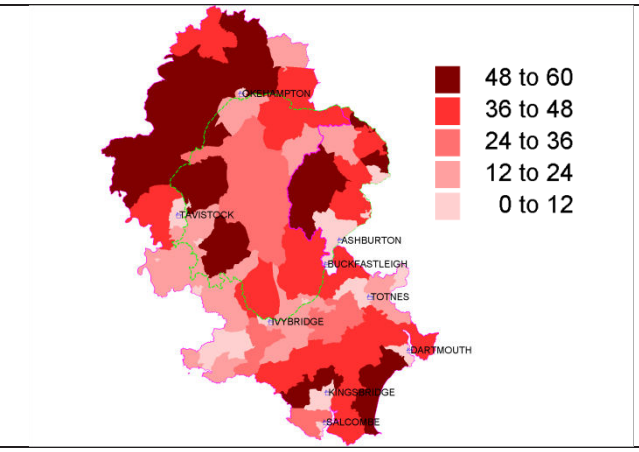
Source: 2011 Census

Proportion of heating type (variable scale)

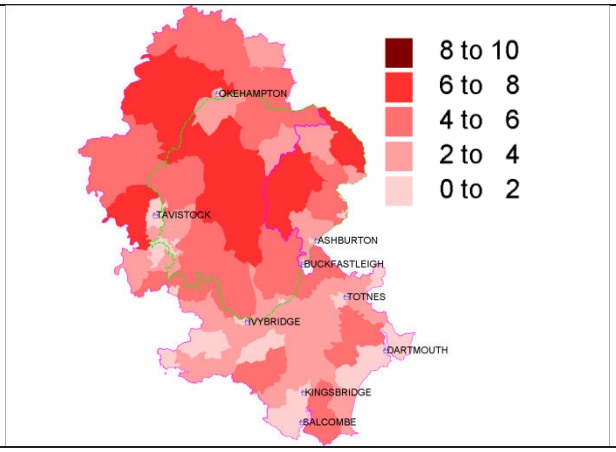
Gas central heating



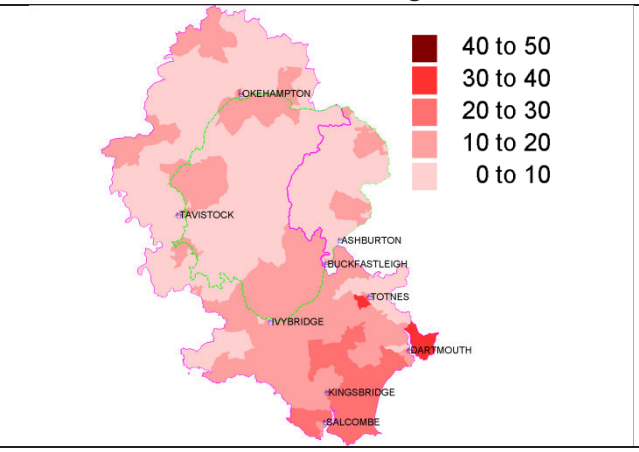
Oil



Solid Fuel



Electric Heating



What is the map showing?

By varying the scale, the sub-regional patterns can be more clearly seen.

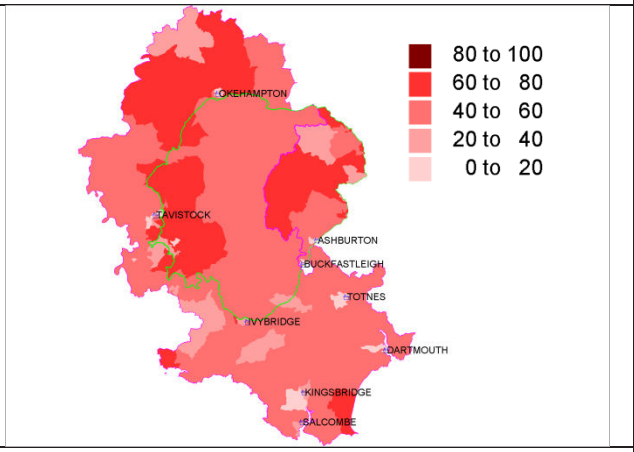
How can I use this map?

Homes heated by means other than gas should be prioritised through improving the efficiency and switching of heating to renewable heat such as biomass boilers or heat pumps.

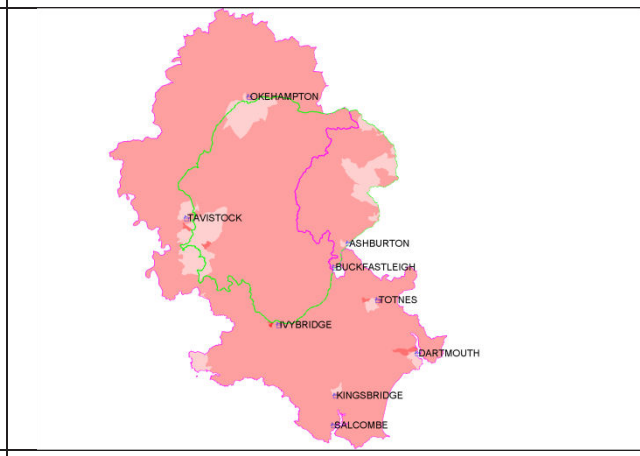
Source: 2011 Census

Proportion of housing type (0-100 scale)

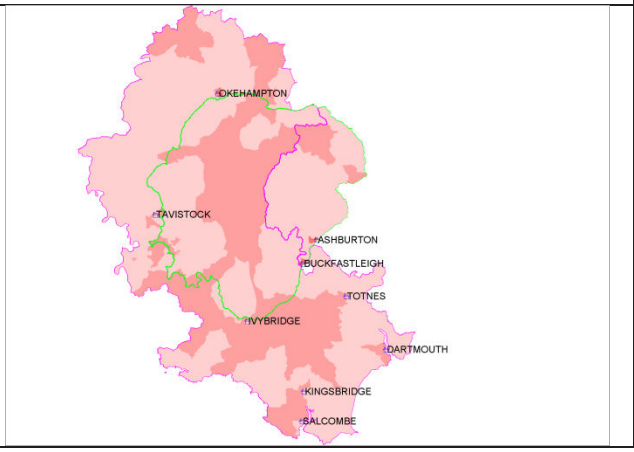
Detached



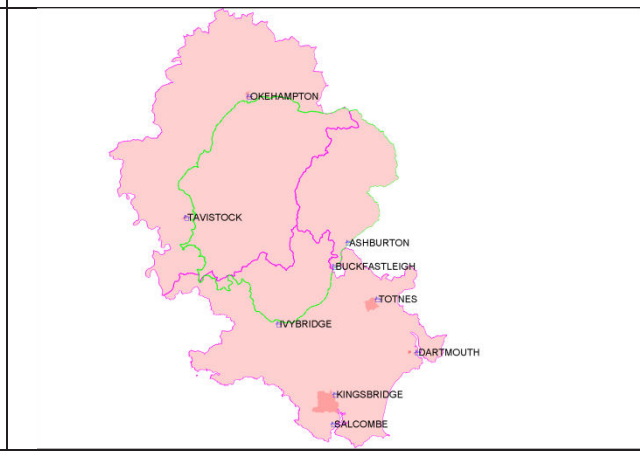
Semi-Detached



Terraced



Flats



What is the map showing?

The dominant housing type is detached, across the whole region. Semi-detached is the next most common.

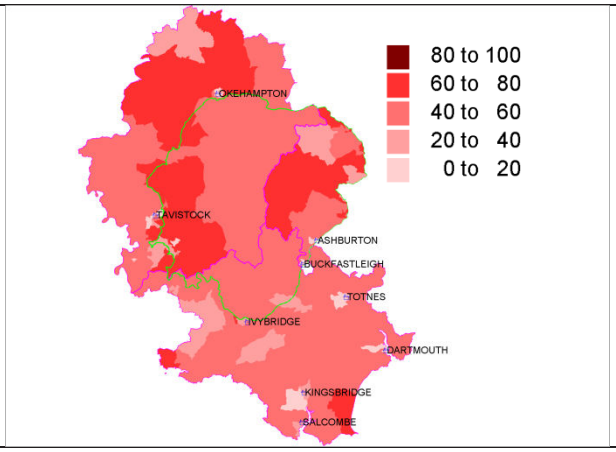
How can I use this map?

Different housing types require different approaches. Improving large detached homes will result in greater impact per project. With terraced homes targeting a street might be more effective, though more challenging than an individual property.

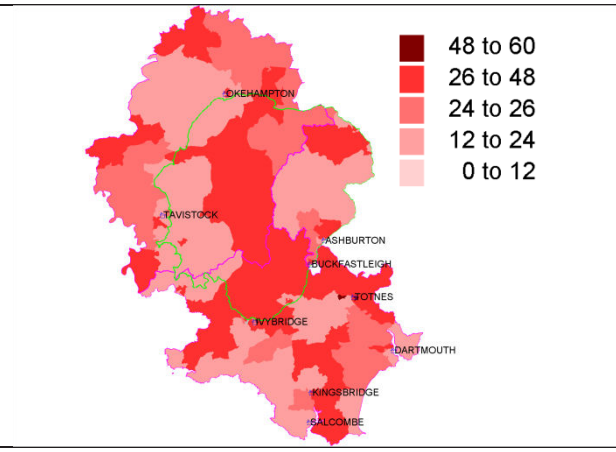
Source: 2011 Census

Proportion of housing type (variable scale)

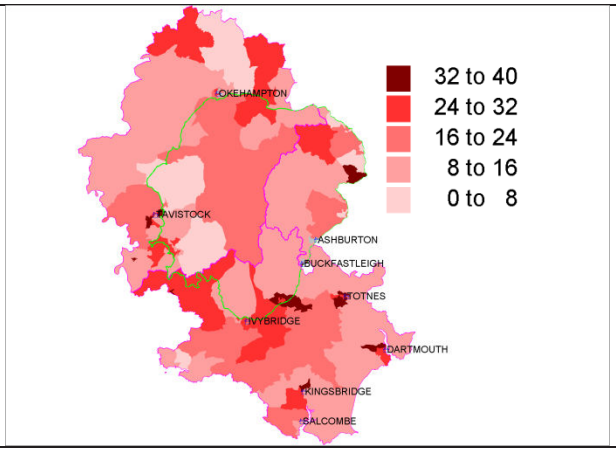
Detached



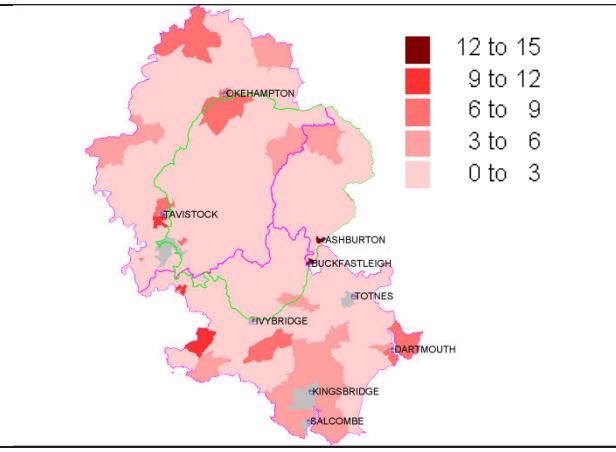
Semi-Detached



Terraced



Flats



What is the map showing?

When the scales are varied for each type, subtle patterns emerge.. Detached is still easily the most common type.

How can I use this map?

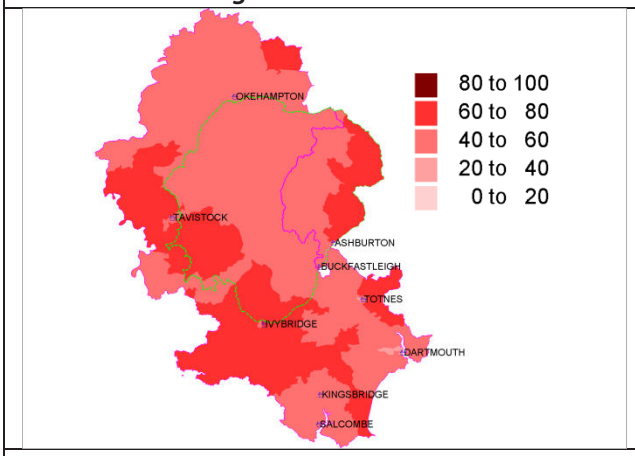
Specific advice and promotion can be targeted to different areas depending on the house type and likely measures that will apply.

Source: 2011 Census

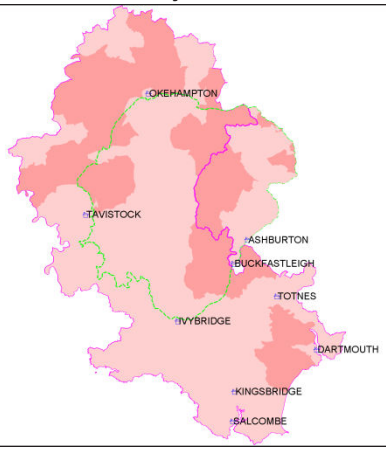
5.4. TRANSPORT

Method of Travel to Work (0-100 scale)

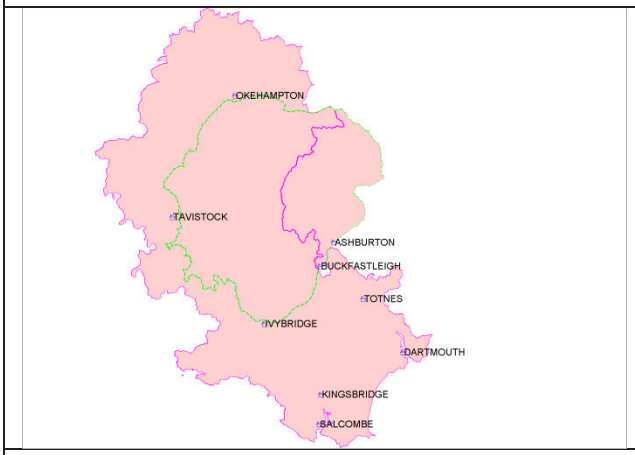
Single Driver in a Car



Mainly Work at Home

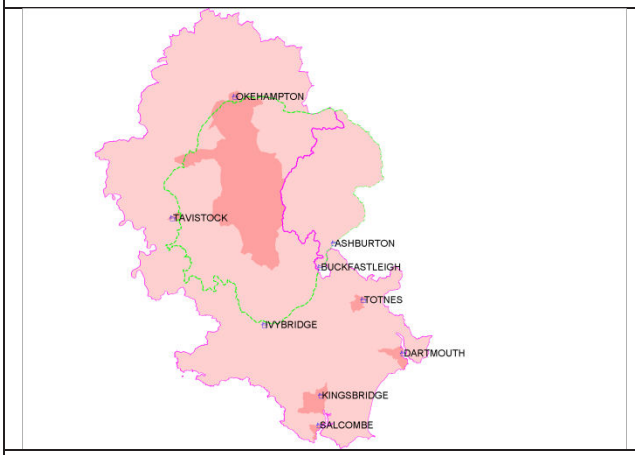


Bus

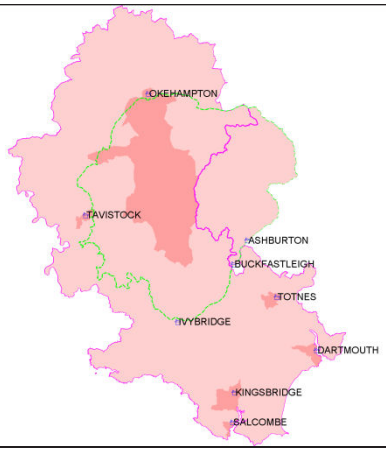


Bike

Walk



Bike + Walk



What is the map showing?

Across the area most people drive to work in cars with only one driver. More people work from home than travel to work using other sustainable means of travel. Some people walk to work, mainly in the urban centres in South Hams (Totnes, Dartmouth, Kingsbridge). These results are likely to be strongly influenced by people travelling to major employment hubs in Plymouth, Exeter and Torbay by car.

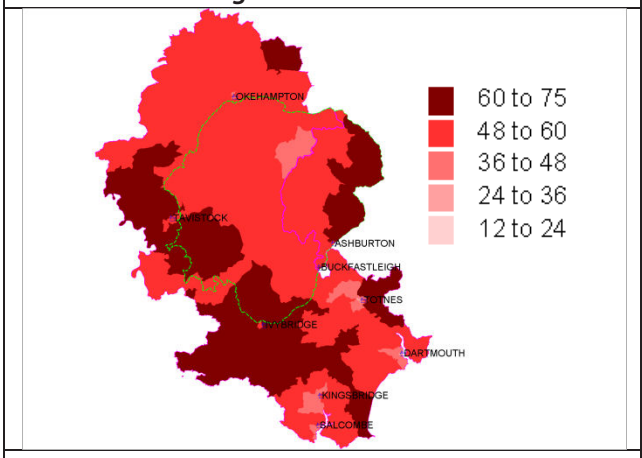
How can I use this map?

Tackling commuting in cars with only a driver should be prioritised.

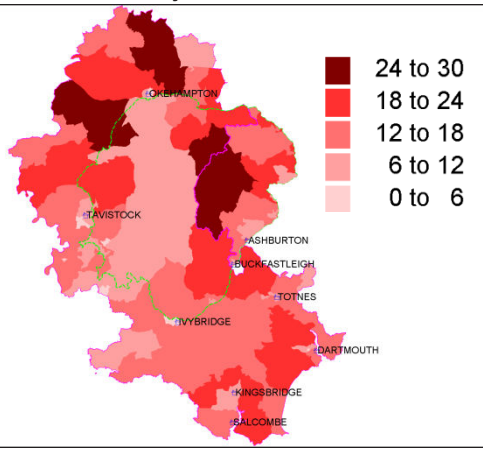
Source: 2011 Census

Method of Travel to Work (variable scale)

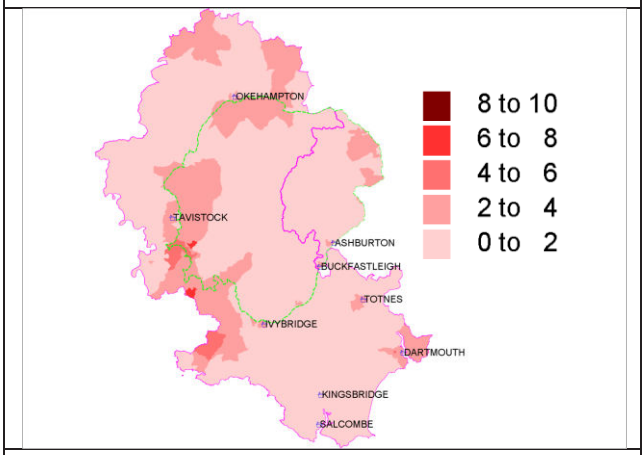
Single Driver in a Car



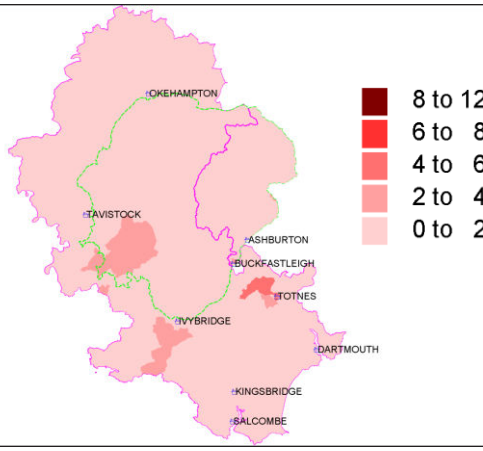
Mainly Work at Home



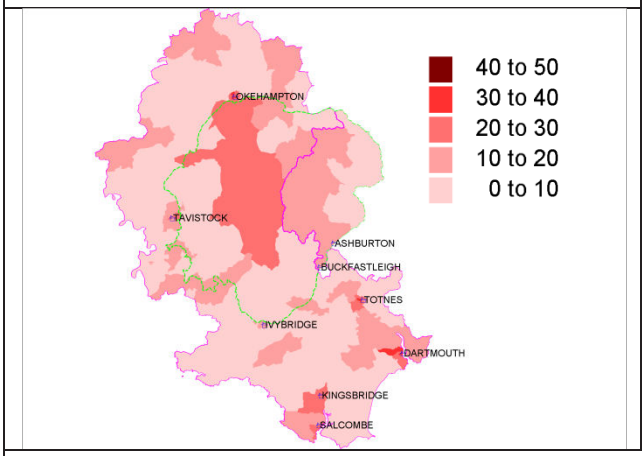
Bus



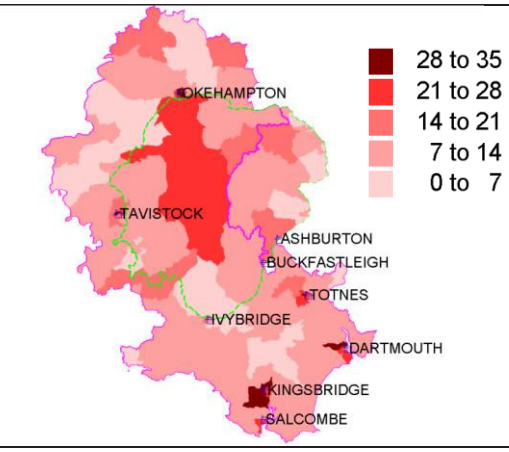
Bike



Walk



Bike + Walk



What is the map showing?

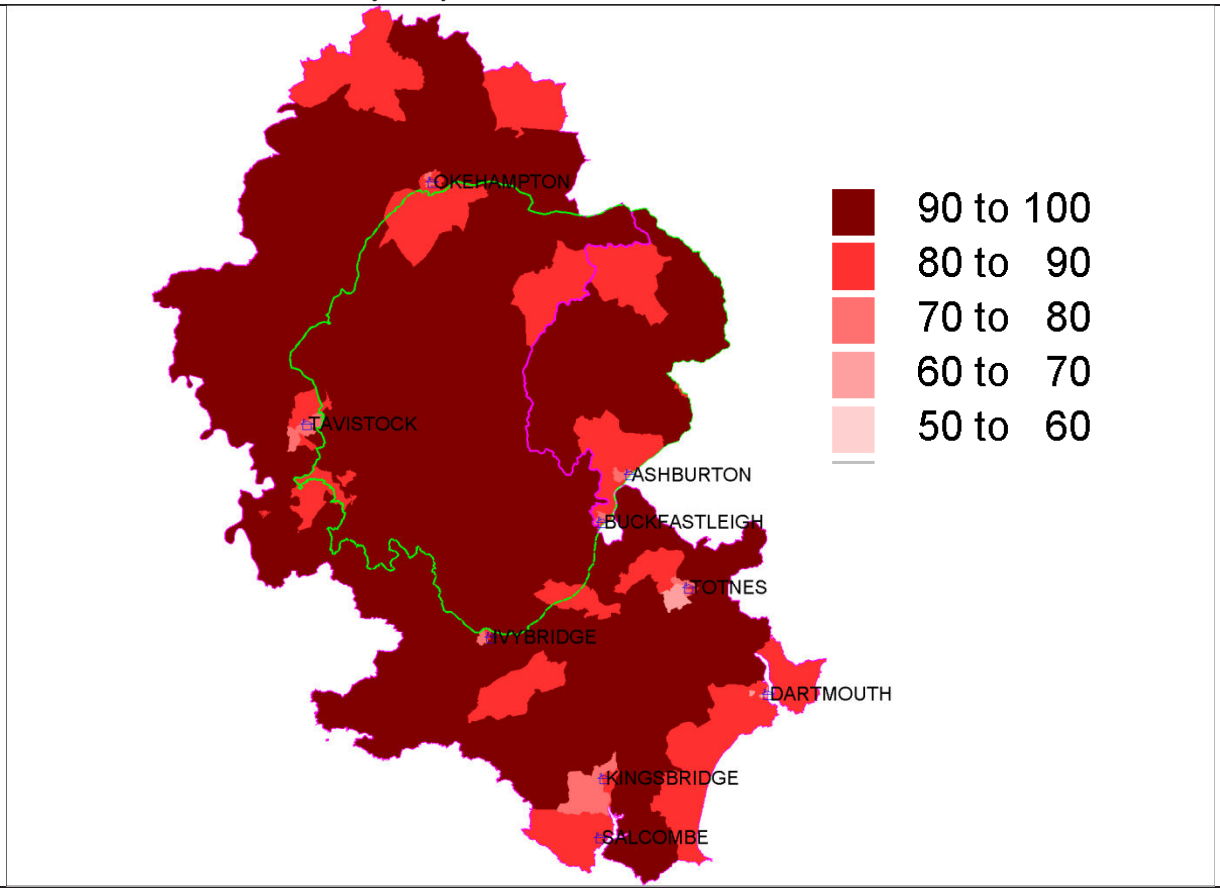
The variable scale allows more localised patterns to be observed. The high density of single car commuters is clearly influenced by the location of major urban employment centres.

How can I use this map?

Specific areas should be prioritised to target single car commuters e.g. in the areas surrounding Plymouth and on the Eastern fringes of Dartmoor. This could include strategically targeting car sharing or promoting home working.

Source: 2011 Census

Car availability: Proportion of households with at least one car or van



What is the map showing?

There is a very high proportion of homes with at least one car. Almost all rural homes have access to a car, and even those close to more urban areas almost always (over 80% of homes) have access.

How can I use this map?

Clearly private cars play an important role in people's lives in the area. Opportunities for reducing energy consumption will need to involve making smarter choices, for example car sharing, planning routes, and reducing trips where possible.

Source: 2011 Census

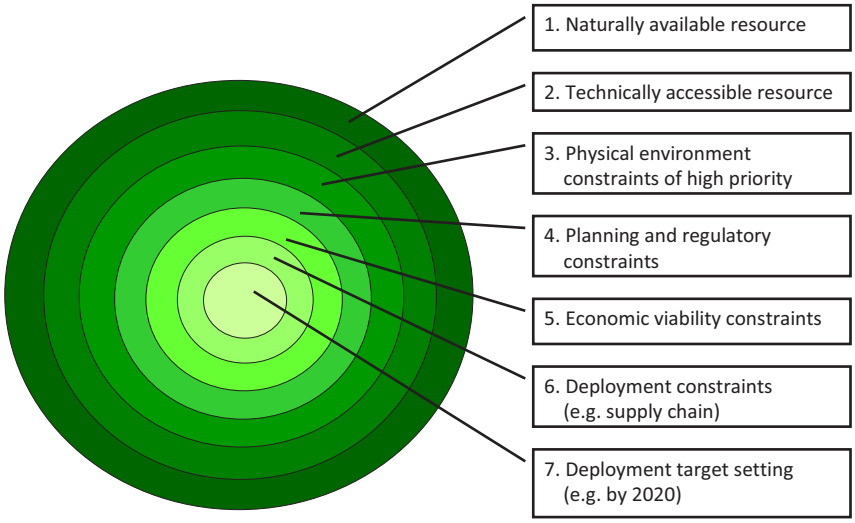
6. RENEWABLE ENERGY ASSESSMENT

The assessment for the potential for renewable energy in the SW Devon study area have been based on the best available existing sources of information. Headline existing studies of the area include the following:

- University of Exeter SWEEG Report 772, A review of renewable energy resource assessment and targets for Devon, ADS Norton, March 2011
- West Devon Renewable Energy Potential Study 2008, DARE[v]
- South Devon Renewable Energy Scoping Study, 2006, DARE[vi]
- Teignbridge District Council Renewable Energy and Sustainable Construction Stud, CSE 2010[vii].
- One Planet Dartmoor: Dartmoor Low Carbon Strategy Chapter 10: Powering Dartmoor: A Renewable Energy Plan for Dartmoor[viii]
- Torbay and District Renewable Energy calculations[ix].

Additional data sources have been used for each technology. The approach taken and data sources used for each technology and scale are stated in the sub-sections.

The assessment of renewable energy resources and the setting of targets involve sequential processes in which layers of analysis are applied that progressively reduce the total theoretical opportunity to that which is considered practically achievable by a target date. In 2010 DECC commissioned a methodology from consultants SQW for assessing renewable energy resource. Seven stages were defined to the assessment process as illustrated in the image below.



Stage 1 refers to the raw renewable energy resource available (e.g. biomass or wind) and stage 2 the opportunity for harnessing the renewable energy resource using current technology solutions. Stages 3 and 4 address the constraints to the deployment of technologies in relation to the physical environment and planning/regulatory limitations. Stage 5, refers to the economic constraints including the cost of the

[v] http://www.westdevon.gov.uk/upload/public/attachments/1000/Combined%20Study%20Document.pdf
[vi] http://transitionculture.org/wp-content/uploads/DARESDAONBFinalReport060424.pdf
[vii] http://www.teignbridge.gov.uk/CHttpHandler.ashx?id=33316&p=0
[viii] http://www.dartmoorcircle.org.uk/lowcarbonplan.html
[ix] http://totnesedap.org.uk/book/appendices/appendix-c/totnes-and-district-energy-budget-calculations/

technology, energy commodity prices, incentives (e.g. FIT, RHI), cost of capital etc,. Supply chain constraints (stage 6) include maturity and capacity of the supply chain to deliver the required renewable fuel or technology (equipment) and to deploy the technology (including qualified engineers and installers). Stage 7 is the point at which all factors can be combined to set a target for an area to be achieved by a particular date.

It is important to recognise the differences between characteristics of the stages. An understanding of the natural resource, the energy that can be technically extracted from that resource and the exclusion of areas where the resource cannot be harvested in stages 1, 2 3 and 4 leads to a fundamental calculation of the amount of renewable energy available which will only change slowly over time. Whereas the latter stages, 5 (economics) 6 (supply chain) and 7 (proximity to a target date), are more time sensitive. For example the introduction or withdrawal of a financial incentive can have an immediate effect on the achievability of a target. **The assessment in this report has generally focussed on identifying the potential from stages 1-4. As stages 5-7 are rapidly changing, it is difficult to provide meaningful estimates for these impacts which would make this evidence base robust going forward.** Barriers on Stages 5-7 are discussed where appropriate, and in some cases represent opportunities to the study area.

Speed of deployment varies by technology and scale. In general, the larger and more complex the technology, the longer the lead time required to deployment. Individual micro generation installations can usually be quickly and easily deployed. The small individual quantities of energy produced are absorbed into a building or the electricity grid. In most instances planning permission is not needed. The equipment is relatively easily available although there can be exceptions to this when uptake accelerates rapidly (e.g. inverters for photovoltaic cells currently). The speed of uptake is therefore governed by the motivation of building owners which is strongly influenced by regulation (new build) and the availability of financial incentives. The Low Carbon Buildings Programme was a good illustration of the acceleration in uptake of micro renewables when financial incentives are available and the subsequent slump when they are not.

Large scale installations have local impacts and require planning permission. Factors such as visual impact transport, and emissions need careful consideration and often raise concerns in the local community. Access to the electricity grid and the need for grid reinforcement can also be a limiting factor for large scale electricity projects as can the ability of the equipment supply chain to deliver the specialist components for large projects when global demand for a technology is strong (e.g. some wind turbine components currently). Large scale projects will therefore take a number of years to progress from concept to operation. However, large scale renewables generally produce orders of magnitude more energy and as a result of their scale have better economics. Large scale technologies therefore tend to require less financial support per MWh than small scale technologies.

6.1. COMMERCIAL AND COMMUNITY SCALE

6.1.1. HYDRO

An assessment of existing installations and potential resource was undertaken for the study area. This assessment was based on a range of previous studies. These included:

- Regen SW Annual renewable survey (2012)
- British Hydropower Association, A Guide to Mini- Hydro Developments
- Teignbridge District Council Renewable Energy and Sustainable Construction Study, CSE
- DARE South Devon Report (2006)
- DARE West Devon Renewable Energy Potential Study 2008 – scope is West Devon and Dartmoor
- SW Water presentations
- One Planet Dartmoor: Dartmoor Low Carbon Strategy

- Environment Agency (2010), Opportunity and environmental sensitivity mapping for hydropower in England and Wales

The RegenSW survey indicates:

	No Projects	Capacity (MWe)
South Hams	11	1.308
Teignbridge	9	0.386
West Devon	6	3.708

Note: DARE 2008 study scoped W Devon and Dartmoor together and stated no hydro in Dartmoor/Teignbridge so those 9 Teignbridge projects taken to be outside study area.

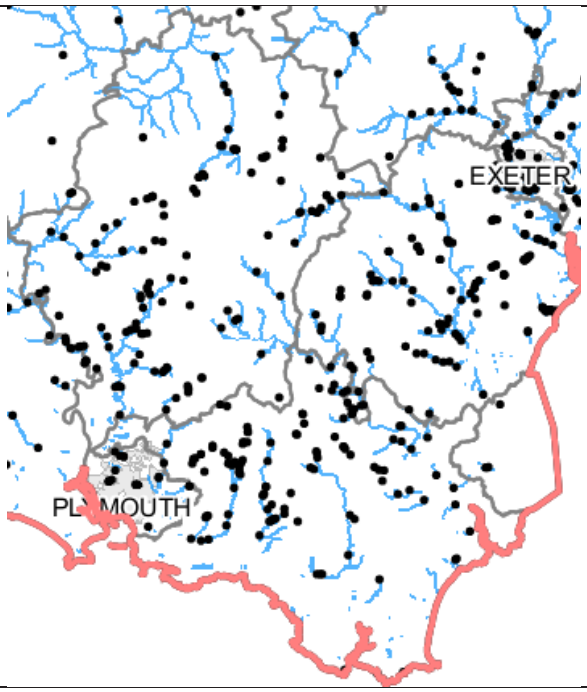
The DARE South Hams study was based on an ETSU Study from the 1980s. It identified a potential of 747 kW (3,884 MWh). These sites were cross-referenced with the more recent Environment Agency assessment, and it was found that only one of the eight sites coincided with where the EA thought there was practical potential. The South Hams DARE study was not taken further.

The West Devon DARE study identified the existing and potential installations in West Devon and Dartmoor. It was observed that the stated powers for Meldon and Morwellham understated installed capacity by a factor of ten compared to SW Water statements. The SW Water data would also mean the RegenSW survey tallies correctly. The power for those schemes was amended from the DARE report and energy consumption scaled up accordingly. An average capacity factor of 54% was deduced from the DARE study and this was taken forward.

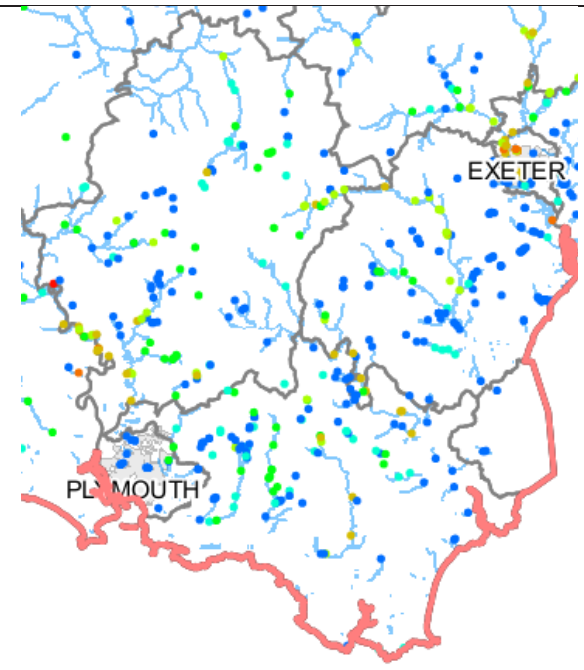
SW Water data was used to cross reference the above sources. It is also possible that a new 200 kW scheme may emerge as part of a water treatment facility at Roborough (South Hams on the borders with Plymouth).

The Dartmoor Circle strategy took figures from DARE and added that a new 48 kW hydro scheme had been implemented at River Dart Country Park. Based on the mean capacity factor of 54%, this equates to 228 MWh.

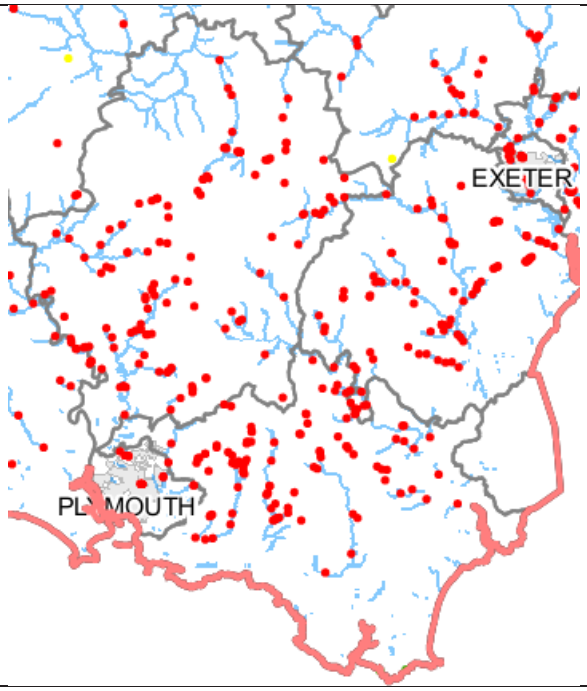
The EA study takes the natural resource then by process of assessing constraints establishes feasible sites. This was taken to be the most robust source. It is assumed that these sites are additional to those already in existence (for example, the EA mapping does not show a potential large scheme at Mary Tavy). The process for the SW Devon study area is shown in the maps below.



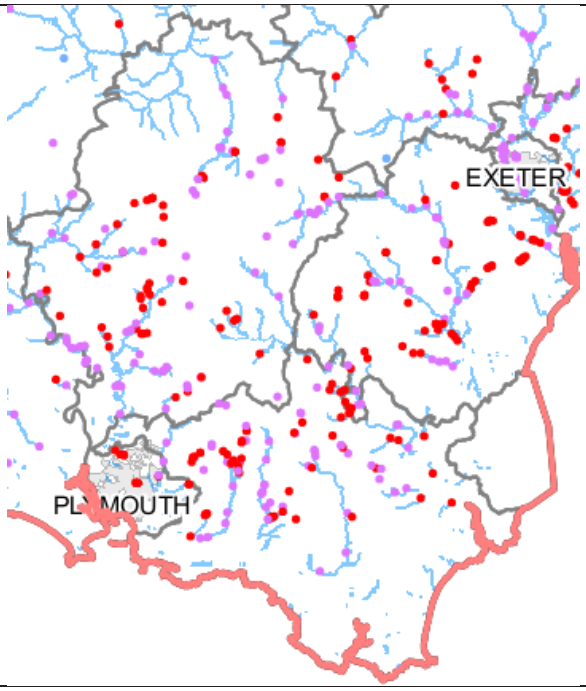
Each black dot represents a potential site (i.e. coincides with an existing “barrier”)



These barriers are then assessed in terms of their potential (kW)

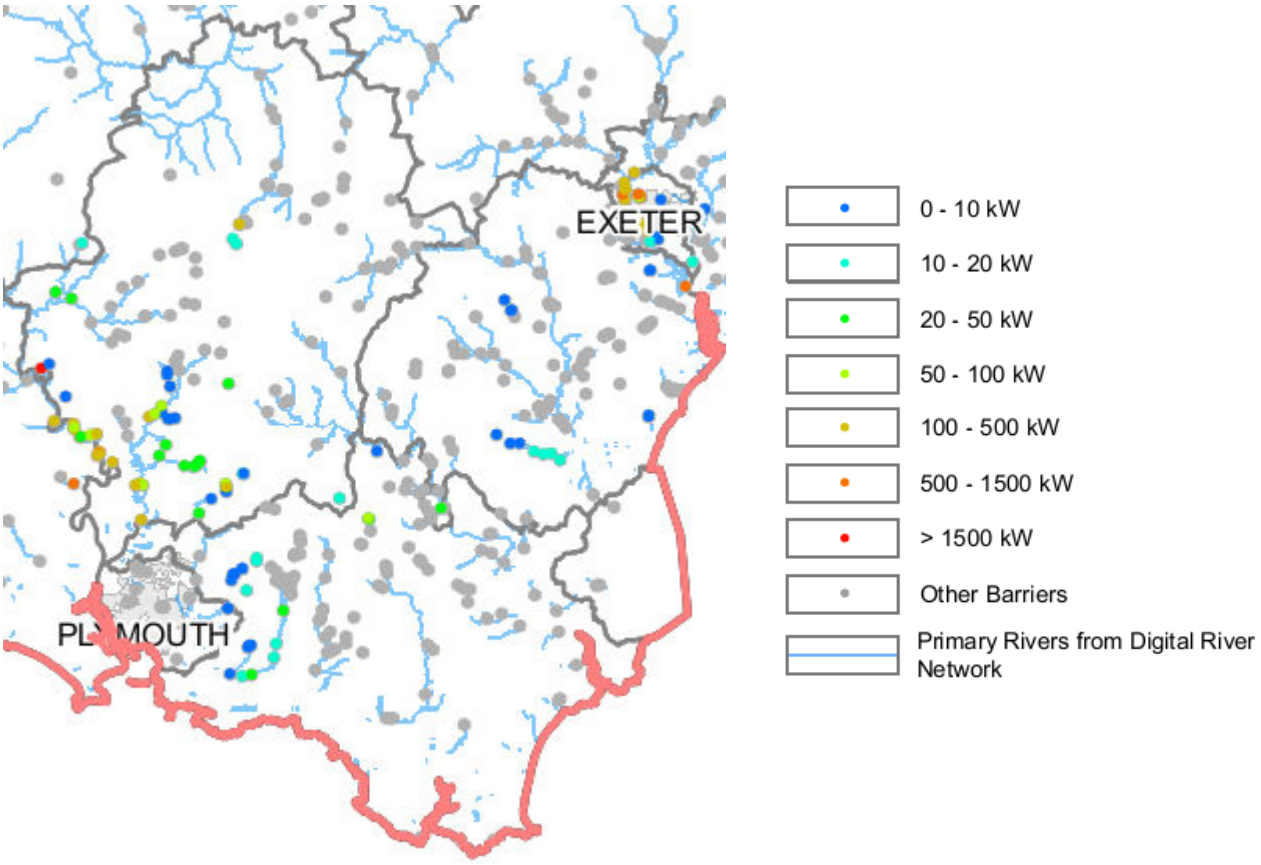


The sensitivity of each site is assessed. It can be seen that all sites in the area have a high sensitivity (red dots)



The sensitivity and generation potential are combined to identify potential sites

From the above exercise, a map was produced detailing potential win-win scenarios i.e. High/Medium Maximum Potential and in Heavily Modified Water Body. This is shown in below, and was taken forward to assess potential.



The sites were then taken and the lower boundary of each power band was taken as a basis for estimating power and energy generation. It was observed that many sites lay on the River Tamar, on the border with Cornwall. The DARE 2008 report identified one potential scheme on the Plym and discounted it on the basis that it would potentially be taken up in Cornwall. The same approach was taken forward for this study, though the EA study does point to a relatively large resource on the Tamar. From this exercise and cross referencing of RegenSW and DARE reporting, the following was established.

	Existing			**Potential additional**			**Total**		
	Number	**Capacity (MW)**	**Energy (GWh)**	**Number**	**Capacity (MW)**	**Energy (GWh)**	**Number**	**Capacity (MW)**	**Energy (GWh)**
South Hams	11	1	5.7	16	0.2	0.8	27	1	7
West Devon	6	4	16.2	40	1.2	5.6	46	5	22
Dartmoor	4	3	13.7	27	0.7	3.3	31	4	17
SW Devon Area	***17***	***5***	***22.0***	***58***	***1.4***	***6.5***	***75***	***6***	***28***

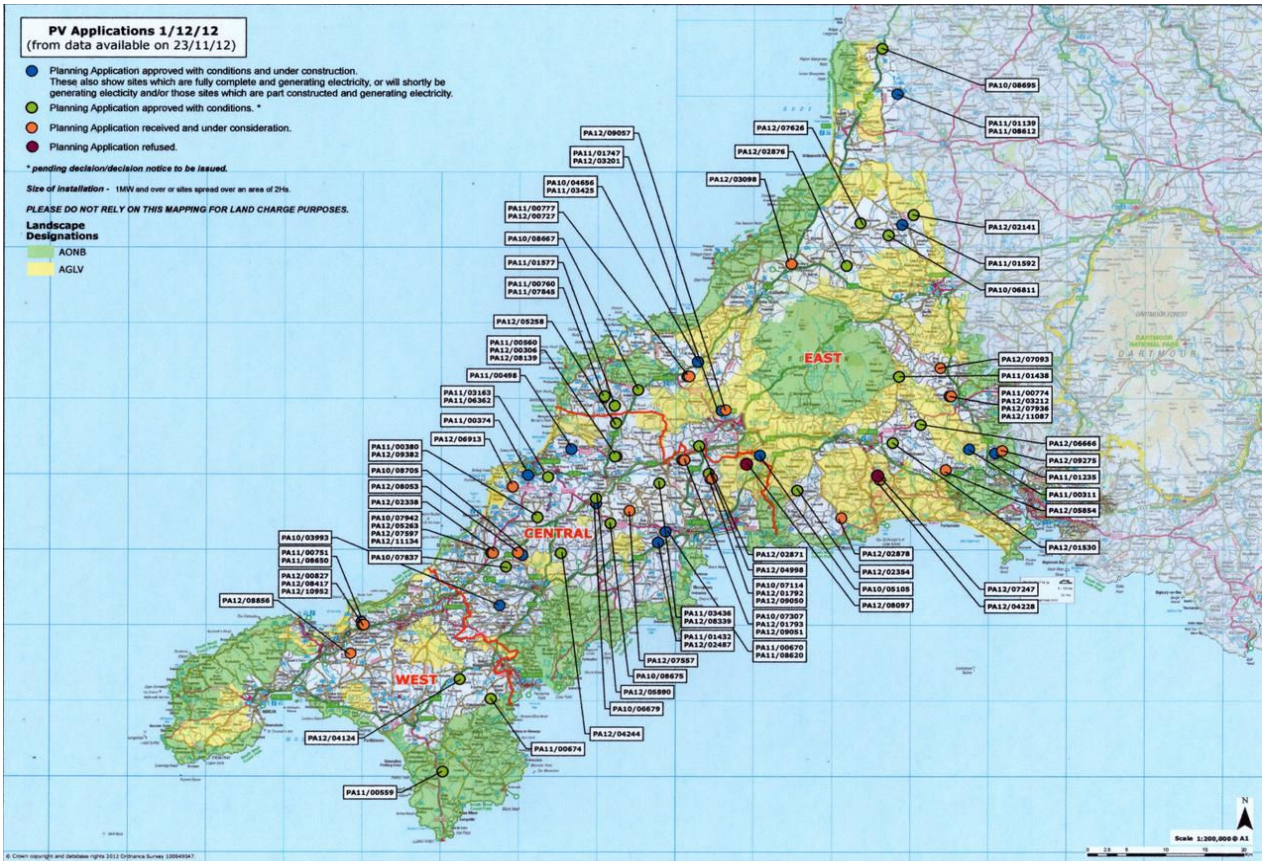
Note: does not sum due to overlapping areas of Dartmoor etc.

These numbers are of the same order of magnitude as the DARE studies, albeit slightly higher.

6.1.2. SOLAR PV

It is difficult to estimate the potential scope for large scale PV in an area. Cornwall Council are the most advanced administrative area in this regard, having experienced a surge in applications for PV at this scale due to a combination of high solar resource together with favourable financial incentives prior to the first review of the FIT scheme. We undertook an initial assessment of the potential for PV at this scale based on

the Cornish experience. A list of planning applications for large scale PV is shown in the map below. The sites are located in less sensitive areas with decent access to the electricity distribution network.



http://cornwallsolarfarms.files.wordpress.com/2012/12/img050.jpg

Cornwall Council has estimated the indication of the level of generation capacity within Cornwall[x]. The estimate (it is stated that this is not strictly a resource assessment) is based on the following assumptions:

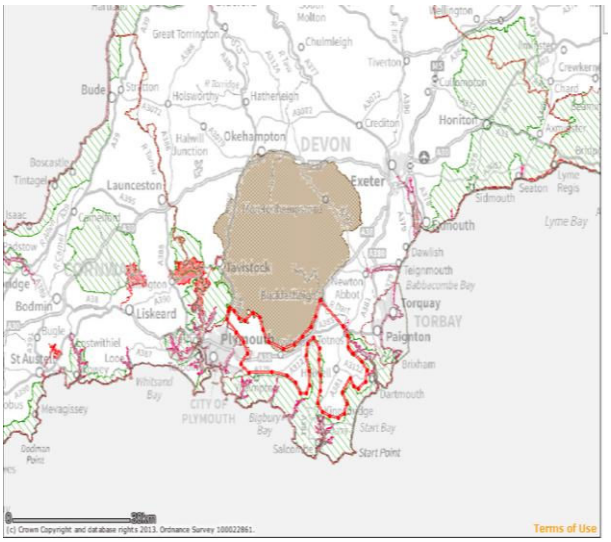
- Average size of PV farm of 4.2 MW (for reference, a 5 MW scheme occupies approximately 15 hectares)
- Annual generation of 3990 MWh (based on Truro)
- 32 sites across the county

We took these numbers to estimate the potential for SW Devon based on the following additional assumptions:

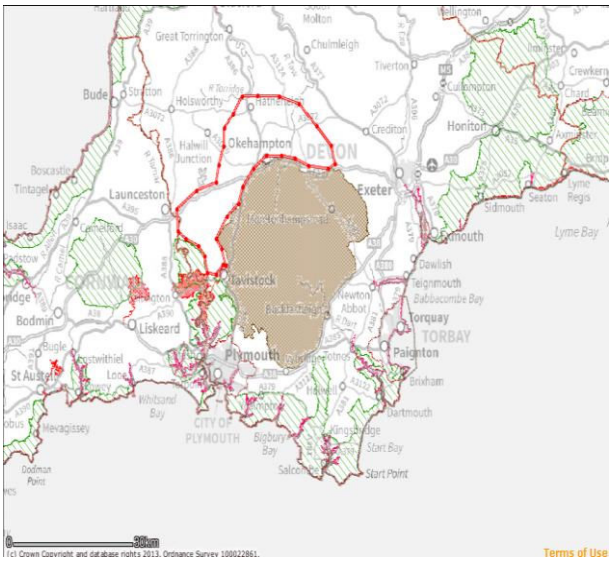
- The generation output was scaled down based on the estimated output for a site in the area (Tavistock) compared to Truro. This was based on an optimally oriented 1kWp system in Truro generating 1070 kWh/annum and 959 kWh/annum in Tavistock. This results in a scaling factor of 90%.
- It was assumed that no PV farms would be sited in sensitive areas such as National Parks, AONBs or World Heritage sites. The area of each of these designations was measured using the Defra Magic interactive mapping tool for potential regions within the study area (see images below) and for Cornwall as a whole.

[x] Technical Paper E2 An Assessment of the Renewable Energy Resource Potential in Cornwall, Cornwall Council January 2012

- The number of potential PV farms was then estimated for the study area on the assumption that they could be deployed in SW Devon on the same basis as in Cornwall. This assumes similar visual sensitivities across the region.



Area of South Hams not in National Park or AONB



Area of West Devon not in National Park or AONB

Source: Defra

From this, we estimate the potential to be:

	Number	Capacity (MW)	Energy (GWh)
South Hams	5	21	75
West Devon	7	29.4	105
Dartmoor	0	0	0
SW Devon Area	12	50	180

These numbers are speculative. For example, we note there is a planning application (0237/13/SCROP) for a 17 MW PV farm near Diptford in the South Hams – this would result in almost the entire South Hams resource as estimated here being met.

Proximity to a grid connection is a major consideration in the siting of a PV farm[xi]. Broad industry experience suggests a 1-3 MW installation would need to be within 4-5km of a 33 kV substation. A 4-5 MW scheme would need to be within 1-2 km of a 33 kV line. Inspection of the Western Power Distribution maps[xii] indicates that the 33 kV distribution network passes through the areas identified in the maps above. In addition, there are 17 33/132 kV substations in the study area, with only one of these (Mortenhampstead) being entirely within the national park.

Devon County Council has recently released draft guidance on the impact of wind and solar developments on the landscape[xiii]. Various constraints are considered regarding PV farms including Landform, Sense of openness/enclosure, Field pattern and scale, Land cover, Perceptual Qualities, Historic Landscape Character

[xi] RegenSW Planning for Solar Parks in the SW of England

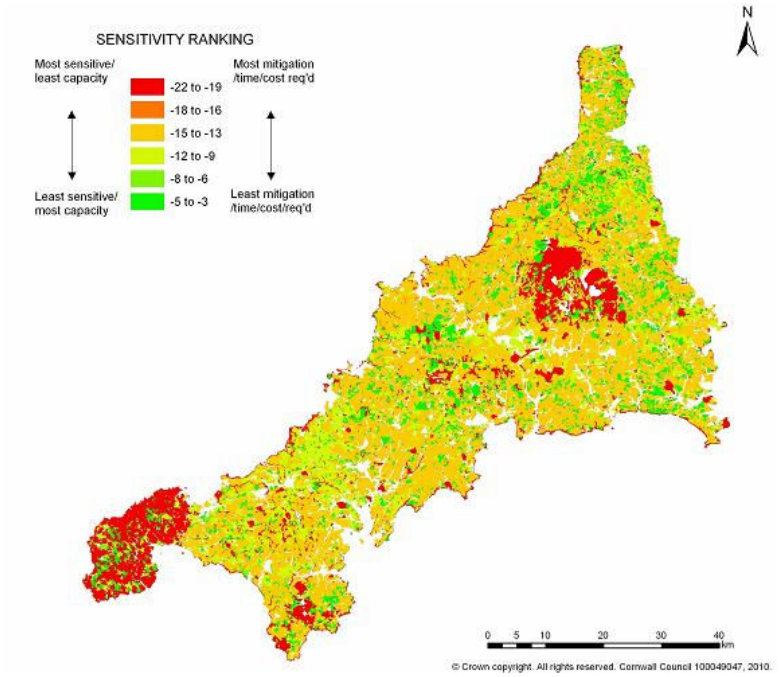
[xii] Long Term Development Statement for Western Power Distribution (South West) plc's Electricity Distribution System November 2009

[xiii] Devon Landscape Policy Group Advice Note No. 2 Accommodating Wind and Solar PV Developments in Devon's Landscape

and Scenic and Special Qualities. From this, it is likely that the following attributes would be required of potential sites:

- Outside of National Park or AONB
- Relatively flat (to reduce views onto site)
- Relatively enclosed i.e. surrounded by hedges or woods
- Large scale modern regular fields
- Arable or brownfield land
- Evidence or close-by to human activity e.g. Industrial areas or modern developments
- Avoidance of Historic landscape types such as park/garden, rough ground, ancient woodland, other woodland, marsh, dunes, mud, sand, outcrop/scree/ cliffs, water meadows, and orchards
- The consideration of the cumulative impact of multiple PV farms.

The study area is mostly covered by two National Character Area profiles – 150 Dartmoor and 151 South Devon. These give qualitative guidance on the landscape characteristics; though do not provide a spatial breakdown of sensitivity to PV farms. Cornwall Council has produced a sensitivity map for Cornwall to PV (see image below) - it would be helpful if such a resource was available for Devon. It was beyond the scope of this study to produce such a map though the numbers we have presented here give an idea of the potential magnitude within SW Devon.



Sensitivity Map to Solar Power in Cornwall (Source: Cornwall Council)

6.1.3. WIND TURBINES

Values for large scale wind were taken from the RegenSW annual survey (existing installations) and from an analysis undertaken by Wardell Armstrong[xiv] for potential capacity. The Wardell Armstrong analysis was based on the SQW methodology and considered constraints such as location within National Parks and AONBs as well as technical potential (wind speeds) and proximity to dwellings. The large scale wind is based on large 2.5 MW turbines. The specific siting of those turbines is not available, and a further exercise would be necessary to investigate issues such as land ownership etc.

[xiv] Wind Resource Assessment for the South West Following SQW energy Methodology, Wardell Armstrong, July 2010

	Existing			Potential Large Scale		
	Number	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)
South Hams	23	0.13	0.2	46	115	325
West Devon	13	0.061	0.1	175	437	966
Dartmoor	1	0.006	0.0	0	0	0
SW Devon Area	37	0.191	0.3	221	552	1291

An estimate was made for the potential of community scale wind turbines. This is not a resource assessment as such, but assumes that each of the following community groups installs a 225 kW turbine (400 MWh annual output) as at South Brent:

- Totnes: Transition Town Totnes
- Ivybridge: PL21
- South Brent: Sustainable South Brent
- Tavistock: Transition Tavistock
- Okehampton: Devon Heartlands
- North Tawton: North Tawton Environment Trust
- Dartmoor (inc. Moretonhampstead, Chagford, Buckfastleigh and Ashburton): Dartmoor Circle
- Dartmouth: Dartmouth Academy
- South Hams (inc. Kingsbridge): South Devon Coastal Renewable Energy Network
- Teign Valley: Greener Teign

	Potential community scale		
	Number	Capacity (MW)	Energy (GWh)
South Hams	6	1.4	2.4
West Devon	3	0.7	1.2
Dartmoor	3	0.7	1.2
SW Devon Area	10	2.3	4.0

It is interesting to note that the output from one large commercial scale turbine is 50% greater than all ten community scale turbines combined.

6.1.4. MARINE (TIDAL & WAVE)

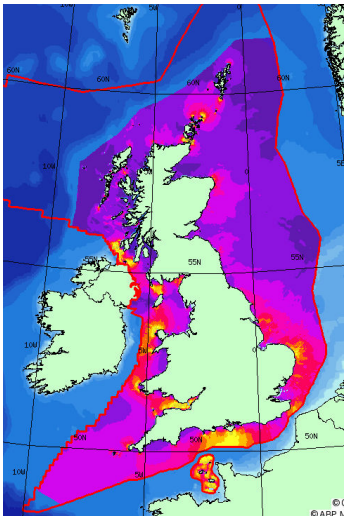
For the SW Devon study area, only South Hams has borders with the sea. The DARE assessment for renewable energy in South Devon provides an analysis of the potential of tidal lagoons, marine current turbines, and wave power.

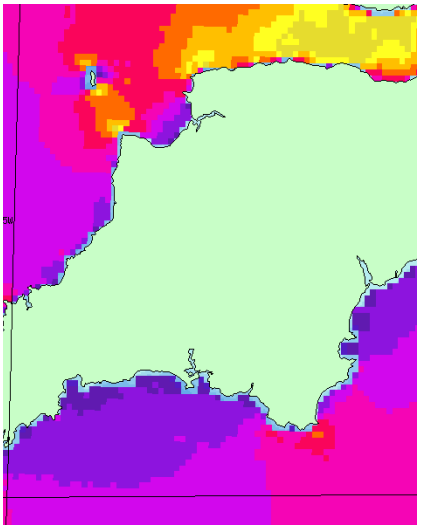
6.1.4.1. TIDAL LAGOONS

The DARE report identified a potential 64 kW turbine on the River Dart at Sharpham (nr. Totnes). It is stated this could produce 64 MWh annually. It stated that a Hydro engineering company had been employed to assess the potential energy capture at the site though no publically accessible evidence of this could be found. The DARE report could not identify costs or paybacks for such a scheme. It is also stated that *"there may be opportunities for additional tidal lagoons on the River Dart at Stoke Gabriel, River Erme at Clyng Mill and the River Yealm below Kitley"* although this is not quantified.

6.1.4.2. MARINE CURRENT TURBINES

The DARE report speculated on a potential Marine Current Turbine array at Start Point, and calculated that ten 51 kW turbines could generate 3,570 MWh/annum. It contrasted this to the larger test turbine at Lynton (North Devon) where the resource was richer. Since the DARE report, the Seaflow prototype turbine at Lynton has been decommissioned[xv]. The developers Marine Current Turbines Ltd have developed the turbine further into the SeaGen tidal energy converter, and are proposing schemes off Skye and Anglesea, where the resource is far greater. It does not seem credible that a significant marine tidal project will be viable off the South Hams coast, and so this technology was not taken further. The tidal resource nationally and locally are shown below[xvi].

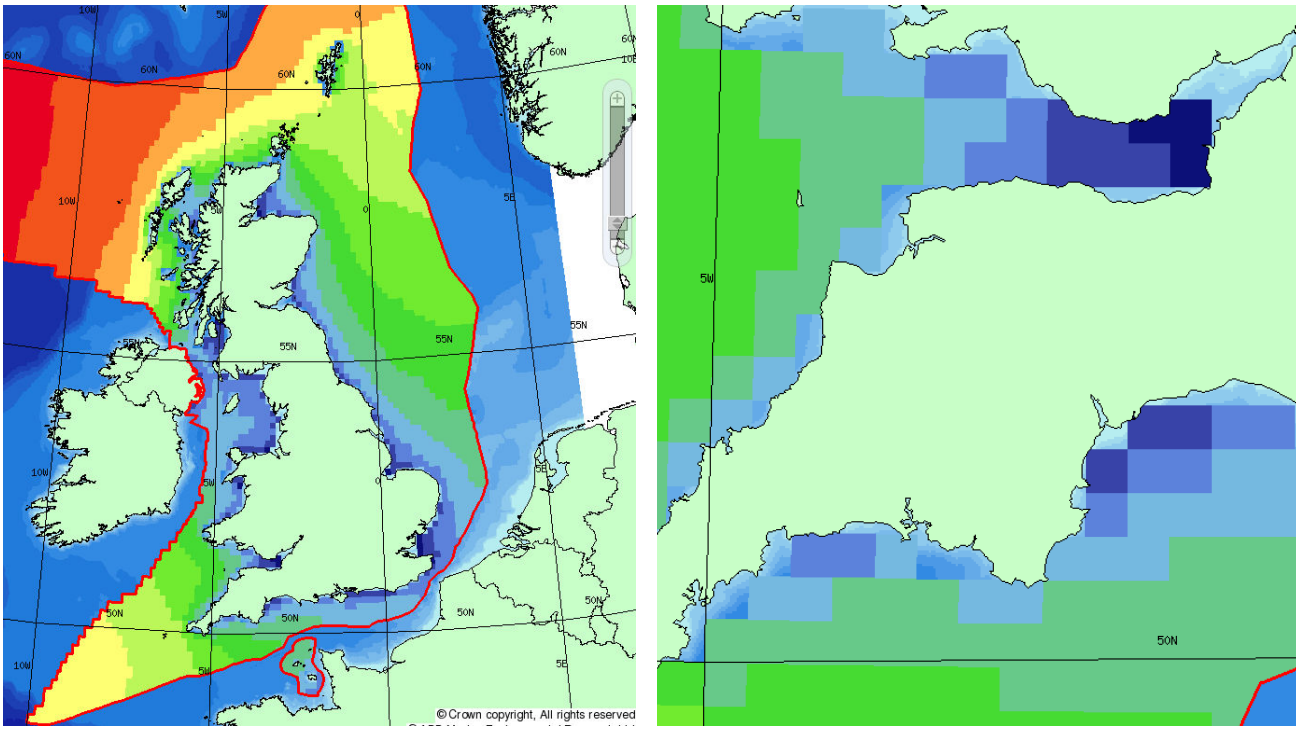




6.1.4.3. WAVE POWER

The wave power around the South Devon coast is constrained through being on Cornwall's shadow. The DARE report identifies wave powers in the region of 11-15 kW/m. It is estimated from Pelamis Wave Power, a leading manufacturer of wave power devices, that "any area with yearly averages of over 15kW per metre has the potential to generate wave energy at competitive prices"[xvii]. All of Pelamis's projects lie around the north coast of Scotland where wave powers are significantly higher (see images below). The Wave Hub scheme in Cornwall is a test-bed for wave technologies, and is located 16 km off the coast of Hayle, West Cornwall. A similar scheme would need to extend significantly further to begin to access a similar wave resource. It is recommended that this technology is not taken further in light of a lack of resource. Should the technology mature, and following lessons from the Scottish projects, then it could be an option in the much longer term. It is expected that at present, there would be many more projects with a higher priority.

[xv] http://www.thisisnorthdevon.co.uk/Wave-goodbye-marine-turbine/story-12156055-detail/story.html
[xvi] http://www.renewables-atlas.info/
[xvii] http://www.pelamiswave.com/global-resource



6.1.5. BIOMASS RESOURCE

A high level estimate of biomass resource and potential energy generation was made for the study area. This was based on a disaggregated resource assessment for the South West by the Environment Agency which estimated the biomass (forestry, wood, agricultural, organic waste) resource by district. The total naturally available resource is shown in the table below.

	Forestry (GWh)	Wood Waste (GWh)						Total wood resource (GHw)	Agricultural Waste (GWh)				Organic Waste (GWh)			Organic Waste total	Total
		Clean wood waste			Treated wood waste												
		Arboriculture	Industry &	Sub-total	MSW	Demolition	Sub-total		Beef	Dairy	Pigs	Poultry	MSW	Industrial	Commerci		
South Hams	59	3	9	11	13	5	18	89	1	12	1	1	6	0	1	22	110
West Devon	87	1	5	6	7	3	10	103	2	9	1	0	3	6	0	22	125
Dartmoor	76	0	0	0	5	0	5	81	0	0	0	0	3	0	0	3	84
Total	185	4	13	17	22	8	30	233	3	21	2	2	11	6	1	45	277

These values were compared with estimates from other resource assessments in the area. Work by the Dartmoor Circle quantified potential forestry resource on Dartmoor. A similar exercise was undertaken to the Dartmoor Circle work using their assumptions and taking the area of forest from the recent Dartmoor Landscape Character Assessment. In short, the area of woodland of various types was converted into potential resource and energy output based on a series of assumptions (in associated spreadsheet). The following additional assumptions were made in the creation of the above table:

- It was assumed that the forestry resource in Teignbridge could be apportioned on an area basis to the Dartmoor element of Teignbridge. In other words, approximately 38% of Teignbridge lies in

Dartmoor and so the Teignbridge forestry resource (odt) was scaled by 38% to establish a "Teignbridge in Dartmoor" value which was used to ensure the total for the SW Devon area could be established.

- The Dartmoor Circle study assumed that 20% of natural resource could be exploited – this factor was not applied here.
- Assumed no arboriculture or industrial wood arisings in Dartmoor
- MSW in Dartmoor area apportioned from the three districts on a population apportionment basis
- Assume no agriculture waste in Dartmoor as unlikely intensity of farming is conducive to AD etc.
- Assume no industrial or commercial organic waste in Dartmoor

This potential resource could be deployed in a number of ways. A high level estimate was made of the potential heat and electricity use for the resource.

6.1.5.1. CLEAN WOOD

An assessment was made based on the identified "clean wood" resource from the above source. The results were as follows:

	Capacity (MW)	Energy (GWh)
South Hams	34	60
West Devon	45	80
Dartmoor	37	64
Total	***98***	***172***

** Assume all clean wood (forestry + arboriculture) is used as wood chip or pellet in biomass boilers with 85% efficiency at 20% load factor.*

An estimate was then made of the resource from hedges in the area based very loosely on work from the Cordiale project[xviii]. Key assumptions made were:

- The total length of hedges in Devon is 53,000 kilometres which was apportioned to the study area based on an area weighted basis of "greenspace" (taken from Neighbourhood Statistics)
- It was assumed that of this there is the potential to harvest 50% (the remainder being excluded for biodiversity or accessibility reasons)
- Whilst energy yield is highly sensitive to the composition of the hedge, it was assumed that 200m of hedge is required each year to provide 30,000 kWh of heat to a farmhouse over a 15 year rotation period i.e. effectively 10 kWh/m based on 30,000 kWh and 3 km (200 m x 15 years).
- Boiler efficiency and loading as stated above for clean wood.

The results for hedge resource were as follows:

Hedge Resource	Available Resource (km)	Capacity (MW)	Energy (GWh)
South Hams	3564	17	30
West Devon	4809	23	41
Dartmoor	4084	20	35
Total	***9466***	***46***	***80***

[xviii] http://www.cordialeproject.eu/en/resources/download

The total clean wood resource was therefore:

Clean Wood	Capacity (MW)	Energy (GWh)
South Hams	69	90
West Devon	92	120
Dartmoor	76	99
Total	***190***	***253***

6.1.5.2. TREATED WOOD

	Capacity (MWth)	Capacity (MWe)	Heat (GWh)	Electricity(GWh)	Total (GWh)
South Hams	1	0	7	4	11
West Devon	0	0	4	2	6
Dartmoor	0	0	2	1	3
Total	***2***	***1***	***12***	***6***	***18***

** Treated wood assumed all MSW and demolition, assumed to fuel WID compliant biomass CHP plant. Energy conversion is assumed at 5.3 MWh per odt with 20% electrical conversion and 2:1 heat to power ratio. Capacity is derived using a 90% load factor.*

6.1.5.3. WET BIOMASS

	Capacity (MWth)	Capacity (MWe)	Heat (GWh)	Electricity (GWh)	Total (GWh)
South Hams	1	1	5	4	10
West Devon	1	1	5	4	10
Dartmoor	0	0	1	1	1
Total	***1***	***1***	11	9	***20***

** Energy conversion assumes methane yields indicated with methane (9.4 kW/ m3) being used in gas CHP engines with an electrical conversion of 20% and a heat to power ratio of 1.2:1. Capacity is derived using a 90% load factor.*

6.1.5.4. BIOFUELS

The Dartmoor Circle discusses the use of land for production of biofuels. It is stated that in terms of hierarchy, food or wood fuel production would take precedence. DARE also state *"Initiatives to grow energy crops for bioethanol and biodiesel production should not be supported at this time, with the possible exception of using land that is unsuitable for growing food crops or woodfuel energy crops."* Biofuel potential was not considered further within this study.

6.1.5.5. ENERGY CROPS

DARE have undertaken analysis of potential for energy crops in the area in their two resource assessments. They state there is the potential for 124 GWh in South Devon. There would be a preference for miscanthus as opposed to short rotation coppice (SRC) as it has higher yields and does not require specialist farm machinery. DARE also discuss the potential conflict between using land for energy crops compared to other uses, and demonstrate that the yields (kWh/ha) are very low compared to alternative forms of

renewable energy (e.g. PV or wind). It is recommended that whilst there is a technical potential for energy crops within the study area, that they are excluded from the mix of energy supply options.

6.1.6. RESIDUAL WASTE

The previous section assumed that organic waste and wood waste have already been utilised separately. A quick assessment was undertaken on the basis that the remaining waste from MSW and Commercial and Industrial were utilised in an advanced thermal treatment plant. The reality is that such a facility may not be in SW Devon itself, but to a larger facility within Devon. The estimate was made by apportioning the waste and potential renewable energy from that waste if threated in an ATT plant with an assumed load factor of 95% on a pro-rata population basis. The potential resource was estimated to be as follows:

Non-Organic Waste	**Capacity (MWth)**	**Heat (GWh)**
South Hams	3.0	25.4
West Devon	1.9	16.1
Dartmoor	1.4	11.6
Total	***5.5***	***46.3***

6.1.7. GEOTHERMAL

Several sources were consulted to establish the potential for geothermal energy. The following statements were found:

Geothermal (hot rocks) energy – apart from certain known areas e.g. Cornwall, this resource is currently thought to be minimal in the UK

Teignbridge Renewable Energy Study, CSE

Geothermal energy is not likely to be a source of renewable energy on Dartmoor within the period of this plan.

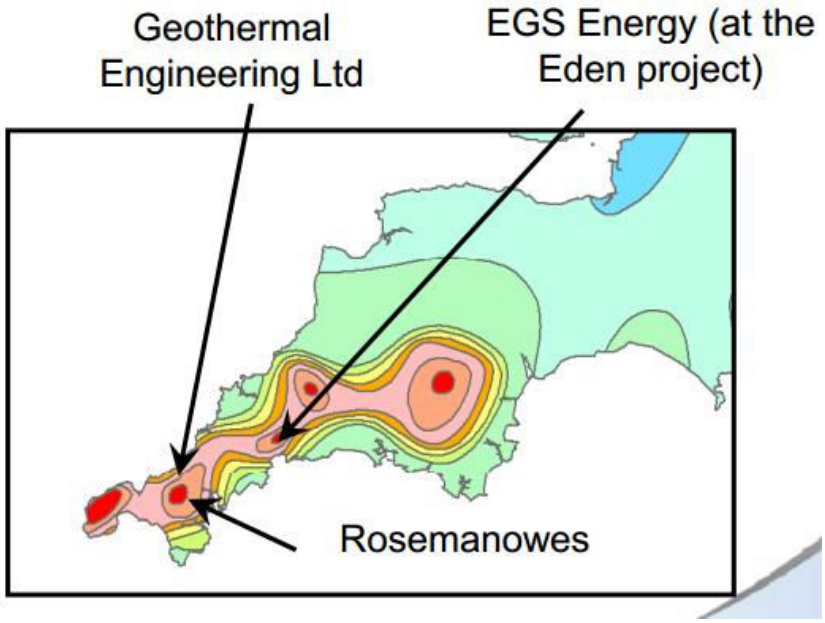
One Planet Dartmoor: Dartmoor Low Carbon Strategy

There is only one geothermal power plant in operation in the UK

www.therenewableenergycentre.co.uk

We did identify a resource map for geothermal ("hot rock") potential, and it appears that there is a potential resource that is of similar magnitude to the experimental scheme undertaken in Rosemanowes, Cornwall in the 1980s and two other schemes currently in development[xix].

[xix] http://www.groundwateruk.org/downloads/4%20Busby.pdf



There are two local precedent schemes that could be relevant to the resource in the study area. Both are in Cornwall.

1. The United Downs project, Redruth by Geothermal Engineering Ltd[xx]. The scheme comprises three 4.5 km deep wells and would generate 55 MW of heat and 10 MW of electricity. The plant is estimated to cost £40 million, with £1.5 million of funding secured from DECC[xxi].
2. Eden Project Scheme[xxii]. The scheme comprises two boreholes 25 cm wide to a depth of 4.5 km[xxiii]. It should produce 4 megawatts of electricity. Drilling began in 2011 with electricity being produced from the second half of 2013.

We undertook calculations based on the above schemes. From United Downs project: Based on a total energy generation of 65 MW, an assumed CHP efficiency of 80% the overall energy output from the scheme would be 81.25 MW. If we assume that if it were used for electricity only then a system efficiency of 25% could be achieved, this would mean an electricity only output of approximately 20 MW. Assuming that the plant would operate continuously, with an assumed 5% shut-down annually, then annual electricity generation could be 170 GWh. If we assume a similar cost of £40 million (assume that majority of cost is in the drilling of boreholes), then such a scheme could cost £237,000/GWh. By comparison, large scale wind costs approximately £1,000,000/MW. Assuming 2.5 MW turbines and capacity factors of 25%, a wind farm sized to produce the same amount of electricity annually would comprise approximately 31 turbines and cost £77,000,000 (~£450,000/GWh). The Eden scheme at 4 MW is a fifth the size of the United Downs project, and so based on similar assumptions could generate 33 GWh of electricity.

If a similar scheme were to be developed on Dartmoor, then the following barriers would need to be overcome:

- As there is a lack of commercially viable local demand for the heat, the resource would need to be exploited to produce electricity using steam turbines in a power station.

[xx] http://en.wikipedia.org/wiki/Geothermal_Engineering_Ltd.
[xxi] http://news.bbc.co.uk/1/hi/england/cornwall/8425272.stm
[xxii] http://www.bbc.co.uk/news/uk-england-cornwall-12026753
[xxiii] http://www.edenproject.com/support-us/future-plans/eden-deep-geothermal-energy

- Such schemes are pioneering within the UK and so are expensive and could be heavily influenced by financial incentives.
- Consideration would need to be paid to potential environmental impacts.
- Planning is likely to be a major barrier as there would likely be visual impact and local objections. By comparison, the two Cornish projects are on far less sensitive sites. Inspection of the planning documents for the Eden Project 4 MW facility indicates buildings of up to 10 m high. In addition, the temporary drilling rig would result in a visual impact (illustration based on Eden shown below). The Eden project estimates it takes 16 weeks of continuous drilling per well.

Image: Dashed line indicates location of temporary drilling rig.

To summarise:

- Geothermal electricity generation is often discounted in resource assessments, and there are few examples of commercially viable schemes.— a deep saline aquifer scheme in Southampton is a notable exception.
- There is potentially a resource on Dartmoor. There are two live schemes in Cornwall that are exploiting a similar level of potential.
- Initial calculations show that based on the Cornish schemes, a plant with capacity in the range of 4-20 MW could generate 33-169 GWh of electricity annually.
- Based on calculations of the larger scheme, it is estimated that the cost could be half that of a commercial scale wind farm, though there is far more certainty on the cost of wind and so there is large risk associated with the estimate of geothermal cost.
- There are likely to be huge planning barriers to bringing forward such a scheme on Dartmoor. For reference, the large scheme is similar in annual output to about 31 commercial scale turbines.
- It has been suggested that there may be potential to site a facility at Lee Mill in Ivybridge which would be considerably simpler from a planning perceptive, though the resource at that site would need to be assessed – it appears from the raw resource map that the energy density is lower there than at the Cornish sites.
- **It is recommended that the success of the Cornish schemes is monitored, and the potential for geothermal electricity on Dartmoor reviewed in the medium term.**

6.2. BUILDING SCALE

6.2.1. SOLAR PV

An estimate for the potential for roof mounted PV has been undertaken. We have followed the Government's SQW methodology as was used in AEA's assessment of Microgeneration in the South West. The assumptions used in the calculations were as follows:

- Total homes taken from 2011 census data. Dartmoor was calculated based on % of postcodes within each LSOA within the national park as determined using a GIS exercise

- Number of non-domestic buildings were estimated based on number of local registered VAT businesses. It was assumed that businesses in the "production" sector were classed as industrial, with the remainder being commercial.
- Domestic installations were assumed to be 2 kWp and achievable on 25% of all dwellings (including flats).
- Commercial installations were assumed to be 5 kWp and achievable on 40% of all commercial buildings (see above)
- Industrial installations were assumed to be 10 kWp and achievable on 80% of all industrial buildings.
- Domestic PV was assumed to be installed on 50% of new homes. The number of new homes was estimated from the Core strategies of the three planning authorities in the study area to 2026.
- Every primary school was assumed to be capable of installing a 10 kWp system.
- Every secondary school was assumed to be capable of installing a 20 kWp system.
- Every public sector building over 1000 m^2 was assumed to be capable of installing a 20 kWp system.
- PV output was assumed to be 959 kWh/kWp as calculated using PVGIS for an optimally oriented panel located in Tavistock.

The results are shown in the table below.

	Domestic			Commercial			Industrial			Public			Total		
	Number	Capacity (kW)	Energy (GWh)	Number	Capacity (kW)	Energy (GWh)	Number	Capacity (kW)	Energy (GWh)	Number	Capacity (kW)	Energy (GWh)	Number	Capacity (kW)	Energy (GWh)
South Hams	10268	21	20	1580	8	8	268	3	3	45	1	1	12161	32	30
West Devon	7111	14	14	1044	5	5	128	1	1	40	0	0	8323	21	20
Dartmoor Total	3856	8	7	664	3	3	79	1	1	22	0	0	4620	12	12
SW Devon Area	***19250***	***39***	***37***	***2906***	***15***	***14***	***443***	***4***	***4***	***98***	***1***	***1***	***22696***	***59***	***56***

The Regen annual survey states that current installed capacity for PV is as follows:

District	Number	Capacity (MW)	% of potential
South Hams	1679	11	33.8%
West Devon	684	2	11.3%

The current installed capacity is significantly higher in South Hams than in West Devon. The average installed power per installation is also higher in South Hams (6.4 kW) compared to West Devon (3.5 kW) indicating that there are larger installations in South Hams, for example those larger than roof mounted scale.

6.2.2. WIND TURBINES

Two sources of information were consulted to analyse the potential for small scale wind. The first of these was the Wardell Armstrong report. This was based on EVERY building being capable of hosting a 6 kW turbine with constraints then added such that reductions in wind speed and terrain designation discounted situations where wind speed drops below 4.5 m/s. This resulted in a very large number of turbines. It was suggested the analysis could be refined further by the omission of homes with a Council Tax band of A, and limiting installations to 1 within any 50m radius. That analysis was not possible to undertake here.

We also investigated an EST and Met Office analysis into the technical potential of small scale wind. This detailed investigation assessed the potential resource based on landscape designation across the UK. We took that analysis and applied the numbers using the following approach:

- The total potential generation from small wind was established to be 41.3 TWh maximum. This assumed that electricity prices increased to over £1/kWh.
- The split of urban to rural was taken from their figures (3381% rural, 19% urban)
- This was pro-rata to obtain a value for England based on UK 2010 ONS population estimates. England is 84% of UK. This was applied to the total generation to obtain 34.6 TWh for England. This is likely an over-estimate as England is more urban than Scotland and Wales.
- Populations from key Devon towns was taken from DCC. These were assumed to be "urban". From these, the fraction of urban and rural within the study area was estimated.
- The total generated energy for England was then pro-ratad to the study area based on known national splits of rural to urban[xxiv]
- From this, the capacity and number of turbines could be estimated based on assumptions made in the Met office report, namely:
    - Capacity factor for rural turbine taken to be 15-20% i.e. 17.5%
    - Capacity factor for urban taken to be 10%
    - Size rural taken as 6 kW pole mounted (study based on 2.5, 6 and 15 kW)
    - Size urban turbines taken as 1.5 kW roof mounted (study based on 1, 1.5 and 2.4 kW)

It should be noted that these numbers are very high. Assuming 2.2 people per household, on average this would result in a turbine on approximately half of all homes in the study area. It is very likely that this number is far too high. A further analysis would be required as suggested by Wardell Armstrong, to limit turbines to say, one per 50m radius. This was beyond the scope of this study.

	Rural				Urban				Total		
	Assumed size (kW)	Number	Capacity (MW)	Energy (GWh)	Assumed size (kW)	Number	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)
South Hams	6	17257	104	159	1.5	3841	6	5	21098	109	164
West Devon	6	11066	66	102	1.5	2386	4	3	13452	70	105
Dartmoor	6	9475	57	87	1.5	1169	2	2	10644	59	89
Dartmoor & Teignbridge	6	2091	13	19	1.5	1169	2	2	3260	14	21
SW Devon Area	***6***	***30414***	***182***	***280***	***1.5***	***7397***	***11***	***10***	***37810***	***194***	***289***

6.2.3. SOLAR HOT WATER

The potential for solar hot water was estimated using the same methodology as was used for roof mounted PV. The main assumptions used in the calculation were as follows:

- Total homes taken from 2011 census data. Dartmoor was calculated based on % of postcodes within each LSOA within the national park as determined using a GIS exercise
- Number of non-domestic buildings were estimated based on number of local registered VAT businesses. It was assumed that businesses in the "production" sector were classed as industrial, with the remainder being commercial.

[xxiv] ONS Regional Trends 43 2010/11 Rural and urban areas: comparing lives using rural/urban classifications

- Domestic installations were assumed to be 2 kWp and achievable on 25% of all dwellings (including flats).
- It was assumed that this technology was not suitable for commercial buildings.
- Domestic installations were assumed to be 10 kWp and achievable on 80% of all industrial buildings.
- A load factor of 8% was assumed. This was taken from an AEA Technologies technical report on heat technologies (2010).

The results are shown in the table below.

SWH	Domestic			Industrial			Total		
	Number	Capacity (kW)	Energy (GWh)	Number	Capacity (kW)	Energy (GWh)	Number	Capacity (kW)	Energy (GWh)
South Hams	9215	18	13	268	3	2	9483	21	15
West Devon	5681	11	8	128	1	1	5809	13	9
Dartmoor Total	3531	7	5	79	1	1	3610	8	5
SW Devon Area	***16442***	***33***	***23***	***443***	***4***	***3***	***16884***	***37***	***26***

The Regen annual survey states that current installed capacity for SHW is as follows:

District	Number	Capacity (MW)	% of potential
South Hams	68	0.19	0.9%
West Devon	56	0.18	1.4%

6.2.4. BIOMASS HEATING

An assessment was made of the potential for biomass heating to buildings in the study area. Renewable heat can be provided to buildings using two broad solutions – wood fuel or electrically driven heat pumps. Previous resource assessments (e.g. AEA Microgeneration in the SW study) have looked at these technologies in isolation. For example, the total potential for heat pumps is very high if we assume that no biomass boilers will be installed. The approach we have taken here is to present a scenario which assumes a mix of these two approaches is implemented. The key methodology we took together with assumptions for biomass heating we took are as follows (many of the assumptions are modifications of those made by AEA in their resource analysis for the SW, and for analysis they undertook for DECC):

- An assessment of accessibility to the gas network and the mix of housing types was undertaken using a combination of data from CSE (% off gas grid by LSOA) and the 2011 Census (for house type).
- The total households in LSOA multiplied by off gas % to establish number of each house type off-gas. From this...
    - All off-gas detached and semi-detached houses assumed to have biomass boilers.
- 75% of homes with access to the gas network were assumed to have a renewable heat technology applied. Of these...
    - 50% of detached and semi-detached assumed to have biomass
- 75%, of all primary schools to have "public small" scale biomass boiler
- 100%, of all secondary schools to have "public large" scale boiler e.g. KEVICCS is heated by 400 kW chip boiler (50% of needs)

- 100%, of all public sector buildings over 1000m^2 to have "public large" scale biomass boiler. These buildings were identified from CSE published register of buildings with a Display Energy Certificate.
- 10%, of all industrial sites to have "industrial small" biomass boiler
- Domestic biomass boilers (assume pellet) were assumed to be 10 kW output with an efficiency of 85% and a load factor of 12.5%
- Commercial/public small biomass boilers (assume pellet) were assumed to be 145 kW output with an efficiency of 81% and a load factor of 20%
- Commercial/public large biomass boilers (assume chip) were assumed to be 975 kW output with an efficiency of 81% and a load factor of 32.5%
- Industrial small boilers (assume chip) were assumed to be 417.5 kW output with an efficiency of 81% and a load factor of 51%

From this method, the results for biomass boilers are as follows:

	Domestic			Industrial			Public Sector			Total		
	Number	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)
South Hams	15299	153	168	34	14	62	38	20	53	15371	187	283
West Devon	10885	109	119	16	7	30	32	10	26	10932	126	175
Dartmoor Total	7151	72	78	10	4	18	17	4	9	7178	80	106
SW Devon Area	***28947***	***289***	***317***	***55***	***23***	***103***	***80***	***33***	***86***	***29082***	***346***	***506***

6.2.5. HEAT PUMPS

As stated above, the estimate for heat pump potential is linked to the assumptions we have made for biomass heating uptake. Based on those, the following additional assumptions were made for heat pumps:

- All flats and shared houses were assumed to have 25% heat pump uptake. The remainder were assumed to be unsuitable.
- The total households in LSOA multiplied by off gas % to establish number of each house type off-gas. From this...
    - All off-gas terraced houses assumed to have heat pumps
- 75% of homes with access to the gas network were assumed to have a renewable heat technology applied. Of these...
    - 50% of detached and semi-detached assumed to have heat pumps
    - 50% of terraced houses assumed to have heat pumps
- 50% of new homes assumed to have heat pumps
- 10%, of all commercial hereditaments to have heat pump
- Heat pumps generally assumed to be Air Source
- Domestic heat pumps were assumed to be 10 kW output with an efficiency of 273% and a load factor of 13%
- Commercial/public small heat pumps (assume pellet) were assumed to be 55 kW output with an efficiency of 350% and a load factor of 35%

From this method, the results for heat pumps are as follows:

Heat Pump	Domestic			Commercial			Total		
	Number	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)	Number	Capacity (MW)	Energy (GWh)
South Hams	11597	116	132	395	22	67	11992	138	199
West Devon	6521	65	74	261	14	44	6782	80	118
Dartmoor Total	2763	28	31	166	9	28	2929	37	59
SW Devon Area	***19972***	***200***	***227***	***726***	***40***	***123***	***20699***	***240***	***350***

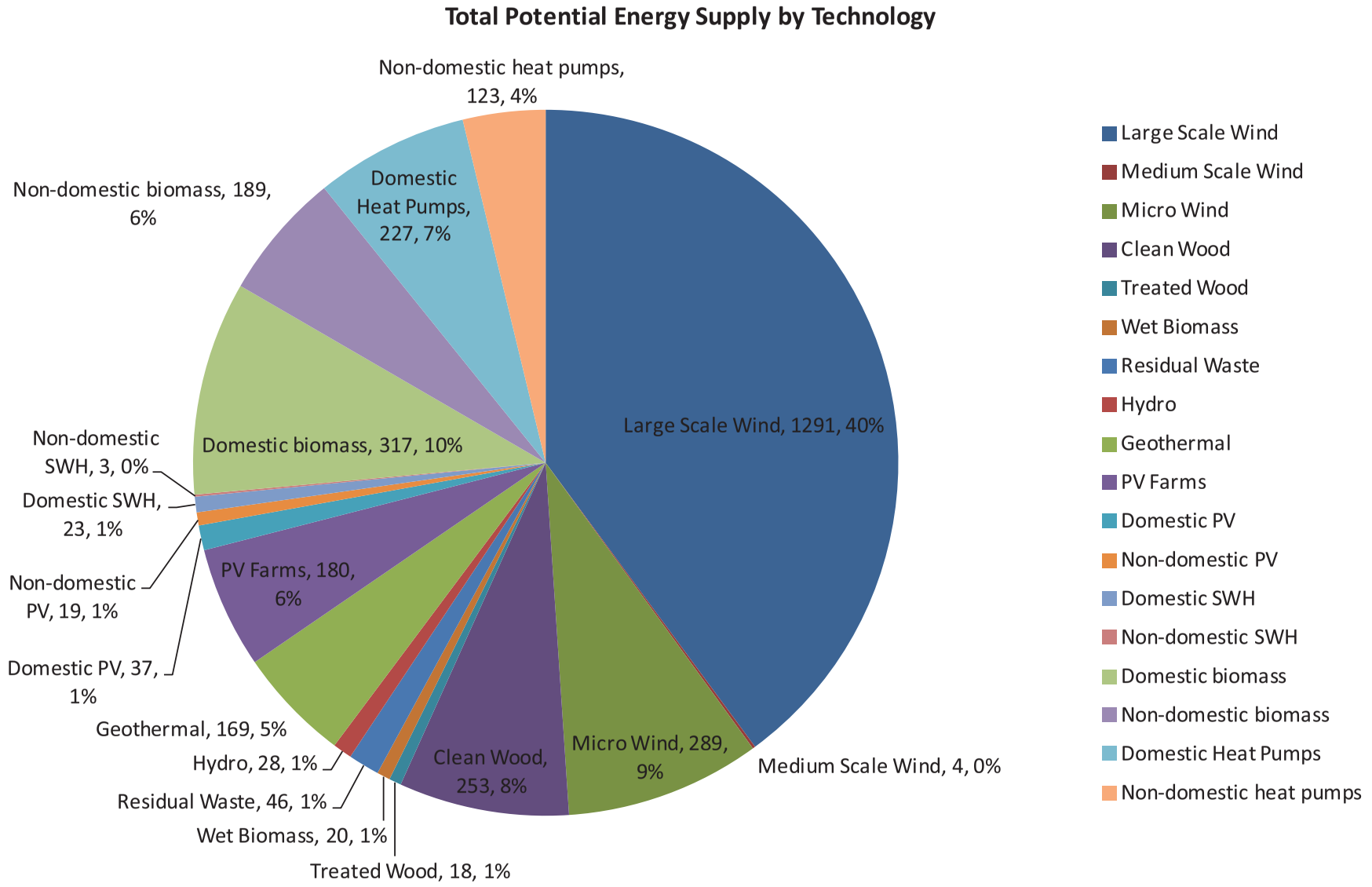
6.3. PLANNING

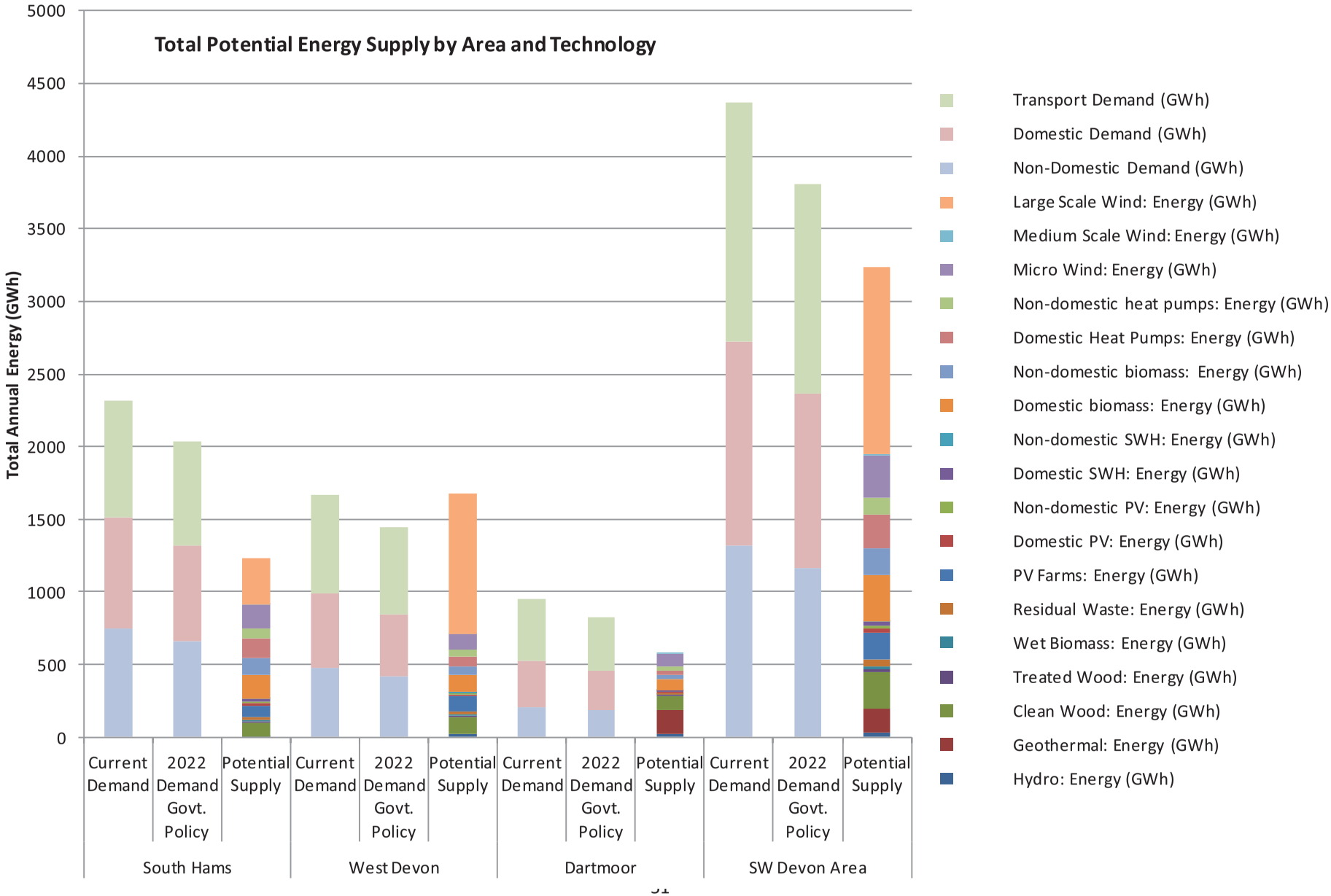
Specific guidance on planning regarding large wind and PV schemes is given in the new Devon and Landscape Policy Guidance
http://www.devon.gov.uk/index/environmentplanning/natural_environment/landscape/landscape-policy-guidance.htm

Guidance on planning in Dartmoor National Park is given in the Darmoor National Park Design Guide.
http://www.dartmoor-npa.gov.uk/__data/assets/pdf_file/0003/72696/14781_111109_Dartmoor-Design-Guide_Web.pdf

6.4. TOTAL POTENTIAL

The total energy generated by the various potential technologies assessed in the previous section is shown in the following two graphs.


Total Potential Energy Supply by Technology
Non-domestic heat pumps, 123, 4%
Domestic Heat Pumps, 227, 7%
Non-domestic biomass, 189, 6%
Domestic biomass, 317, 10%
Large Scale Wind, 1291, 40%
Non-domestic SWH, 3, 0%
Domestic SWH, 23, 1%
Non-domestic PV, 19, 1%
PV Farms, 180, 6%
Domestic PV, 37, 1%
Geothermal, 169, 5%
Hydro, 28, 1%
Residual Waste, 46, 1%
Wet Biomass, 20, 1%
Treated Wood, 18, 1%
Clean Wood, 253, 8%
Micro Wind, 289, 9%
Medium Scale Wind, 4, 0%
Large Scale Wind
Medium Scale Wind
Micro Wind
Clean Wood
Treated Wood
Wet Biomass
Residual Waste
Hydro
Geothermal
PV Farms
Domestic PV
Non-domestic PV
Domestic SWH
Non-domestic SWH
Domestic biomass
Non-domestic biomass
Domestic Heat Pumps
Non-domestic heat pumps


Total Potential Energy Supply by Area and Technology
Total Annual Energy (GWh)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Current Demand
2022 Demand Govt. Policy
Potential Supply
South Hams
West Devon
Dartmoor
SW Devon Area
Transport Demand (GWh)
Domestic Demand (GWh)
Non-Domestic Demand (GWh)
Large Scale Wind: Energy (GWh)
Medium Scale Wind: Energy (GWh)
Micro Wind: Energy (GWh)
Non-domestic heat pumps: Energy (GWh)
Domestic Heat Pumps: Energy (GWh)
Non-domestic biomass: Energy (GWh)
Domestic biomass: Energy (GWh)
Non-domestic SWH: Energy (GWh)
Domestic SWH: Energy (GWh)
Non-domestic PV: Energy (GWh)
Domestic PV: Energy (GWh)
PV Farms: Energy (GWh)
Residual Waste: Energy (GWh)
Wet Biomass: Energy (GWh)
Treated Wood: Energy (GWh)
Clean Wood: Energy (GWh)
Geothermal: Energy (GWh)
Hydro: Energy (GWh)

7. DATA SOURCE DIRECTORY

The table below lists key data sources which were used to establish the current and projected energy use in the study area.

Name	Notes	Link
DECC statistics	Key resource bank including national and sub-national energy, carbon and fuel poverty datasets. Domestic Electricity and Gas energy consumption 2008 to 2010 including ordinary and E7 consumption and number of meters. Domestic gas and electricity to LSOA level, others only to MSOA. Updated annually. Domestic Carbon Dioxide Emissions 2005-2010 including breakdown into electricity, gas and "other". Needs converting from CO2 to energy for this study. Updated annually though two years in arrears	https://www.gov.uk/government/organisations/department-of-energy-climate-change/about/statistics
DECC Interactive Maps	Ata at Local Authority level. Cavity and loft insulation, fuel poverty, domestic PV, gas and electricity consumption.	http://www.decc.gov.uk/en/content/cms/statistics/local_auth/interactive/interactive.aspx
Home Condition Surveys	For either/or council owned or RSL, or private sector.	Varies by Local Authority
Renewable Energy Progress Report: South West 2012 Annual Survey (RegenSW)	Annual report on installed renewable capacity in region, broken down by county.	http://regensw.s3.amazonaws.com/final_web_version_156da5ede9b529d2.pdf
Responsible Retro□t of Traditional Buildings, STBA 2012	Technical report on retrofitting traditional buildings including Green Deal overlaps	http://www.building.co.uk/Journals/2012/09/27/x/u/l/RESPONSIBLE-RETROFIt.pdf
Fuel Poverty Sub-regional statistics (DECC)	Fuel poverty statistics by LSOA for 2010.	http://www.decc.gov.uk/en/content/cms/statistics/fuelpov_stats/regional/regional.aspx
CSE Fuel Poverty Dataset	Fuel poverty and Hard to Treat information at LLSOA level.	http://www.cse.org.uk/pages/resources/open-data#Fuel_poverty_data
LSOAs qualifying for Carbon Saving Community Obligation (CSCo) support under the ECO element of the Green Deal.	Note: This revealed there are no areas within the South West Devon study area which qualify for CSCo	http://www.cse.org.uk/downloads/file/decc_eco_csco_data.xls
Excess Winter Deaths, ONS	By local authority area, annually. Most recent is 2010/11	http://data.gov.uk/dataset/excess_winter_deaths
Indices of Multiple	Data down to LLSOA. Most recent is	https://www.gov.uk/govern

Deprivation	2010 release though based mainly on 2008 data	ment/publications/english-indices-of-deprivation-2010
Neighbourhood Statistics	A range of information at ward or parish level taken from the national census and range of other sources	http://www.neighbourhood.statistics.gov.uk/
National Atmospheric Emissions Inventory	Breakdown of carbon dioxide emissions at a 1 x 1 km resolution nationally	http://naei.defra.gov.uk/
Planning Portal	Information on planning and building regulation in the UK	www.planningportal.gov.uk
The Microgeneration Certification Scheme	List of approved installers of renewable energy eligible for FIT and RHI.	http://www.microgenerationcertification.org/
Energy Saving Trust	Energy and carbon reduction information for the residential sector	www.energysavingtrust.org.uk/
EST Powering the Nation	Large scale study of domestic electricity consumption (2012)	http://www.energysavingtrust.org.uk/Organisations/Working-with-Energy-Saving-Trust/The-Big-Energy-Rethink/Our-research-Powering-the-nation
Carbon Trust	Energy and carbon reduction information for the non-domestic sector	www.carbontrust.co.uk
Enhanced Capital Allowances: Energy	List of technologies that qualify for tax relief through the ECA scheme for businesses.	http://etl.decc.gov.uk/etl
BRE Domestic Energy Factfile 2008	Detailed information on national housing stock trends back to 1970	http://www.bre.co.uk/filelibrary/pdf/rpts/Fact_File_2008.pdf
Wind Resource Assessment for the South West Following SQWenergy Methodology, Wardell Armstrong for Regen SW, 2010	Wind assessment of SW region, detail available by district	Detailed information not on website
Warwick Wind Trials	Detailed field measurement of performance of small scale wind	http://www.warwickwindtrials.org.uk/
Mapping Hydropower Opportunities and Sensitivities in England and Wales, Technical Report, Environment Agency, February 2010	SW resource assessment	
Hydropower Association assessment of the potential for hydro sites, 2012	Hydropower resource assessment.	http://www.british-hydro.org/hydro_in_the_uk/uk_hydro_resource/2010_england__wales_hydro_resource_study.html
Conversion Factors, Carbon Trust (2012)	Conversion factors for energy and carbon for energy and transport,	http://www.carbontrust.com/media/18223/ctl153_conver

	2012 version based on 2011 Defra data	sion_factors.pdf
Typical calorific values of fuels, Biomass Energy Centre	Net calorific values of different fuels.	http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,20041&_dad=portal&_schema=PORTAL
West Devon Borough Council Strategic Planning	Including local plan and core strategy	http://www.westdevon.gov.uk/doc.asp?doc=16175&CAT=2389
South Hams District Council Planning	Including local plan and core strategy	http://www.southhams.gov.uk/ksp-development_and_planning-forward.htm
Dartmoor National Park Authority Planning	Planning policy and guidance	http://www.dartmoor-npa.gov.uk/planning
English National Park Authority Climate Change Statement	Joint statement from all national parks on climate change	http://www.enpaa.org.uk/climate_change_statement
Dartmoor Circle Low Carbon Plan	Including baselining of Dartmoor and Covering a range of sectors including homes, business, transport and renewable energy	http://www.dartmoorcircle.org.uk/lowcarbonplan.html
North Devon Biosphere: Low Carbon Winkleigh Project	Low Carbon study for Winkleigh with main focus on domestic and transport. An example of follow up local projects which could be applied within the study area.	http://www.northdevonbiosphere.org.uk/assets/Resources/Documents/Research/Winkleigh-Carbon-plan-finalreportNDBR.pdf
Devon Landscape Policy and Guidance	Character assessments of different regions of Devon	http://www.devon.gov.uk/index/environmentplanning/natural_environment/landscape/landscape-policy-guidance.htm
Community energy - a manifesto, The Co-operative 2012	Manifesto on pathways to community owned renewable energy	http://www.co-operative.coop/Corporate/CSR/downloads/community_energy_manifesto_2012_the_co-operative.pdf
South Devon Renewable Energy Scoping Study, DARE	Resource Assessment for South Devon area (excluding the Dartmoor overlap but including a strip of coastline within the Plymouth and, Berry Head and Churston Ferrers both within Torbay)	http://transitionculture.org/wp-content/uploads/DARESDAONBFinalReport060424.pdf
West Devon Renewable Energy Potential Study, DARE 2008	Resource Assessment for West Devon including Dartmoor. Considers large scale only.	http://www.westdevon.gov.uk/upload/public/attachments/1000/Combined%20Study%20Document.pdf
Newton and Noss Environment Group Energy Audits, DARE 2010	Energy audits on six community buildings within Newton Ferrers and Noss Mayo in South Devon	
South Devon Coastal	Numerous individual building and	

Renewable Energy Network	site energy assessments	
South Brent Carbon Dioxide Report, 2008	Analysis of domestic and transport emissions from South Brent	
South Brent Community Energy Society, Community Share Offer	Details of share offer for 225 kW turbine in South Brent.	
Towards a Sustainable Kingsbridge: Carbon Reduction, An Action Plan for Kingsbridge, 2011	A carbon reduction plan for Kingsbridge	
Transition Tavistock Energy Savers Case Studies	14 case study buildings in the Tavistock area	
South Hams Private Sector House Condition Survey, 2010	Includes housing profiles and energy efficiency	
Economic Blueprint for Torbay and District	Exploration of potential for retrofit and renewable energy, including strong emphasis on economic benefits	
Evaluation of solid-wall insulation in fuel poor households in the private sector, CSE 2011		https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CDIQFjAA&url=http%3A%2F%2Fwww.cse.org.uk%2Fdownloads%2Ffile%2Fsolid-wall_insulation_in_fuel_poor_households_in_the_private_sector.pdf&ei=gHACUY_rF8yX0QX8tIHgCA&usg=AFQjCNE3IlL9A--4OM2T48n3xNVSTB66KQ&bvm=bv.41524429,d.d2k
Responsible retrofit of Traditional Buildings, STBA 2012	Technical report on retrofitting traditional properties	http://www.spab.org.uk/downloads/STBA%20RESPONSIBLE-RETROFIT.pdf
Co-operative renewable energy in the UK A guide to this growing sector, The Co-operative 2012	Examples of implemented projects and business models	https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&ved=0CFAQFjAB&url=http%3A%2F%2Fwww.uk.coop%2Fsites%2Fdefault%2Ffiles%2Frenewableenergy_0_0.pdf&ei=rHECUeXhM6nW0QWikYCoDg&usg=AFQjCNHyvp69_RfLesHzf0txolmKGHyldQ&bvm=bv.41524429,d.d2k
The Power Book, LGU 2012	Essays on community energy efficiency and power projects	
A Review of Renewable Energy Resource Assessment and Targets for	Resource assessment for Devon county, in some instances broken down by district.	

Devon, University of Exeter, South West Energy and the Environment Group ID 772, 2011		
South Hams Interactive Mapping		http://mapping.southhams.gov.uk/shdcwebmappingnew/map.aspx