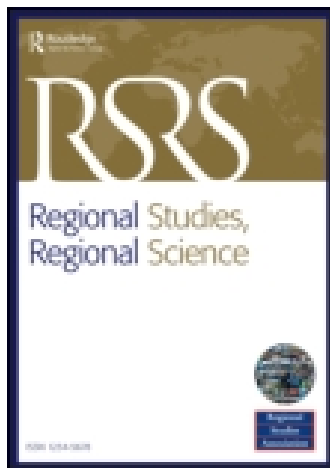


This article was downloaded by: [University College London]

On: 10 March 2015, At: 04:08

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



## Regional Studies, Regional Science

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/rsrs20>

### Domestic energy use in England and Wales: a 3D density grid approach

Duncan Alexander Smith<sup>a</sup>

<sup>a</sup> Centre for Advanced Spatial Analysis, University College London, London, UK

Published online: 10 Dec 2014.



CrossMark

[Click for updates](#)

To cite this article: Duncan Alexander Smith (2014) Domestic energy use in England and Wales: a 3D density grid approach, *Regional Studies, Regional Science*, 1:1, 347-349, DOI: [10.1080/21681376.2014.986190](https://doi.org/10.1080/21681376.2014.986190)

To link to this article: <http://dx.doi.org/10.1080/21681376.2014.986190>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Versions of published Taylor & Francis and Routledge Open articles and Taylor & Francis and Routledge Open Select articles posted to institutional or subject repositories or any other third-party website are without warranty from Taylor & Francis of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. Any opinions and views expressed in this article are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor & Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

It is essential that you check the license status of any given Open and Open Select article to confirm conditions of access and use.

## REGIONAL GRAPHIC

### Domestic energy use in England and Wales: a 3D density grid approach

Duncan Alexander Smith\*

*Centre for Advanced Spatial Analysis, University College London, London, UK*

*(Received 21 October 2014; accepted 6 November 2014)*

Household energy use is of relevance for studies of sustainability and fuel poverty. Detailed mapping and spatial analysis is possible in the UK due to the release of fine-scale household energy-use data. The cartographical approach used here focuses on urban energy use and the relative performance of urban areas in England and Wales. The energy-use data were transformed to a 1 km<sup>2</sup> grid of cells allowing consistent comparisons to be made between urban areas at the same zonal scale. Additionally cells were extruded according to population density, highlighting basic relationships between density and energy use. The urban perspective on energy use is important due to the strong influence of the built environment in determining energy efficiency, and furthermore due to the clustering of affluent and deprived social groups in cities. The results of the mapping highlight how the lowest and the highest energy-use districts are located within the same city-regions, and how further variations in energy use relate to housing density and energy-efficiency behaviours.

**Keywords:** domestic energy use; urban form; density; consumption; 3D grid

#### Method

A recent innovation from the UK government has been to increase the spatial resolution of household energy consumption data to Lower Layer Super Output Area (LSOA) scale (DECC, 2014a), enabling more detailed mapping. Note that a number of assumptions are made in the production of these data (DECC, 2014b). For this analysis, gas and electricity use have been combined into a total household energy measure.

Standard UK energy use maps (e.g., ONS, 2013) suffer from the limitations of choropleth mapping (Dorling, 1993): namely the visual prominence given to large rural zones of low population, and the restricted legibility of urban areas. As an alternative approach, the data here have been transformed to a 1 km<sup>2</sup> grid (using a spatial join based on areal proportion). This technique assumes that the households within each zone are evenly distributed across space. In urban areas the LSOA zones are smaller than the 1 km<sup>2</sup> grid squares, and these assumptions have little effect. In rural areas, where census zones increase significantly in size, the grid technique is not appropriate. Consequently a threshold of 1000 residents per km<sup>2</sup> has been applied, and the map is not suitable for understanding patterns in rural areas.

---

\*Email: [duncan.a.smith@ucl.ac.uk](mailto:duncan.a.smith@ucl.ac.uk)

As a final step, the grid cells have been extruded in three-dimensions (3D) according to the population density in each cell. The reasons for doing this is, firstly, to give greater visual prominence to areas where more people live and, secondly, to provide a visual indication of relationships between density and energy use.

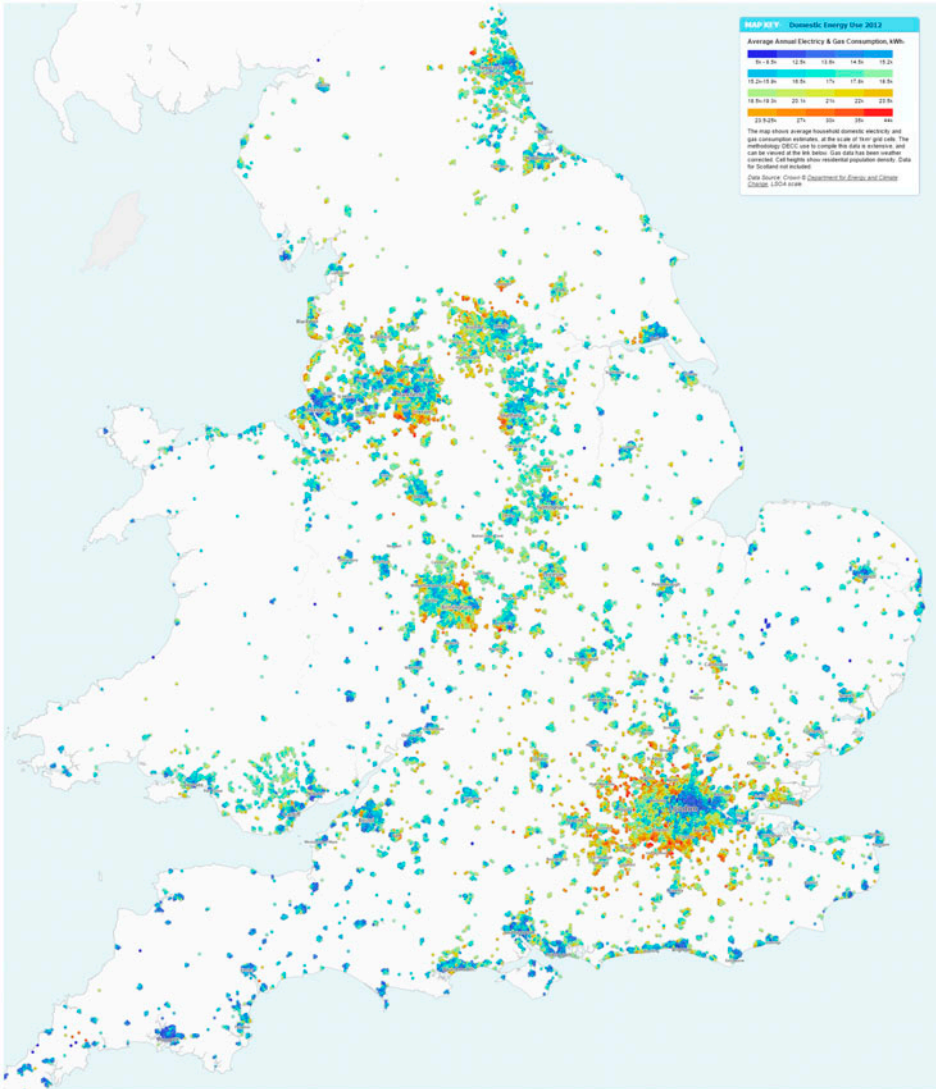


Figure 1. Household domestic energy consumption estimates in England and Wales, 2012, at the scale of  $1 \text{ km}^2$  grid cells. Cell heights show population density in 2011; densities below 10 residents per hectare are excluded. The map is available in interactive form at: <http://luminocity3d.org/>.

## Results

The household energy consumption map (Figure 1) clearly displays the two primary drivers of household energy use: housing type and affluence. Major cities are characterized by a high-density core of lower energy consumption, averaging less than 15,000 kWh per household compared with city-wide averages of around 18,000 kWh for London, Manchester and the West Midlands. This density trend can also be seen in the efficient performance of higher density cities, such as Brighton (15,750 kWh city average), Bristol (16,000 kWh) and Liverpool (16,500 kWh).

The areas of lower consumption contrast strongly with affluent suburban areas, where average consumption is above 27,000 kWh. This wealth relationship is most clearly seen in Greater London in the stark difference between east and west. The towns with the highest energy use in England and Wales (above 20,000 kWh) are in the commuter belt of London. Similar trends of high-consumption suburbs are also visible in South Manchester, North Leeds and West Sheffield. In addition to the built-environment factors of large detached housing, there is also a significant behavioural element in the wealth–energy relationship. Richer households can generally afford to be more profligate in their heating and appliance use (Druckman & Jackson, 2008).

By far the most efficient region in England and Wales is the South West, where cities such as Plymouth and Exeter have the lowest average consumption figures of around 14,000 kWh. As well as being the influence of the milder climate, this could reflect positive behavioural measures in a region renowned for green industries.

## Acknowledgements

Energy-use data are Crown © Department for Energy and Climate Change. Population data 2011 Census are Crown © Office for National Statistics. Boundary data are Crown © Ordnance Survey.

## Funding

Duncan Smith is employed at CASA UCL on the MECHANICITY grant. This research is funded by the European Research Council MECHANICTY grant, 249393-ERC-2009-AdG.

## References

- Department for Energy and Climate Change. (2014a). *Sub-National Energy Consumption Statistics: LLSOA electricity and gas 2012*. London: Author. Retrieved from gov.uk: <https://www.gov.uk/government/statistics/lloa-electricity-and-gas-2012-experimental>
- Department for Energy and Climate Change. (2014b). *Sub-national consumption statistics: Methodology and guidance booklet*. London: Author. Retrieved from gov.uk: <https://www.gov.uk/government/statistics/regional-energy-data-guidance-note>
- Dorling, D. (1993). Map design for census mapping. *The Cartographic Journal*, 30, 167–183.
- Druckman, A., & Jackson, T. (2008). Household energy consumption in the UK: A highly geographically and socio-economically disaggregated model. *Energy Policy*, 36, 3177–3192.
- Office for National Statistics. (2013). *Household energy consumption in England and Wales, 2005–11*. London: Author. Retrieved from Office for National Statistics. [http://www.ons.gov.uk/ons/dcp171766\\_321960.pdf](http://www.ons.gov.uk/ons/dcp171766_321960.pdf)