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CASE STUDY

Local energy policy and managing low carbon transition: The case of Leicester, UK

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ABSTRACT

National and local energy policies are implemented within a complex energy landscape that makes any evaluation of their impacts far from straightforward. Drawing upon a case study of Leicester this paper argues that the ability of local authorities to deliver significant energy savings within this landscape is questionable, albeit with other additional benefits being realised (e.g. job creation, community engagement). It examines existing domestic energy demand and multiple deprivation data for Leicester and neighbouring cities and combines this with a qualitative description of the transition process. The paper identifies the need for a more systematic analysis of how national energy policy translates to the local level and concludes that it is problematic even for a leading, pro-active and innovative local authority to have a statistically meaningful energy policy. Even where energy policies are favourable, carbon reduction is less easy to realise than other — more local - co-benefits and that in the light of significant financial and co-ordination constraints more attention needs to be given to how local communities can be more effectively supported in their desire to meet (or exceed) national targets.

1. Introduction

In their analysis of energy transition, Verbong and Geels [1] are critical of attempts to link the low take up of renewable electricity options to policy and of failures to adequately recognise the importance of the wide range of actors outside of policy makers. More recently Simmie [2] argues that energy pathways invariably emerge through incremental improvements to existing technologies and innovations in how those technologies might be integrated, and or, used in new ways. Both of these analyses suggest that energy transitions are determined by the dynamic interconnections between the national landscape made up of climate change, fuel prices and policy initiatives, and local contexts as defined by levels of deprivation, building stock, geography and local government initiatives.

The following paper will consider how these complex landscapes determine the ability of UK energy policy to reach down to the local level and, concurrently for local initiatives to respond to national policy. It is framed around a case study of one urban centre, the City of Leicester, which has been selected due to its reputation in sustainability, energy efficiency and climate change mitigation. Within the general theme of sustainability, we focus more narrowly on energy policy because this is potentially a measureable and tractable set of policies around electricity and heat production and consumption. The specific goals of the paper are: to explore, quantitatively and with a focus on domestic energy use, the impact that energy initiatives are having on total energy consumption; to present a qualitative picture of the local factors (e.g. levels of deprivation); and to summarise the network of agents who have been involved in that transition at the local level. The quantitative and qualitative aspects of the paper are then pulled together to consider, first, how improved data at the local level, and the expertise to manage that data, is key to the generation of local energy policy and, second, how national policies must be formulated with a better understanding of the local contexts into which they are to be introduced.

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1.1. Leicester city: the study context

Leicester is the 11th largest city in the UK with a population of 329,900.[1] In 1990 it became the UK's first "Environment City" and later, in 1996, became Europe's "Sustainable City" [6] and one of twelve cities to receive local government honours at the 1992 Rio Earth Summit. The city's 2008 carbon dioxide emissions amounted to 1.9 million tonnes (0.36% of UK total emissions [42]) and the council's (LCC) own CO_2 emissions for 2008/9 was 66,179 tonnes [3]. Among other environmental objectives, LCC has set itself a target of reducing its CO_2 emissions to 50% of 2008/09 levels by 2025/6 and to reduce city-wide emissions to 50% of 1990 levels by the same date [3]. Fleming and Weber [7] discuss a substantial improvement in energy efficiency between 1996 and 1999 with annual savings of 86,667 MWh (312 TJ), equal to 6.0% of Leicester's 2009 electricity demand. The national UK Government has recognised Leicester and its council as being "impressive" in terms of energy efficiency [8] and the city is one of the eleven board members of the European Energy Cities network, which has 1000 towns and cities as members.[2]

Based on environmental performance, quality of life and future-proofing criteria, Leicester was assessed by Forum for the Future [10,12] as the most improved city, year-on-year between 2007 and 2010, and was Britain's second most sustainable city in 2010, up from 14th in 2007. It was noted that the One Leicester Partnership, which was a non-legally binding agreement between groups pursuing a sustainability agenda, was an important strategic step for the city to have taken in tackling the issues encompassed by the future-proofing category [5,11].

The paper will now consider the data requirements for assessing the capability of local authorities to manage low carbon transition, particularly where there are high levels of deprivation. Section 2 will introduce national data for the consumption of gas and electrical energy before discussing a quantitative analysis of this consumption as it relates to levels of deprivation with a specific focus on the performance of domestic users in Leicester. The paper will then compare the energy performance of the city with two similar locations in the Midlands of England (Nottingham and Coventry). Section 3 will draw upon a systematic review of local energy initiatives within Leicester, supplemented by semi-structured interviews with key players, to present a qualitative energy landscape of the city before Section 4 relates this analysis to the present and near-term energy policy goals of the UK Government. The final section of the paper will offer conclusions on what our analysis means for local authorities (and the central governments that support them) seeking to have a statistically meaningful energy policy.

2. Data sources for understanding local energy use

Detailed explanatory notes for how regional electricity and gas data are reported are available from the Department of Energy and Climate Change [25] and the key points are summarised as follows. In 2003 and 2004 the DECC released experimental electricity statistics for LAU1 NUTS administrative regions. There are 410 LAU1 areas in the UK, 356 of which are in England and Leicester city constitutes one; these have been classified as National Statistics since 2005. In 2004 provisional electricity statistics were also reported for Mid Level Super Output Areas (MLSOA) [26] and subsequently awarded National Statistics status in 2005. There are 7193 MLSOAs in England and Wales, of which 36 are in Leicester. Local level (LLSOA) electricity data was first released in 2007, although only for 45 local authorities; in 2008 and 2009 the reporting scheme remained experimental but data is now released for the whole of England and Wales. There are a total of 34,482 LLSOAs in England, 1896 in Wales and 187 from the City of Leicester. The available data is not controlled for the variation from average weather conditions that each region experienced in the years reported for; it is reasonable to assume however that no significant variations exist between the nearby cities represented in the following analysis – Leicester, Coventry and Nottingham.[3]

2.1. Deprivation data

The Department for Communities and Local Government (DCLG) has developed a methodology for quantitatively determining the degree of deprivation experienced by UK residents. Data is collected for the whole country using this methodology and is reported for each LLSOA layer. Each LLSOA is then ranked relative to the others with Rank 1 corresponding to the most deprived area [27]. Deprivation data is not reported for MLSOAs and it is not possible to accurately calculate MLSOA deprivation based on the LLSOA data due to the latter boundaries not always residing entirely within a single MLSOA. The measure of deprivation is determined by an Index of Multiple Deprivation (IMD), which is based on seven categories – income, employment, health and disability, education, barriers to housing, crime and living environment - with an individual weighting according to their influence on the overall IMD. According to the DCLG's IMD measurements [28], Leicester's 187 LLSOAs are more deprived than the average for England and 25% of Leicester's LLSOA's are also among England's 10% most deprived areas.

The MLSOA and LLSOA consumption data [29] and the NUTS LAU1 consumption data are available from the DECC [30,31] and the deprivation data from the DCLG [28]. Only data defined to be for domestic consumption is considered in this analysis.

2.2. Gas and electricity data with deprivation

Lemon et al. [38] provides a detailed analysis of MLSOA data ranked by deprivation over the period 2006–2009. They look at the fitted mean changes in gas and electricity consumption against the IMD rank discussed above. In 2009 the city's consumption of gas had reduced by 16.3% of the 2006 demand and the country as a whole had reduced by 15.6%. However adjusting for the index of deprivation the fall in gas consumption was actually lower in MLSOAs in Leicester than for similarly deprived MLSOAs in England as a whole.

Similar results were also observed for electricity demand. The MLSOA data shows that over the 2006–2009 period Leicester's mean household electricity demand reduced by 5.6%, while the mean English reduction was 6.8%. However once deprivation is taken into account electricity demand fell faster in the rest of England. The more detailed LLSOA data (also analysed in Ref. [38]) shows similar effects for the fall in gas and electricity observed between 2008 and 2009: that adjusting for relative deprivation demand in Leicester's LLSOAs fell less than LLSOAs in England as a whole.

Analysis of the detailed MLSOA and LLSOA data suggests that deprivation rank is likely to be a major driver of the absolute differences in the consumption of electricity and gas. Leicester is relatively deprived and does not show a notably superior drop in either gas or electricity consumption over the period 2006–2009 compared to the rest of England, adjusting for its level of deprivation.

2.3. European gas and electricity data

The local administrative (LAU1) data shows that in 2004 Leicester's gas demand per household was greater than the average of

[1] Source: ONS Census website. http://www.ons.gov.uk/ons/interactive/vp2-2011-census-comparator/index.html, (accessed 25.03.14).

[2] See http://www.energy-cities.eu/, (accessed 14.01.14).

[3] The monthly highest and lowest temperatures for Leicester, Coventry and Nottingham are almost identical. See http://www.worldweatheronline – (accessed 24.03.14).

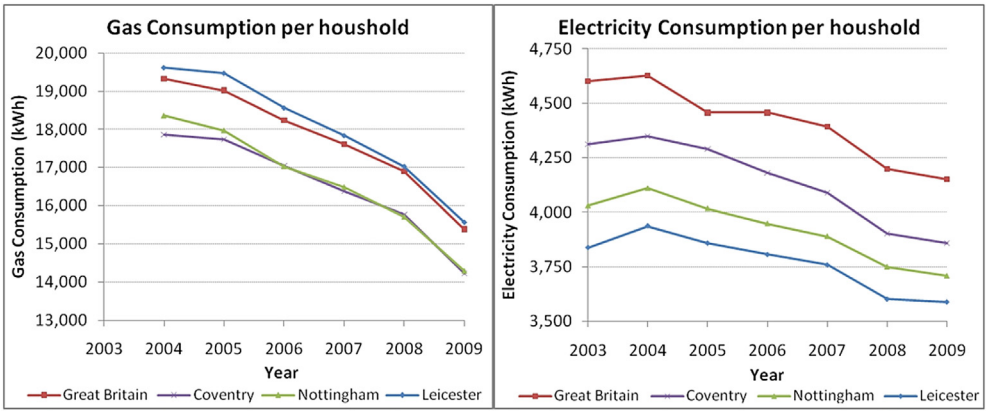

Fig. 1. Annual gas and electricity consumption per household for Leicester, Coventry, Nottingham and Great Britain using data for LAU1 NUTS regional boundaries.

Britain, Nottingham and Coventry; however, its electricity demand was lower than all of the others (Fig. 1). This remained the case in 2009. A breakdown of the actual and percentage changes in demand for these four localities is given in Table 1 and shows that, while Leicester has reduced demand at a slightly higher rate than Britain as a whole (which is consistent with its performance compared to England in the super output area data), compared to Coventry and Nottingham its gas demand is greater and is reducing at a slower rate. The city's electricity demand is also reducing at a slower rate; however, as mentioned above the demand for electricity per household is already lower than for Coventry and Nottingham.

Leicester's demand for electricity is consistently lower when compared to the country as a whole, to similar cities and to similarly deprived regions. While not conclusive, appropriate comparative electricity data for the years prior to 2004 is not available, however the overall trend is consistent with the city council's longstanding efforts to improve energy efficiency. Leicester's actual and percentage rate of improvement in electricity efficiency is however less than the areas it has been compared to; this might be explained by the easier and more cost effective improvements already having been made in the city.

The picture for Leicester's gas demand is less positive. When compared to Great Britain as a whole, Coventry and Nottingham, the city is found to have the highest demand and one of the lowest percentage rates of reduction in demand. Comparison with similarly deprived areas again shows the city to have higher gas demand, but does show a slightly better rate of demand reduction.

2.4. Carbon emissions data

Per capita carbon dioxide emissions are published annually by DECC for the European NUTS LAU1 layer, although the requirement for local areas within Britain to report this information, National Indicator (NI) 186, was scrapped in 2010 [32]. The emissions for Great Britain, Leicester, Coventry and Nottingham are given in Fig. 2 and show that while Leicester is performing better than the national average, its emissions per capita have been consistently higher than Nottingham and Coventry for the period 2005–2008.

3. Local level coordination of energy policies: Leicester's energy landscape

It would seem to be obvious that local government authorities are uniquely placed, through their own activities, to influence the potential benefit realised from national energy policies (see for example [42] and review in Ref. [45]). They should also be well positioned to innovate, test and implement additional policies that may suit their own, and potentially other local areas. Public administration accounts for approximately 5% of UK energy demand and socially rented houses a further 5%.[4] Local authorities also manage a wide range of public services; a responsibility that brings them into contact with local communities and businesses [33]. As a result they can exert influence over a significant proportion of total energy demand both directly in their managed buildings and also through interaction with local communities and businesses in the energy market. However the question remains as to what contribution they actually make to the achievement of energy efficiency and carbon emissions reduction targets.

As mentioned above, groups in Leicester joined together to form the One Leicester Partnership, which was replaced by the City Mayor's Partnership[5] in April 2012. This is a community driven partnership dedicated to improving Leicester through a collaborative strategic vision. Fundamentally this vision is a non-legally binding statement of intent by its members with seven core objectives:

> "investing in our children, planning for people not cars, reducing our carbon footprint, creating thriving, safe communities, improving wellbeing and health, talking up Leicester, investing in skills and enterprise" [5].

The One Leicester Partnership produced an annual State of the City report detailing the progress towards meeting its' goals. With respect to "reducing our carbon footprint" the 2009/10 report [35] claimed carbon emissions had reduced by 7.5% between 2005 and 2008, with improvements made across all sectors. Amongst other interventions it also claimed that 79% of schools had travel plans in place, with fewer children travelling to school [9] and 39% of the labour market included in workplace travel plans.

The 2010 State of the City report was released with an accompanying technical report [35] which acknowledged, as presented above, that the city lies 20th out of 354 local authorities (using the DCLG IMD ranking methodology [27]) and, as seen above, is deprived compared to most other regions in the UK. The report also pointed to further activities that aimed to improve energy usage; these included ensuring that every new building constructed after 2013 is

[4] These percentages are derived from manipulation of 2011 data from the Digest of UK Energy Statistics [Table 1.3 in Ref. [44] and from the National Energy Efficiency Data framework additional tables, available at https://www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-report-summary-of-analysis-2014 (accessed 26.11.14). Social housing is around 18% of total housing in the UK, and hence adjusting for lower consumption accounts for 14% of domestic gas and 15% of domestic electricity consumption.

[5] See http://citymayor.leicester.gov.uk/welcome/city-partnership/ (accessed 14.02.14).

Table 1
Gas and electricity demand per household for 2004–2009, as reported for the EU NUTS LAU1 layer [30,31].

Location	Demand per household (MWh)					
	2004 Gas	2009 Gas	2004–2009 Gas demand reduction	2004 Electricity	2009 Electricity	2004–2009 Electricity demand reduction
Great Britain	19.3	15.4	3.9 (20.2%)	4.63	4.15	0.48 (10.4%)
Coventry	17.9	14.2	3.7 (20.7%)	4.35	3.86	0.49 (11.3%)
Nottingham	18.4	14.3	4.1 (22.3%)	4.11	3.71	0.40 (9.7%)
Leicester	19.6	15.6	4.0 (20.4%)	3.94	3.59	0.35 (8.9%)

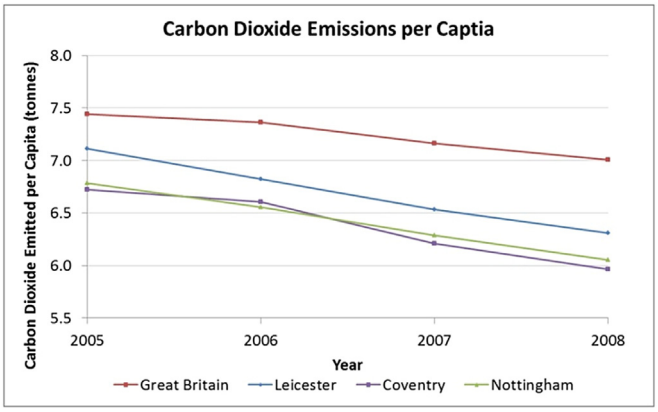

Fig. 2. NI186 data for carbon emissions per capita given for the NUTS LAU1 layer.

zero carbon, installing insulation in homes, upgrading and expanding the city's district heating networks and implementing energy management schemes for Small and Medium Enterprises (SMEs).

Surveys of local authorities in England and Wales suggest that councils are able to introduce more comprehensive climate policies if they get more support from other local actors [36]. This suggests the importance of local interaction between the relevant players; it also suggests that we need to understand the receptivity (willingness and ability to respond [37]) of those players to central and local government policies and a changing landscape.

Owing to the wide-ranging environmental, social, economic and historical factors that influence the energy landscape considerable differences are often apparent in the networks of players or actors who are involved with energy efficiency issues in any given local area. Furthermore, local 'players' and their priorities are changing all the time. This combination of factors means there can be no single model for how energy policy is best enacted at the local level and it is precisely because of this that it is difficult determine whether any single area is taking the best course of action available to it when tackling energy policy issues. It is, however, informative to undertake a qualitative, as well as quantitative, examination of specific local communities, such as Leicester, that are viewed as being successful in the ways we noted in the introduction. To initiate analysis of the way this local community is tackling, particularly domestic, energy issues, and to relate this to the statistical analysis presented above, an examination of energy-related local players and activities and the resultant energy landscape has been undertaken [38].

Information was gathered on the local authority through a systematic reading and analysis of its own published documents and through seventeen, hour long, semi-structured interviews with members of council staff and other stakeholders (a local MP, academics, a local NGO, commercial energy managers and a senior official from the district energy scheme).[6] Two types of information were gathered from this: the network of actors and the features of the energy landscape in Leicester were identified and more detailed information regarding the council, and the other actors was gathered.

The landscape that emerged highlighted a wide range of organisations and activities that are involved with tackling energy issues. These include a mix of UK wide activities, such as the Neighbourhood Renewal Fund (NRF) and the Home Energy Saving programme (HESP) alongside more innovative undertakings that groups in Leicester have embarked upon following local initiatives, such as the local council's intelligent metering scheme.

There are also examples of collaboration between groups, for example loft insulation has been installed by the Mark Group, but funding for it provided by British Gas (presumably prompted by their national energy efficiency obligations). The prioritisation of homes to receive the insulation was managed by the local council whose decisions were aided by thermal photography provided by Blue Sky International Ltd. The intelligent metering scheme for monitoring energy and water consumption exemplifies complementary policies being enacted and by making available time-series demand data at a building level the direct measurement of energy consumption was made possible. This allowed for better targeting of demand reduction efforts and therefore greater efficiency savings; the provision of metering data also aided the decision making process regarding what future actions to take, and where and when to take them.

4. Discussion: what impacts have local and national energy initiatives had in Leicester?

4.1. Local initiatives and their significance

Our investigation of Leicester's local energy landscape, with its focus on domestic energy, indicated that the city council does indeed hold a central role among the players concerned with energy related activities. This reinforces perceptions that for energy efficiency and climate change measures to be successfully brought into practice at the local level local governments have an important role to play [34]. Leicester City Council (LCC) has undertaken a facilitative role in a wide range of energy activities. For example it has reviewed options for the District Heating network and advertised a tender for its regeneration but outsourced the construction and managerial work of that regeneration; it manages policy and regulation for new buildings but does not construct them itself and it has invested in a private firm to gather data for its Hot Lofts scheme and again outsourced the work of installing energy measures based on this data to a private firm. LCC's Leicester Energy Agency (LEA) has responsibility for managing the council's own energy consumption, is a focal point for energy players and has been positioned to undertake innovative activities, like the management of a local near-real time metering scheme.

In the context of an ambitious local carbon emissions target (by 2025–26 50% of 2008–09 levels) our earlier quantitative analysis points to the difficulty of local energy policy having an aggregate impact on overall figures for

[6] The major sets of interviews were conducted on 9–10 September 2010 and 13–14 July 2011.

electricity and gas consumption or for carbon emissions. While Leicester has lower per capita electricity consumption than the English average or for comparator cities, the gap is narrowing and direct council energy and emissions contributions only form a small percentage of the local total.[7] Local coordination, while easier than national coordination in theory, was in practice very difficult and the District Heating CHP scheme provided a good illustration of this [4,39]. Thus within the public sector two local hospitals, the prison and the two universities located in Leicester ultimately report to different government departments and have their own autonomous governance arrangements which make the coordination of large one off energy investment decisions very difficult in spite of their close physical proximity and the goodwill of their local managers.

In the search for local policies with measurable impact we examined two flagship Council policies [38]. These reveal how small the savings in energy and emissions currently are. Intelligent energy metering of council buildings produced recent examples of savings equivalent to only 0.4% of total council energy consumption (0.02% of Leicester). While the recent extension of the district heating scheme from 2012 also produces relatively small overall savings equal to around 1% of the carbon emissions of Leicester. Some of the smaller schemes however offer the prospect of high cost effectiveness; for example the Green Doctor scheme could have reduced Leicester's total energy consumption and emissions by 1% p.a., if rolled out over all of its houses, at a cost of £4.675 m.[8]

The most significant schemes in Leicester appear to be local manifestations of national policies rather than council initiatives. The Hot Lofts Scheme — which has reached 7200 homes - is the local incarnation of the Carbon Emissions Reduction Commitment (CERT). We saw that household demand for gas has fallen in Leicester (and by absolutely more than the national average). The DH-CHP scheme is a long run local innovation, but deeply rooted in national initiatives towards community energy that date back to the early 1980s and revived recently in the Community Energy Savings Programme (CESP).

One significant tangible benefit of Leicester's commitment to a local energy policy has been the development of energy related jobs; for example the Mark Group, which is based in the city, has 2500 employees worldwide, with 1500 of these in the UK [40]. Within Leicester and Leicestershire 14,400 people are employed within the low carbon and environmental goods and services sector (LLEGS) generating approximately £2 billion in sales. The region is ranked 20th among Local Enterprise Partnerships in overall Gross Value Added per capita but performs significantly better in the LLEGS with a ranking of 15th [40].

In looking for local impact it became evident that much more does need to be done to marry up local and national data collection initiatives in order to ensure that national statistics are as accurate as possible. The extent to which national government was interested in collecting more detailed data that might be available to local authorities (via intelligent metering) was not obvious, indeed the reverse was also true, in that it was not clear that LCC were aware that detailed statistics which they could have been using to monitor their performance were available.

4.2. *A national perspective on UK energy policy: locating Leicester*

Following the previous discussion about the local energy landscape in Leicester we will now summarise the UK national energy policy framework towards energy efficiency and renewable energy production and relate it to the situation in the city (Table 2). A significant factor in this analysis is the high level of deprivation in Leicester and the consequent impact on fuel poverty [13]. As seen above, in 2011 roughly 25% of households were in the social housing sector and 23% in private rented housing in Leicester.[9] Owner occupied dwellings may of course be wasteful of energy, but such households may be more difficult for local authorities to influence.

The emergence of the national energy policies described above can be seen in the context of large, cross boundary suppliers, local housing bodies (local authorities, social housing) and individual householders (private, rented). As has been briefly discussed within the paper this multi-scalar and complex set of agencies and relationships has a significant impact on the 'well-being' of the fuel poor and constitutes very different local energy contexts with corresponding uncertainty about low carbon transition.

5. Conclusions

Two significant sets of implications follow from the analysis presented above.

Firstly, it is important to understand just how difficult it is for even an internationally recognised urban local authority to have a statistically meaningful energy policy. The policy may produce co-benefits such as a greater sense of local community, the opportunity to enhance a locality's national and international reputation and local employment in energy initiatives (as noted by Mills and Rosenfeld, [41]). However our quantitative and qualitative analysis of Leicester's experience illustrates that these co-benefits may be easier to achieve than demonstrable impact on local energy consumption or emissions.

Second, even where national energy policy has favoured a local authority, this may not translate into clear demonstrable outperformance in the achievement of national energy policy goals. In the case of Leicester, we observed coordination failures within the public sector and the fact that financially constrained local authorities find it difficult to take significant local initiatives. Thus, more careful attention needs to be given to how communities can be facilitated in their desire to take, well informed, initiatives which support national targets.

We believe that the lessons from this case study are widely applicable in the sense that Leicester is sufficiently typical of cities in England (and in many other countries, see for example [43]) to make the conclusions of this research generalizable. Local councils only have direct control of a small percentage of total energy consumption within their locality. Co-ordination of local energy policy even within the public sector, which is itself subject to multiple levels of governance, is very problematic. Local councils, however well-intentioned, have only so much influence over energy consumption and production. Working to coordinate local decision making in such a way as to make a statistically meaningful difference to energy consumption and production in a large urban area requires the sort of detailed understanding of the key stakeholders involved that we outline in this paper.

One final observation is that any attempt to understand complex phenomena such as the energy consumption of a city will require

[7] It might be the case that Nottingham and Coventry are undertaking similar initiatives to Leicester which is masking Leicester's performance. Looking at Table 1, Nottingham is not improving its relative sustainability performance, but Coventry is. However our detailed analysis is necessarily limited to Leicester.

[8] In the context of Leicester's total emissions of 1.9 million tonnes in 2008 (Leicester Partnership, 2010a) the 409 tonnes of CO2 savings is approximately 0.02% of the total, returned on an investment of £34,000. The Green Doctor scheme visited 800 homes. By simple extrapolation, if 110,000 households were served (this is approximately the total number of households in Leicester (LCC, 2012)) then it would cost £4,675,000 and reduce emissions by 19,000 tonnes of carbon per annum (1% of the city 2008 total). At a social discount rate of 3.5%. This implies discounted emissions savings of 542,857 tonnes, implied a cost per tonne saved of roughly £8.60 (which is much less than the government's benchmark carbon price).

[9] See http://www.leicester.gov.uk/your-council-services/council-and-democracy/city-statistics/census2011/key-statistics/how-we-live/tenure/. (accessed 26.11.14).

Table 2
National Energy Policies and their relevance to Leicester.

National Policy	Nature of Policy	Significant in Leicester?
CERT – Carbon Emissions Reduction Commitment	Larger energy company supplier targets for energy efficiency improvements via loft insulation and low energy light bulb distribution. Ended 2012 [14,15].	Yes, because uptake higher for poorer households.
CESP – Community Energy Saving Programme	Energy companies required to target low income households with improved energy efficiency standards and lower bills. Additional credit for 'whole house' and community approaches. Ended in 2012 [14,15].	Yes, because targets 10% most deprived areas in the country.
Warm Home Discount	Financial support from electricity and gas suppliers for fuel poor households.[1]	Yes, because of incidence of fuel poverty in Leicester.
CRC – Carbon Reduction Commitment	From 2012 large commercial organisations - with consumption of more than 6000 MWh of electricity must pay CO_2 tax initially set at £12/tonne [16].	Yes, because targets large non-energy intensive public sector users.
Green Deal	Owner occupiers can borrow against future household energy bills to pay for home energy efficiency improvements [15–19].	Potentially, but low impact nationally so far.
ECO – Energy Company Obligation	From 2013, CERT and CESP replaced by three schemes. *Carbon Emissions Obligation* requires major suppliers to target 'hard to treat' households. *Carbon Saving Community Obligation* requires suppliers to support community energy efficiency schemes such as District Heating. *Home Heating Cost Reduction Obligations* requires targeting of heat energy efficiency measures (e.g. boiler replacement) on low income and vulnerable customers [17].	Yes, because focussed on lower income households.
FiT – Feed-in-Tariff	This is the renewable electricity generation support scheme for generators with capacity of less than 5 MW. This offers a fixed payment per kWh depending on size and type of technology [20].	Yes, targets household and community renewable energy projects.
ROC – Renewable Obligation Certificate	Under the Renewables Obligation (RO) eligible generation can receive ROCs which can be traded in addition to the energy produced. The rate of ROCs per MWh can vary by technology [21].	Not particularly, because favours larger scale renewable generation.
CfD – Contract for Difference	The RO scheme is due to be replaced by CfDs. This offers insurance payments equal to the difference between the average wholesale market price and a fixed strike price in the CfD for eligible large scale renewable generation [22].	Not particularly, because favours larger scale renewable generation.
RHI – Renewable Heat Incentive	From 2011 Renewable Heat Premium Payments were available to both non-domestic and domestic producers of renewable heat, providing partial support for those who install renewable heating systems. The domestic RHI budget was only £15 m in 2011/12 but the total RHI budget was £251 m in 2013/14 [23,24].	Potentially, because supports household and community renewable heat schemes.

[1] See https://www.gov.uk/the-warm-home-discount-scheme (accessed 25.02.15).

a triangulated (multi-method) approach that is capable of reflecting that complexity. The analysis of energy data is of limited use without a qualitative understanding into what underpins that profile; equally a qualitative and systemic understanding is of limited use if it is unable to relate to measurable changes in consumption.

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