Supplementary information

Energy planning tools for low carbon transitions: an example of a multicriteria spatial planning tool for district heating

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# Method for calculating the score of each census super output area in the Leeds Heat Planning Tool

The following supplementary material details the methods used for building the Leeds Heat Planning Tool. This includes the publically available data that was used in the tool, the approach to processing data and calculating a score for each local area based upon the weighting assigned to criteria by the user.

## Data sets

Table 1 details the data sets that were incorporated into the Leeds Heat Planning Tool for use by local government officers in district heating planning activities. The data sets are classified by techno-economic criteria, governance criteria and social criteria.

Notable areas where data was not publically available consisted of:

* Potential heat sources (other than existing CHP plants),
* Non-domestic buildings, in particular, large heat demands such as hospitals or swimming pools.

The tool provides an opportunity for users to add their own information to these areas where they deem it relevant, using post codes to indicate location.

Table 1: Data sets included within the Leeds Heat Planning Tool to represent techno-economic, social and governance indicators relevant to district heating development.

|  |  |  |
| --- | --- | --- |
|  | Data category | Data source |
| Techno-economic | Existing Cobined Heat and Power plants  | UK Government CHP database (CHPQA Programme, 2012) |
| Heat sources | Can be added by the user - Postcode |
| Large heat demands | Can be added by the user - Postcode |
| Household density (number of households per km2) | Area of LSOA calculated using ArcGIS. Density calculated using the 'number of households' from the census divided the area of the OA to give the number of houses per km2 (Census Data, 2011a) |
| Flats, maisonettes or apartments (number) | Census data - accommodation type by OA level (Census Data, 2011a) |
| Terraced households (number) | Census data - accommodation type by OA level (Census Data, 2011a) |
| Governance | Social rented households (number) | Census data - accommodation type by OA level (Census Data, 2011a) |
| Council owned social rented households (number) | Census data - accommodation type by OA level (Census Data, 2011a) |
| Social | No central heating system (number of households) | Census data at OA level of central heating (Census Data, 2011b) |
| No gas central heating (number of households) | Census data at OA level of central heating (Census Data, 2011b) |
| Oil central heating (number of households) | Census data at OA level of central heating (Census Data, 2011b) |
| Solid fuel central heating (e.g. wood, coal) (number of households) | Census data at OA level of central heating (Census Data, 2011b) |
| Electric heating (including storage heaters) (number of households) | Census data at LSOA level of central heating (Census Data, 2011b) |
| Off-gas households  | Centre for Sustainable Energy (Xoserve, 2013) |
| Fuel Poverty households 10% measure (number of households) | UK Government statistical data set (DECC, 2013a) |
| Fuel Poverty households LIHC (number) | UK Government statistical data set (DECC, 2013b) |
| Index of Multiple Deprivation | English Indices of Deprivation, 2010 data (DCLG, 2011)Welsh Index of Multiple Deprivation 2011 data (Welsh Government, 2011) |
| Eligible for CSCO funding (Energy Company Obligations) | Energy Company Obligation - Carbon Saving Community Obligation: Rural and Low Income Areas – Sourced from Centre for Sustainable Energy website (DECC, 2012) |

### Aligning lower super output area data to super output area resolution

The highest available spatial resolution of ‘census output area’ (approximately 125 households per area) was used where it was available. However, fuel poverty data and indices of multiple deprivation data was only available at lower super output area (LSOA). This offered sufficient resolution for early stage district heating planning to identify general areas of potential.

A score was generated for each census output area based upon the lower super output area to which it belonged. Figure 1 illustrates how scoring for these data sets were assigned to each census area, using the example of fuel poverty data. When a lower super output area had a high level of fuel poverty, all the census areas contained within that lower super output area would receive a score to indicate a high level of fuel poverty.

|  |  |  |
| --- | --- | --- |
| LSOA - Aa1 | a2 | LSOA - B |
| a3 | a4 |
| LSOA - C | LSOA - D |

Figure : Description of the process for assigning a score to each census output area for data only available at lower super output area (LSOA) resolution – using the example of fuel poverty data.

## Scoring census output areas

|  |  |
| --- | --- |
|  Data sets representing a characteristic |  |

Selected percentile cut-off point e.g. census areas with fuel poverty in the highest 10%

Areas in percentiles above the selected cut-off point

Figure : The percentile cut-off point for data sets

Characteristics that are binary in their nature (i.e. where the characteristic is either present in an area or it is not) are assigned a score if the characteristic is present. For example, the presence of an existing CHP plant and large heat loads such as a hospital or swimming pool are binary characteristics. No percentile cut-off point is required for these characteristics.

For characteristics represented by a continuous data set, a percentile cut-off point is used to determine when an area exhibits a ‘high’ level of a characteristic (Figure 2). The percentile cut-off is selected by the user and is calculated using the data sets within the local government area in question (as opposed to data sets across England and Wales). An increased score is assigned to the census areas with characteristics in these top percentiles.

## Weighting of characteristics

Users can weight each characteristic by rating it between 1 and 5. This enables the user to explore and compare the impact of different weightings; for example, where social factors are weighted very heavily compared to techno-economic factors.

The user can enable and disable characteristics according to their preferences. The weighted scores are assigned as a percentage of the activated characteristics to ensure scenarios are comparable. The scores received for each activated characteristic are then added up to give the total score for each area. This calculation is described algebraically by the following equation:

$$S\_{i}= \sum\_{j}^{}(\frac{W\_{j}}{\sum\_{}^{}W}\*X\_{i}\_{j}) $$

Where:

$S\_{i}$ is the total score attributed to census output area $i $in the selected local government;

$W\_{j}$ is the individual weighting given to the activated characteristics $j$;

$X\_{ij}$ = 1 when the activated characteristic $j$ is above the percentile cut-off point in the given area$, i$. Otherwise $X\_{ij}$ = 0

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