APPENDIX 1

ENERGY DEMAND ASSESSMENT METHODOLOGY

Residential Heat Mapping Methodology

1. All residential properties within the Herefordshire county boundary were mapped using the supplied Local Land & Property Gazetteer (Live Extract) data set (LLPG).

2. Investigation of this data showed there were 83,080 records in total. Of these some 62,000 were sub classified by the type of property they referred to. This descriptor was then used to ascribe a typical heat consumption (based on space heating and hot water bench marks that closest resembled the particular property type – see Table A1.1 below for benchmark allocation).

Table A1.1: Residential Type Matching

Code Point Tertiary Description	Heat Consumption Benchmark Allocation
Caravan	Top floor flat
Flats	Top floor flat
Terrace	Mid/end terrace
Semi detached	Semi-detached
Detached	Detached
Care Homes	Top floor flat
Educational Residences (Halls)	Top floor flat
Bungalow	Detached

3. This left some 18,000 properties remaining unclassified in the supplied data. In order to properly assess domestic heat demand densities across the region it was necessary to allocate a classification to these properties. This was implemented based on geographical proximity to neighbouring LLPG data points. It was noted that flats within a block tended to be displayed on a coincident geographical point. The data set was queried to identify unclassified points centred on a common location and these were ascribed the status of “top floor flats”. Terraces were nominally defined as having neighbouring non-coincident LLPG data points within 4m proximity. Semi-detached properties were defined as having at least one neighbouring LLPG data point within a distance of 4m-13m and any properties with no neighbours within 13m were classified as detached. While this approach can never be 100% accurate, sample visual inspections of the resulting allocations superimposed on to aerial photography suggests a fairly high degree of correlation. On this basis the newly classified points were amalgamated back into the primary residential dataset.

4. Once each of the properties in the dataset had been classified into a nominal benchmark type, its category was used to attribute a kWh/year heat consumption value based on the appropriate space heating and domestic hot water (DHW) benchmarks. It should be noted that the benchmark figures differentiate between 'mid' and 'end' terrace energy consumptions. To account for this in the heat mapping it has been assumed that an average terrace consists of 8 individual properties i.e. two end terrace properties and six mid terrace properties. An average terrace value based on a 25%/75% end/mid split has been applied to all terraced properties.

5. The same classification was used to assign an electrical demand to each household based upon cooking, lighting and appliance benchmarks.

6. It has been necessary to assume that the cooking contribution is based on electrical consumption while the space heating and hot water contribution is based on heat. This assumption is clearly not strictly correct as those on the gas grid will quite likely use gas for cooking and there will be many instances of night storage and immersion heaters providing heat. However, in the absence of a detailed breakdown of individual properties fuel sources this approximation is the best available.

7. To calculate CO_2 emissions the average DEFRA[1] figure of 0.542kg/kWh was applied to the calculated electricity consumption figures for each dwelling, assuming generation to come from the national grid through a typical mix of generation. For space heating it is more complex as it is not clear which dwellings are on the gas grid nor whether those that are off the gas grid use oil or some other form of heating. The DEFRA report indicates that oil produces 0.245kg of CO_2/kWh (gross calorific values), while natural gas produces an average of 0.184kg/kWh.

8. Once the correct attributes had been applied to each residence it was necessary to amalgamate individual household contributions by postcode area. This was in order to bring the residential dataset in line with the commercial/industrial dataset (see below) which could only be developed on this basis. However, the post code zones are all different sizes with those in the urban areas being predominantly quite small and some

[1] DEFRA 2010 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting (*http://www.defra.gov.uk/environment/business/reporting/pdf/100805-guidelines-ghg-conversion-factors.pdf*)

of the rural zones being very large. To normalise the data the heat load per unit area was derived by dividing the total heat load for a particular postcode by the area of that zone. The heat mapping exercise therefore reflects heat load per unit area rather than an absolute heat load for that postcode district.

9. The resulting dataset was then thematically mapped to produce the residential maps in Appendix 3, before being combined with the commercial/Industrial contributions to obtain the overall heat and power maps in Appendix 2.

10. The benchmark figures available were designed for new buildings. Since old buildings vary considerably according to age and for new buildings.

Non-Residential Heat & Power Mapping

For non-residential heat and power loads it was not possible to apply a generic benchmark and so an alternative approach was required. Energy benchmarks for commercial and industrial heat and power uses are prescribed in the Chartered Institution of Building Service Engineers (CIBSE) Guide F document "Energy efficiency in buildings".

These benchmark figures are given based on unit floor area for various commercial and industrial practices. The guide identifies separate figures for fossil fuel consumption and electrical consumption for each nominal business type and based on whether operations fall within what is termed 'good practice' or 'typical practice'. For the purposes of this exercise it has been assumed that the typical practice figure applies to all commercial and industrial premises in Hereford. Furthermore, it has been necessary to assume that the fossil fuel use corresponds to heat loads and the electrical use corresponds to power consumption. Clearly this is an approximation as some businesses will use electricity to generate heat and some businesses may run diesel generators to supply their electrical needs but it is suggested that this approach will provide as realistic a representation of usage within Herefordshire as possible without conducting a census of businesses to establish actual usage.

In order to apply the CIBSE energy benchmarks it is necessary to know the floor area of all the industrial and commercial buildings within Herefordshire as well as categorise them by type of business. Determination of these characteristics has proved difficult for a number of technical reasons. The LLPG dataset supplied by Herefordshire County Council categorises

commercial and industrial properties into 73 distinct subgroups. 8013 such business addresses exist in the LLPG and these are mappable (i.e. the location of the properties is known and can be geo-referenced). Unfortunately the LLPG database does not include floor areas.

It would potentially be possible to cross-reference the LLPG dataset against Ordnance Survey's MasterMap dataset which contains polygon data for all of the buildings within the county. This could then be queried to establish the footprint of the polygon that coincided with the commercial listing in the LLPG. The approach was considered at length but ultimately rejected due to the problem associated with a business operating from more than one building. For example a commercial operation, which could have a significant heat load, may consist of several factory buildings, an office/admin centre and any number of other buildings. If only the office building coincided with the LLPG address location the query would only be able to distinguish a footprint for this when actually the benchmark ought to be applied to the much larger factory area. This omission could lead to a significant underestimate in the actual heat load within a given area. Extensive research concluded that no known data set containing all the relevant detail, available in an appropriate format is available to Herefordshire County Council.

The only other dataset that has been identified which does include commercial building footprint areas is the Valuation Office Agency's (VOA) "2010 Rating List for Business Properties". This data was acquired for Herefordshire and was found to identify 7351 business addresses, further attributing floor areas to 6,300 of these addresses. Out of the 1,051 records that do not contain information on floor areas, the majority do contain an overall rateable value. The rateable value of a business is set according to a number of factors including the type of business carried out, its location and its 'shop floor' layout.

Where the records exclude the floor area it has been necessary to estimate this from the rateable value of the business. These businesses fall into several categories and where similar commercial business areas exist the average cost per m^2 of those businesses has been used to estimate the floor area of the undeclared business using its rateable value.

Furthermore, in its native format the VOA s dataset was not mappable - it only contained address strings, not geo-referenced points. In order to create mappable dataset it would be necessary to geo-code the VOA data. This process would effectively create a join between the LLPG dataset and the VOA dataset based on corresponding addresses. Several attempts

were made to do this but it was found to be a non-trivial exercise because the format of the address string itself and the data contained within it was not consistent in the two datasets. Experimentation with conventional geo-coding software failed to achieve satisfactory results as did an attempt to construct a software algorithm to produce a match between the two addresses. The approach resulted in a mappable dataset containing floor areas, however, because of the differing number of records and inconsistent address formats the algorithm necessarily produced 'best-match' results. Consequently the merger produced numerous errors and duplication. While in theory these could have been manually removed due to the number of records this method was abandoned.

It was decided to use the VOA dataset as it stood and, rather than locating each building precisely, to use the postcode to map it to an area. This would enable the generation of maps based on the heat, power and CO_2 emissions of the businesses although this did limit the resolution of the maps, as described below.

The resulting dataset was further combined with the CIBSE benchmarks in order to establish the expected heat and power loads. The benchmarks categorise 98 different types of business activity compared with the 452 subgroups present within the VOA dataset. Once again there was considerable inconsistency in the manner in which the businesses were categorised and therefore further approximations were required to assign the benchmarks. Eleven new categories were formulated summarising 'business sectors' by averaging the benchmarks appropriate for that sector and then each of the 452 subgroups were assigned to one of these new categories.

Table A1.2: Categories formulated to simplify benchmark application

(kWh/m²/yr)	Good Practice		Typical Practice	
	Fossil Fuels	**Electricity**	**Fossil Fuels**	**Electricity**
Catering	1426.7	923.3	1806.7	1040.0
Entertainment	378.8	141.3	510.0	192.5
Education	169.3	101.3	224.2	122.5
Hospital	401.3	65.8	482.8	95.0
Hotel	266.7	83.3	406.7	136.7
LEA	280.4	49.6	334.4	66.4
Offices	92.3	112.3	172.5	180.8
Public	181.9	45.7	263.7	59.6
Retail	118.1	245.0	168.5	294.8
Sports & Leisure	287.1	123.3	640.0	195.0
Warehouses	103.0	53.0	169.0	67.0

The 'Typical Practice' benchmark figures were applied to each of the businesses in the VOA database using the actual or derived floor area, and the resulting heat and power demands were used to calculate the CO_2 emissions. The total heat and power demand for each postcode zone was calculated and then normalised by dividing by its area to give a demand per unit area and this dataset was mapped to produce the commercial/industrial heat and power maps in Appendix 2B.

The resulting map had a much courser resolution than was originally envisaged but it was concluded the result was the best achievable with the available data. Since some of the postcode areas were considerably larger than others, particularly the more rural ones, the data was normalised by dividing the resulting totals by the areas of the postcode zone to which they applied.

The figures in Appendix 2 were formed by summing the residential and commercial/industrial demands for each postcode area to generate a map of overall demand within the county and specifically within the four target urban areas.