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Climate change mitigation and the age of tourism accommodation buildings: a UK perspective.

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Abstract

Recent research on climate change mitigation has emphasized decision-making within tourism businesses is vital for sustainable futures. However, there has been little consideration of how the age of buildings and (historic) property frames, modifies or constrains the sector's response to climate change. Through surveys of accommodation providers in South-West England, this paper explores relationships between property age, energy performance and pro-environmental innovations requiring adjustment to the fabric of buildings. Findings are presented from empirical research with small- and medium-sized tourism enterprises (SMTEs) occupying properties often well over a century old. This paper's large-scale dataset and series of intensive case-histories demonstrates that property age does not play a straightforward role in encouraging or hindering efforts among accommodation providers to tackle climate change. Some (but not all) businesses with the oldest buildings performed and responded strongest, successfully introducing the latest renewable energy technologies, although adapting older buildings was not without complications and cost implications. Conceptually, this research points to the limits of calls for greater pro-environmental behaviour change without clearer understanding of the contexts and settings in which such behaviour takes place. Its findings are important to heritage based destinations worldwide: accommodation in heritage buildings can be a unique selling point.

Keywords

Building, premises, historic, age, SMTE, accommodation, climate change, mitigation

Introduction

A growing body of knowledge attests to the importance of behaviour change as a major means of reducing the contribution of the tourism sector to dangerous future climate changes (Becken 2013; Kajan and Saarinen 2013; Higham et al 2013). Among supply-side research, motivations and barriers to greater action among businesses (Sampaio et al 2012a, 2012b; Tzschentke et al 2008; Vernon et al 2003) have attracted considerable attention as have variations in response rates (Hall 2006; Saarinen and Tervo 2006; Smerecnik and Andersen 2011; Coles et al 2014). Demand-side analyses have pointed to the significance of understanding contemporary travel choices (Hares et al 2010; Cohen et al 2011, 2013) and the nature of individual behaviour away from home (Barr et al 2011; Mair and Laing 2013). Collectively, this work has emphasized the importance of individualized decision-making by both service providers and customers if tourism is to contribute more fully to emissions stabilisation. However, recent theorization of pro-environmental practices in service encounters has stressed that both practice and its change are outcomes of agency as well as the structures in which it takes place (Halkier et al 2011). While the latter may more obviously connote the framing role of regulation (cf. Hall 2013), it also includes the particularities of settings, spaces and sites of practice (Shove 2010).

Viewed through this lens, largely absent from the discourse is a fuller understanding of how buildings frame the modification of environmental behaviours within tourism settings. This is a significant oversight. Many tourism activities and experiences make use of historic buildings (Graham et al 2000). As early as 2007, the Fourth Report of the Intergovernmental Panel on Climate Change (IPCC) records ‘high agreement’ and ‘much evidence’ that buildings present ‘global potential to reduce approximately 29% of the projected baseline emissions by 2020 cost-effectively in the residential and commercial sectors’ (Levine et al 2007: 389). In other words, potential exists in those segments of the property market occupied by accommodation providers (Coles and Shaw 2006), especially those operating 'commercial homes' (Lynch et al 2008). Moreover, there is similar consensus that the largest savings in energy use (75% or above) can be made using new buildings, using the latest technologies and management processes, especially in whole building solutions (Levine et al 2007: 389). Conversely, older buildings present greater challenges: notable savings may be secured from them but retrofitting, replacing energy-using equipment, and low stock turnover are notable impediments (Levine et al 2007: 389). With the publication of the Fifth IPCC Report in 2014, little has changed. Buildings remain 'a critical piece of a low-carbon future and a global challenge for integration with sustainable development' (Lucon et al 2014: 5). Furthermore, the long-life spans of buildings and their associated retrofits are a very significant source of 'lock-in risk' that, in turn, point to the 'urgency of ambitious and immediate measures' (Lucon et al 2014: 5). Predictably then, property age and the challenges it presents, have been central to policy interventions in countries like the UK where 43% of all carbon emissions are from buildings (GOV.UK 2013).

This paper explores the extent to which there are relationships between the age of buildings used, energy performance and pro-environmental innovations among small- and medium-sized tourism enterprises (SMTEs) through an examination of accommodation providers in South West England. Within the European Union (EU) small- and medium-sized enterprises (SMEs) are defined as companies with fewer than 250 employees and/or turnover less than €50 million (EC 2014). SMTEs dominate the global tourism sector numerically (Thomas et al 2011) and in England's south-west region (BIS 2013). Estimates are somewhat dated but in 2005 the tourism sector contributed around 5% of global anthropogenic CO_2 , and as much as 14% if radiative forcing is considered (Simpson et al 2008: 66). Of that total, accommodation (hotels, motels, bed & breakfast, camping, apartments and second homes) contributes 21%, second to transport globally in emissions generation from tourism via energy throughput only (Simpson et al 2008: 77); accommodation therefore produces just under 1% of global emissions . Within South West England, estimates based on 2006 data suggest that overnight visitors account for 27% of the total regional CO_{2e} footprint (Whittlesea and Owen 2012: 853). Within this accommodation for overseas and domestic overnights accounted for 4% and16% of their CO_{2e} emissions respectively, or 1.4% of the total regional footprint (Whittlesea and Owen 2012: 854).

There are three common measures for lowering greenhouse gas (GHG) emissions from buildings: reducing energy consumption; controlling emissions of non-CO_2 GHG gases; and switching to low-carbon, cleaner energy sources (Levine et al 2007: 389). This paper examines the extent to which there are variations in mitigation measures taken in properties of different age and how far there is an age-related effect on energy performance (and hence emissions). In the case of former, it explores whether there are, as anticipated by the IPCC meta-analyses, lower levels of (low carbon) innovation in older buildings resulting from issues like retrofitting and building control. The latter leads to consideration of whether older accommodation should be targeted in mitigation policy. In the next section we review how buildings in general, and their age more specifically, have featured in recent tourism research in order to frame the later empirical analysis.

Literature Review

Buildings play multiple roles in the global response to climate change. New designs, technologies and construction techniques offer opportunities for buildings to adapt to changing climate while simultaneously lessening their environmental load. However, as the IPCC has recognised, one of the main challenges is that much of the world's built fabric was not constructed with the demands of climate change in mind (Levine et al 2007). Instead, there is a considerable legacy of historic buildings of varying age, style and appointment that are in need of renovation and renewal in order to mitigate their environmental effects. Building age, or the date of original construction, connects to environmental performance through the nature of the built fabric (i.e. the building itself) and the installations used to make the building liveable.

Recent macro-level, sector-wide accounts have set out a range of ways in which buildings may feature in tourism sector adaptation and mitigation activity. For instance, Gössling (2011) has demonstrated through a series of case-studies and vignettes how new technologies can be incorporated into both existing and new purpose-built premises. This has included examples of the modification of current activity as well as 'future proofing' sites against predicted changes. Building codes and regulations have been frequently-invoked as drivers of beneficial change at the scale of individual premises and at the destination level (Becken and Hay 2012; Scott et al 2012).

Beyond such overviews, two connecting strands have emerged from a developing but still limited body of knowledge. First, there have been attempts to measure the environmental resources (and by inference emissions) used by tourism businesses within their premises, with a view to establishing benchmarks from which to monitor future consumption levels (Bohdanowicz and Martinac 2007; Beccali et al 2009; Rossello-Batle et al 2010; Filimonau et al 2011; Bohdanowicz and Zientara 2012). A range of energy (and water) efficiency measures have been calculated for a variety of hotels and other property types in the accommodation sector. Results have been (selectively) compared across studies by the respective authors in order to compare, contextualise and triangulate their data. A fragmented array of studies has resulted, with contributions variously from Hong Kong (Deng and Burnett 2000; Deng 2003), Singapore (Priyadarsini et al 2009), Taiwan (Wang 2012), Australia (Warnken et al 2005), Italy (Beccali et al 2009), Spain (Rossello-Batle et al 2010; Oreja-Rodriguez and Armas-Cruz 2012), and Turkey (Onut and Soner 2006). There has also been limited investigation of property portfolios and accommodation estates of international hotel chains, like Hilton and Scandic (Bohdanowicz and Martinac 2007). Intra-organizational comparisons of this nature expose significant variability in environmental performance, measures and practices among properties associated with major brands (Bohdanowicz and Zientara 2012).

A second, connected strand has been the potential of particular technologies to enhance the environmental performance of tourism premises. For instance, solar control window film was evaluated as a potential energy saving device in hotels in Southern China (Chan et al 2008). Another recurrent theme has been the possibilities of renewable energy technologies (RET, Karagioras et al 2006; Michalena and Tripanagnostopoulos 2010). For example, in a series of studies Dalton et al (2007, 2008, 2009) investigated issues surrounding uptake, perceived business benefits, payback periods and the capacity for innovation within buildings and premises. Others have explored energy use over the life-course of a building. Rossello-Batle et al (2010: 557) concluded that around 78% of total energy in the assumed (50-year) life of hotels is consumed during the operational phase. For established properties, this represented 'where it is possible to achieve the biggest reductions in energy' by retrofitting and renovation. Similarly, one hotel inspected by Filimonau et al (2011: 1929) habitually undergoes minor refurbishment every two years. While efficiency may improve as a result, they reported that there are also 'considerable "hidden" energy and carbon impacts' that go largely unaccounted.

A closer examination of both strands is instructive. Although the possibility for building age to impact on total energy demand or energy use intensity (EUI) has been identified in general terms, neither relationship has been a primary nor sustained focus of attention. In fact, building age has been (too) briefly considered as a secondary issue in four studies that have explicitly invoked it as a variable of interest. Bohdanowicz and

Martinac (2007: 89) recorded extremely low correlation co-efficients (r^2 [sic] = 0.0056 and 0.02 [n.b. no p values reported]) between energy consumption and year of construction in their analyses of both mid- and up-market Hilton and Scandic properties in Europe. Median ages were 1976 and 1988 for properties in the respective samples. As they noted, 'both coefficients are too low to allow the year of construction to serve as an indicator of energy consumption'. For Deng and Burnett (2000: 10), 'no noticeable pattern relating the year of construction to EUIs can be identified for the 16 hotels' in their sample which were constructed between 1969 and 1994. Correlation analysis of building age and EUI was also conducted by Priyardarsini et al (2009) for 29 hotels in Singapore. A correlation co-efficient of -0.205 (i.e. intensity declines as properties become older) was reported but this effect was not statistically significant. With one exception (1929), the surveyed hotels were otherwise constructed between 1969 and 2004. In their view this result occurred because 'most old hotels have had major energy retrofit [sic] during the last decade or so. In most cases, these retrofits equipped them with advanced technology one can find in new constructions' (Priyardarsini et al 2009: 1323). However, they observed a strong and significant positive correlation ($r=0.539$, $p<0.01$) between time since retrofit and energy use intensity. This was because retrofits 'have generally been effective in reducing energy use and improving energy performance' but actually the direction of the correlation suggests that intensity increases over time since refitting, not as the authors contend. Finally, Wang (2000) observed moderate statistically-significant correlations for energy consumption ($r=0.236$, $p<0.01$) and EUI ($r=0.283$, $p<0.01$) with year of construction, thus suggesting that overall environmental performance declined with age. On this basis, year of construction was entered into multiple regression analyses for both environmental parameters. However, it was only a significant predictor for EUI, explaining just 1.3% of the variance (Wang 2012: 274) for a sample of 200 hotels of varying service and quality grade built between 1959 and 2009.

Taken together, this research presents a statistically indeterminate picture of the relationship between age and environmental performance, and it does so for relatively recent properties (i.e. built after 1945). In many developed countries, especially in Europe, much older buildings form a significant component of the accommodation stock (alongside more recent properties). In the UK context, a 'traditional building' is classified as pre-1919 (DCLG 2010), a year when building regulations were radically updated. Hence, in the remaining sections of this paper, these relationships with properties constructed over a much longer time frame are revisited. A further dimension is added to the discussion by investigating the how far building age is related to the uptake of technologies commonly used to mitigate the effects of SMTEs in terms of emissions generation. Indices such as energy demand, energy use intensity and total emissions are related to property age through the assumption that age influences the capacity for properties to adopt the latest, most efficient technologies. In other words: the older the property, the older the technologies it employs and the less beneficial its performance (Levine et al 2007). However, this working hypothesis has not been previously investigated for SMTEs and serviced accommodation businesses in much older properties.

[Insert Table 1 near here]

Research Design and Methods

These issues were investigated within a wide-ranging, five-year, two stage, programme of research on climate change mitigation and related issues among SMTEs in South West England (see Table 1). In Stage One, from 2009 to 2011, a mixed methods strategy was adopted. This blended data from an extensive, online questionnaire completed by 417 accommodation providers with a series of 18 semi-structured interviews on motivations, barriers and stimuli to greater mitigation activity.

The questionnaire survey covered *inter alia* the perceived relationship between business and the environment; the environmental practices of the business; and their operating characteristics. The regional tourist board (RTB) distributed it by email to 5,000 business which it randomly selected, and the effective response rate was calculated by the RTB to be 8.9%. Stratified random sampling could not be used because there was no census of tourism building age for the region. In fact, building age represented one explanatory dimension in the extensive 31-question survey instrument. In this particular context it incorporated the date when the main premises were first built; the nature of the technological innovations introduced to mitigate their effects; the date and level of investment in such innovations; and the extent to which the nature of the premises and the planning regime acted as barriers to mitigation. As part of the UK planning apparatus, since 1947 historically valuable buildings are 'listed' buildings to protect historic fabric to ensure its appropriate conservation and preservation (English Heritage, undated). By 2014, there were 374,081 listed buildings in England. Early pilot research revealed that 'Listed Building Status' (which is more prevalent among traditional buildings) may represent a barrier not only to newer technologies such as solar panels, solar water heating and wind turbines but also even to more modest measures such as double- and triple-glazing. Listed Building Status pertains to internal configuration as well as external appointment (i.e. windows, door, porch, roof, walls). Planning permission must be obtained for modifications that will change the essential nature or character of a property.

The questionnaire revealed several distinct features at the macro-scale while the interviews disclosed insights at the meso-scale, with individual businesses as the unit of analysis. In addition the interviewees suggested detailed investigations should be conducted within-businesses at a micro-scale. Several contended that, for businesses comprising multiple buildings, there were marked differences energy consumption and efficiency in different parts of the business or among individual accommodation units depending on development date, type and capacity for innovation. Thus, in the second stage of the programme a series of extensive 'case-histories' of energy management and mitigation behaviours were compiled. The case-study method (Yin 2014) offered two principal opportunities: a greater intensity of engagement between researcher and subject, and the triangulation of quantitative metrics with rich qualitative data to make sense of complex phenomena. None of the businesses participated in both stages of the research. 29 case-histories inform this paper, 24 of which delivered accommodation within fixed premises only (i.e. not involving touring caravans or camping). As recommended (Yin 2014: 59), a purposive sample was drawn from businesses expressing interest to participate in a demanding review of their energy use and management.

Access was requested to each business, its premises, staff and data during two episodes. Both were intended to be day-long but in practice required more time. In the first episode, key business parameters such as floor-space, rooms, occupancy, pricing and age of the premises were collected alongside financial, bill and metered data related to energy and water use. The operation of key environmental procedures was surveyed and the performance of energy-related technologies was examined. Notes of short, unstructured interviews with owners, managers and other employees were taken. The data were entered in a database, comprising several matrices of quantitative and qualitative material, and preliminary analysis was then conducted. This involved calculating a series of standard indices for resource use and energy efficiency as well as commercial performance. The second episode had two roles: to present the initial findings to, and to discuss them with, the business owners and/or managers; and to collect additional data, with a view to revisiting initial calculations. In the case of the former, this represented crucial verification. A wide range of energy-related practices and behaviours was encountered. Some were not anticipated by our prior research in Stage One nor by the extant body of knowledge. Hence our data required both 'sense testing' and corroboration. Case-study material is often presented in the form of detailed business-specific vignettes. Nevertheless, to be succinct here, where the analysis is informed by Stage Two it employs only quantitative data and emblematic examples of attitudes, behaviours and practices.

[Insert Figure 1 near here]

South West England was an ideal region in which to conduct this programme. Before its dissolution in 2011, on behalf of central government the RTB led UK policy development and implementation in sustainable tourism, including climate change adaptation and mitigation (Coles 2008; SWTA 2011; Whittlesea and Owen 2012). Just as crucial though, tourism accommodation stock in South West England has become heavily reliant on older, converted building stock alongside more recent, purpose-built premises, as a synthesis of several sources indicates. In Stage One of this research only 23% of premises were purpose-built while 62% and 15% occupied converted ex-residential and ex-commercial premises. Figure 1 also indicates that building stock among accommodation providers was much older than the regional average for the domestic sector. In some respects, this profile was to be expected, because of the history of tourism in the region. Resorts grew rapidly in the late-nineteenth and early-twentieth centuries through the efforts of the railway companies. Conversion of domestic housing stock into visitor accommodation started early (Shaw and Williams 1991; Morgan and Pritchard 1999). More recently, the conversion of farms, barns and other agricultural buildings into tourist accommodation and related facilities has been encouraged, especially through rural restructuring funds such as the EU Leader I (1991-95) and Leader II (1996-99) schemes and the Cornwall and Isles of Scilly Rural Tourism Improvement Fund (Cole undated).

[Insert Table 2 near here]

Results

Meso and macro scale perspectives on property age and mitigation activity

Although there was no complete census of accommodation providers in South West England when Stage One started, the RTB estimated that the total number may have been 14,970. If so, the resulting sample, the basic characteristics of which are described in Table 2, constituted around 2.8% of that population, or above the minimum sample size of 390 required for a 95% confidence level (Israel 1992). Typically, micro- and small-sized enterprises participated in the research covering the full range of service providers, including: full service hotels (3.6%), farmhouses and farm-stays (3.4%), general self-catering businesses (27.6%), bed-and-breakfast establishments (14.1%) as well as the RTB's 'catch-all' category of guest accommodation.

Three features of the sample are especially relevant. First, the modal class for property age was pre-1919 (71.1%, n=408). Most premises pre-dated the post First World War construction boom (Power 1993; Figure 1). Just under a third were constructed after that time, with 10% from the period of the Margaret Thatcher (1979-1990) and subsequent Conservative Party administrations (1990-1997) during which property ownership and development were extolled as major drivers for economic growth (Gulliver 2013). The sample exhibited a range of property ages through which to examine the relationships with mitigation behaviours. Second, when Stage One was conducted, businesses had been in their current ownership for an average of ten years (Table 2), *before* public discourse in the UK about climate change first gathered momentum in 2005 (Stern 2007). Thus, the owners had had sufficient time to implement measures in response to climate change, had they so wished. Finally, nearly two-thirds of accommodation was graded as four-star or above. In order to achieve such grades the majority of businesses must have been well-managed in order to satisfy the quality assurance thresholds.

Hjalager (2002: 465) has noted five different types of innovation associated with tourism enterprises. Process innovations are enhancements to existing operations, perhaps by new or improved technologies or the re-design or configuration of internal systems. The respondents were asked which of 20 process innovations related to climate change mitigation they had introduced. Of these, 13 types of innovation would require some modification to the premises and physical infrastructure so as to reduce environmental load (Figure 2). The IPCC approach was adopted and so both energy- and water-related measures were examined. As Bates et al (2008: 117) note, there is a reciprocal relationship between climate change mitigation measures and water. Mitigation can influence the availability of water resources but, more importantly here, water management measures influence GHG emissions. For instance, water heating accounts for around a quarter of energy use in the average hotel (Carbon Trust 2012). The final list of innovations ranged from relatively well-established and basic ideas (i.e. loft insulation, use of A-rated domestic appliances) to more recent technologies requiring a higher level of commitment (i.e. photovoltaic cells, solar-powered water heating, wood chip boilers). The respondents were also asked the value of their recent investments, if any, in six broad mitigation technologies (see Table 2 footnote).

[Insert Table 3 near here]

[Insert Figure 2 near here]

A Kruskal-Wallis test for analysis of variance revealed that there was no significant difference in the number of innovations implemented among the property age categories (H(4)=6.88, p=0.142). On average, across the entire sample this was just under five per business (of 13 possibilities, Table 3). As Figure 2 indicates, the most popular technologies for mitigating climate change were loft insulation, A-rated appliances, introducing more efficient boilers, water-saving devices, and enhanced glazing. The easier and/or relatively cheaper measures were, therefore, most commonly taken. In contrast, renewable energy technologies were comparatively unpopular. Fewer than 11% of businesses had invested in solar panels, solar water heating or wood-chip boilers (Table 3). Indeed, across the sample, the average investment in all mitigation-related technologies was just £12.6k which represented a re-investment by the current owners of just 2.0% of total revenue since they took over the businesses. Further Kruskal-Wallis tests demonstrated that there were no significant differences among building age categories in the number of investments that had been made in the six main technologies (H(4)=6.618, p=0.157), nor the total volume of investment made by each business (H(4)=5.628, p=0.229).

At first inspection of Table 3, the age-related statistical differences in uptake may be expected when the particular types of measure are considered. However, closer reading reveals several subtle features within the data set. For instance, as Figure 2 indicates, the oldest property category was the modal category for each technology. Owners and/or managers of many businesses with the oldest premises had found ways to implement all kinds of measures. These included both the modest and more involved as well as the more established and newer technologies depending on appropriateness to individual business contexts. Chi-Square tests revealed no statistically-significant relationship between building age category and the introduction of renewable technologies, such as solar water heating, solar energy panels and wood chip boiler systems (Table 3). Here, age had not militated against their use. In fact, the results were significant for just five technologies: the introduction of double- or triple-glazing throughout; smart metering; efficient showerheads; power-control room keys; and cavity-wall insulation.

The last aspect reflected the need to better insulate more recent buildings (Table 3), although the data pertaining to the oldest buildings should be treated with some caution. Cavity walls became more common in buildings in the 1920s and 1930s, partly as a result of regulatory changes, but primarily against rain and damp penetration (English Heritage, 2012). The use of cavity wall insulation became routine from the late 1970s (Cook 2009). The identification of cavity walls among the oldest properties may be a function of partial knowledge and/or multi-phased building histories where such insulation has been retrofitted or incorporated in extensions. It may also include businesses that insulated their solid walls (through internal or external wall insulation) although this is unlikely. Of the four other technologies, in two cases (smart metering and efficient shower-heads and taps) the proportion of businesses among the oldest (i.e. pre-1919) was broadly the same as the sample average. The relative differences were in greater uptake rates in post-1945 buildings. Moreover, properties from 1919-45 had lower uptake than those before 1919. In two cases (power-control room key and glazing), the oldest properties had uptake rates below the sample average. For glazing, the difference between the pre-1919 category and post-1980, the next lowest, was over 10%.

While all five results hint at cost and planning controls as notable issues, perhaps the clearest manifestation of the latter was the introduction of double- and triple-glazing. In general, interviewees (in both stages of the research) reported that they were dissuaded from any changes that would have potentially adverse effects on the appearance and character of their premises. As noted above, these criteria form a major basis for historic building conservation in the English planning system. Finally then in this regard, respondents were asked (on five-point Likert Scales) whether the nature of their premises and planning regulations made it harder to implement measures to tackle climate change (Table 3). Kruskal-Wallis tests revealed robust property age-related variations with respect to both premises ($H(4)=31.022$, $p<0.000$) and planning regulations ($H(4)=18.736$, $p=0.001$). Overall, planning regulations were perceived as less of an impediment than the nature of premises. The most emphatic results were obtained for the pre-1919 category, where 74.5% believed that their buildings made action harder compared to 60.8% with respect to planning regulations. Only those occupying properties from after 1980 viewed planning regulations as relatively more difficult than their buildings. With the exception of this category, there was a trend that the older the building, the harder it was perceived to implement change (Table 3).

Micro-level perspectives on property age and emissions.

Data collected in Stage One pointed to a complex relationship between property age and mitigation activity. Despite statistically-significant differences in the *perceived* difficulty presented by premises, the data on the *actual total* number of actions and levels of investment demonstrated no property age-related effects.

In other words, Stage One did not reveal compelling evidence to suggest that there was a disproportionately low innovation rate in older premises when it came to addressing climate change. Moreover, the lack of age-related differences in the implementation of renewable technologies remind us that these measures are not restricted to more recent buildings. Thus, if renewable technologies were in use across the sector even in the oldest premises, this raised the linked questions of how did older tourism properties perform in terms of energy consumption and efficiency compared to the younger? Was there an age-related effect? And hence should older properties be targeted in policy and practical efforts to encourage greater mitigation?

[Insert Table 4 near here]

Detailed intra-organizational research with the 24 businesses in Stage Two extended the initial analysis. As Table 4 makes clear, this considered a much broader age range of premises, which in some cases dated back several centuries. This sample was not representative of the population, nor was it designed to be. Nevertheless, it contained an array of mainly small- and micro-sized accommodation providers in a range of settings that allow for some generalization. Their quality assurance ratings attest they are reasonably well-managed and well-appointed as service providers. Commercial performance varied (Table 4) as did energy consumption and energy-related practices (Table 5). Where businesses were connected to the mains supply, with one exception gas was the main fuel source. Only four businesses used renewable energy sources and there was a relatively heavy dependence on hydrocarbons (gas, LPG and oil). These results were compared with one major international benchmarking scheme intended to assist European small- and medium-sized hotels sector with energy efficiency (HES 2011: 2). Although there were limits to the applicability of this general diagnostic tool to this particular data set, over half (n=14) of the 24 cases rated as 'excellent' (i.e. <195kWhm^{-2}) for energy efficiency (Table 5). Of these, eight pre-dated 1900 and the two oldest properties were first built in 1690 and 1750. Conversely, only three properties were rated as less than good (i.e. >280kWhm^{-2}) and two dated to the nineteenth century.

Property age was correlated against EUI. Both variables were normally distributed according to Kolmogorov-Smirnov tests (D(24)=0.107, p=0.200 and D(24)=0.112, p=0.200 respectively, i.e. p>0.05) and subjected to the Pearson correlation technique (r=-0.13, p=0.954). A weak negative effect (i.e. energy efficiency declined with increasing age) would have been recorded. However, the salient detail is that this relationship was not statistically significant; we cannot be confident that the relationship between the two variables occurred other than by chance (Field 2009). Moreover, the p-value is greater that the acceptable rejection level (ß=0.2) that may point to a Type II error, or when it is believed that an observable effect may have been erroneously overlooked (Field 2009: 56). A similar procedure was conducted with emissions intensity (CO_2m^{-2}). The variable was not normally distributed (D(24)=0.183, p=0.037) according to a Kolmogorov-Smirnov Test, and a Log_{10}. transformation was applied to adjust for the positive skew in the raw data (Field 2009: 155). The Pearson correlation procedure returned a weakly positive (i.e. CO_2m^{-2} increased in older properties) but non-significant correlation (r=0.083, p=0.699). Again this suggested it was unlikely to be a 'false negative' of the statistical test erroneously failing to detect a relationship in the sample.

Discussion

No compelling or irrefutable evidence emerged from Stage Two to suggest that, in general, older properties perform better or worse than more recent ones in terms of energy use intensity or emissions intensity (Table 4). Indeed in several cases older buildings performed relatively well, especially in terms of energy efficiency measures and benchmarks. Moreover, sometimes this was better than their more recent counterparts. The inconclusive findings in Stage Two corroborated results from Stage One. More importantly, they resonated with three of the four previous studies considering age (Bohdanowicz and Martinac 2007; Deng and Burnett 2000; Priyardarsini et al 2009), albeit this research examined a much wider age range of properties. Notably though, they diverged from the general view taken in practitioner and policy documents that older buildings routinely perform worse than more recent ones (Levine et al 2007; BRE 2005), and hence it is worthwhile reflecting further on the results of this research.

One obvious starting point is to question whether these results are a function of the research design, sampling and analysis. There is always a possibility that, were the research repeated, another sample may yield different results. This is the nature of all work involving sampling and probabilistic procedures. Nevertheless, *prima facie* Stage Two suggests 'false negatives' to be very unlikely. Furthermore, a sample size of 24 is not small in the context detailed, intensive research with SMTEs more generally (Morrison and Teixera 2004; Sampaio et al 2012a, 2012b) nor, as noted above, in studies on energy among tourism businesses (Deng and Burnett 2000; Priyardarsini et al 2009). In fact, the Stage One results are drawn from a random sample which represented nearly 3% of the background population. This sample size was greater than standard sample size predictors require; it was also larger than many other studies of SMTEs have employed, in particular in the context of climate change research. Hence, the sample from Stage One may be regarded as robust.

If the issue is approached differently, the complexities evident in Stage Two corroborate Stage One. They contribute important new perspectives on climate change mitigation especially in destinations relying on older building stock. First of all, it is important to record that no single construction technique has been exclusively employed in the past. This observation may appear axiomatic. However, prior studies are skewed towards late twentieth-century buildings and technologies (Deng and Burnett 2000; Wang 2000; Bohdanowicz and Martinac 2007; Priyardarsini et al 2009), with a relative homogenisation of building techniques and technologies. In contrast, this research includes properties constructed over a more protracted period. The absence of clear age-related effects may be a consequence of the existence of multiple construction techniques in parallel to one another and to their endurance over time. Many of these 'traditional' approaches are still in use today and have been so across the last century. Variations in building technique and style imbue buildings of similar basic age with quite different thermal properties. They also impact differentially on the capacity for, and cost of, retrofitting. For instance, two businesses in Stage Two with similar energy intensity results (Table 5) use premises dating from the nineteenth century but have sharply contrasting basic construction styles: Business 3 is in the typical Victorian brick style, whereas Business 5 employs the traditional cob[1] building technique that is well-established and still in use in the region. Recent research suggests thicker walls perform better than thin walls, such that rubble stone and cob, built to a thickness of 6.00cm typically, performs better than 22.86cm brickwork. Moreover, walls made of less conductive materials like daub and cob (both mixed with straw) are better insulators than brick and stone (Suhr and Hunt 2013: 101).

Connected to this, several businesses reported that their main properties had been developed in phases (i.e. in a piecemeal manner) and had incorporated different building techniques, styles and technologies during their extended life span. Hence, in the context of this study, time since last retrofit was not an especially valid variable (cf. Priyardarsini et al 2009) or conceptual construct because properties had developed incrementally in multiple stages over protracted periods, undergoing renewal and regeneration of varying scale and scope on several occasions in the past, during the current owners' stewardship, and at their predecessors' hands. In one particular variant of this, several respondents' noted in interviews in both Stages One and Two that their accommodation stock had expanded as their businesses grew, due to the conversion of outhouses, barns, sheds, stables and other (largely agricultural) buildings. Rural restructuring initiatives in the 1980s and 1990s had encouraged the development of many holiday apartment complexes. These comprised multiple units clustered around imposing rural residences, especially farmhouses. Irrespective of former use, conversions had made use of the basic 'shell' of the original buildings (with their inherent thermal properties). Subsequent construction of guest accommodation had utilised the latest late twentieth-century heating and insulation technologies.

Listing, preservation orders and other restrictive covenants were argued to be routine impediments. However, a small minority from Stages One and Two offered the insight that, despite public perception and stereotype, not all older properties are subject to heavy regulation and restrictions. For the majority of interviewees in this programme, dealing with age-related features was routine: there are so many very old premises in the South West. For the majority of interviewees in both stages, age only became an issue where it impacted heavily on the cost of retro-fitting. However it was also noted that costs can be both high and a deterrent even in the more recent (comparatively) buildings from the 1940s, 1950s and 1960s. Offering accommodation in a heritage building can, however, be a unique selling point.

Finally, Table 5 points to the relative absence of renewables in the energy mixes. Notwithstanding, several participants in both stages were emphatic in arguing that property age was *not* a main driver for this. Among the small minority who were well-versed in the topic, it was routinely observed that the context of their buildings (e.g. orientation, roof pitch, sight lines, planning control etc) had militated against the introduction of such technologies, not age. Context, it was argued, ultimately determined their productiveness, efficiency and cost effectiveness (in terms of payback), not to say their ability to contribute towards emissions reductions (in that order). The more perceptive in Stage Two even contended that renewable energy had become synonymous with solar energy because of high profile public discourse in the UK about the Feed-in-Tariff (see Coles et al 2013). However, other renewable energy options were perhaps more suitable to older buildings. Most notable was the use of biomass boilers for their apparent inconspicuousness in older premises (although cost and difficulties of fitting were still reported as common obstacles).

Conclusion

This paper has examined the relationship between property age and mitigation responses to climate change among SMTEs as revealed through a long-term programme of empirical research. Although a much stronger relationship between property age and climate change mitigation may have been anticipated, the principal contribution of this paper has been to demonstrate that age of premises does not play a straightforward nor definitive role in encouraging or hindering efforts to tackle climate change among accommodation providers.

Results from Stage One demonstrated that as many innovations were taken in older, traditional properties (i.e. pre-1919) as more recent ones (i.e. post-1945), and that the original age of the property was not an impediment to the deployment of renewables. Business owners and managers for some of the oldest premises had introduced some of the latest renewable energy technologies. Nevertheless, as micro-level inspections in Stage Two revealed, adapting older buildings was not without complications and cost-related considerations. However, it is too simplistic to think that businesses in older properties have not responded (and cannot contribute more) to the mitigation effort. Similarly, there is insufficient evidence that property age impeded mitigation in the manner predicted by general prescriptions like those of the IPCC.

While an inverse relationship between age and environmental performance may have been expected, this was not observed. It is difficult to generalise, therefore, that older tourism premises are either worse or better in terms of energy efficiency than more recent buildings. The environmental performance of historic building fabric is often portrayed in a more negative manner than is actually the case (May and Rye 2012).

There are three broad implications for future research. First, further investigation of this relationship would be welcome for properties built over various age ranges. South West England was an ideal first location because of its long history of tourism and leadership in the practice of sustainable tourism. However, the regional property profile is distinctive. Questions remain as to whether similar results may occur in other destinations with different arrays of construction styles, techniques and materials or with contrasting histories of building stock development and utilisation. Further research of this nature may overcome the lack of a census about specific building ages for accommodation providers. Future empirical research would be beneficial where a stratified sampling and greater differentiation among older, traditional (i.e.pre-1919) buildings is possible. Both would allow research to progress from the generalization of the case-study approach to the generation of representative results and findings.

This research also encountered difficulties in relying on business managers and owners for accurate information on dates of original construction as well as subsequent extensions, conversions and retrofitting exercises, in particular those that predated their stewardship. An inter-disciplinary approach combining expertise from the social and physical (i.e. construction) sciences may also enable more precise identification of measurement of construction dates and types. Of course, it was only ever the intention here to investigate age as an explanatory variable in a singular sense. However, a more detailed, intimate knowledge of older accommodation buildings would, along with other contextual variables (such as ownership type, target market/s and facilities offered), potentially enable the specification of multiple regression models to aid deepen our understanding of their environmental performance.

A second implication for future research is that a more extensive evidence base is required to inform bespoke approaches to energy efficiency and carbon reduction in older tourism premises. Much of the current energy efficiency advice for UK businesses is geared towards modern commercial buildings, and takes little account of the differences in approach needed for older, often formerly residential buildings (May and Rye (2012). This research demonstrates that a more refined approach is necessary: buildings do not always conform to stereotypes of inefficiency, and they can be successfully modified to achieve further reductions if a sensitive and appropriate approach is deployed. Finally, there is a need to revisit how emissions reductions are conceptualised. Pro-environmental behaviour change among visitors and business operators may be pivotal to future emissions trajectories; however, agency is not unconstrained. As this research has demonstrated, a clearer understanding is needed of the precise appointment -and hence modifying role- of particular settings, spaces and sites where behaviours are played out, if the capacity of pro-environmental behaviour change is to be properly assessed.

Footnotes

[1] Cob is a material made of unbaked clay with straw and other ingredients, also known as rammed earth, pisé or forms of mud brick. It was often used in areas with poor quality building stones or brick clays for low cost vernacular buildings.

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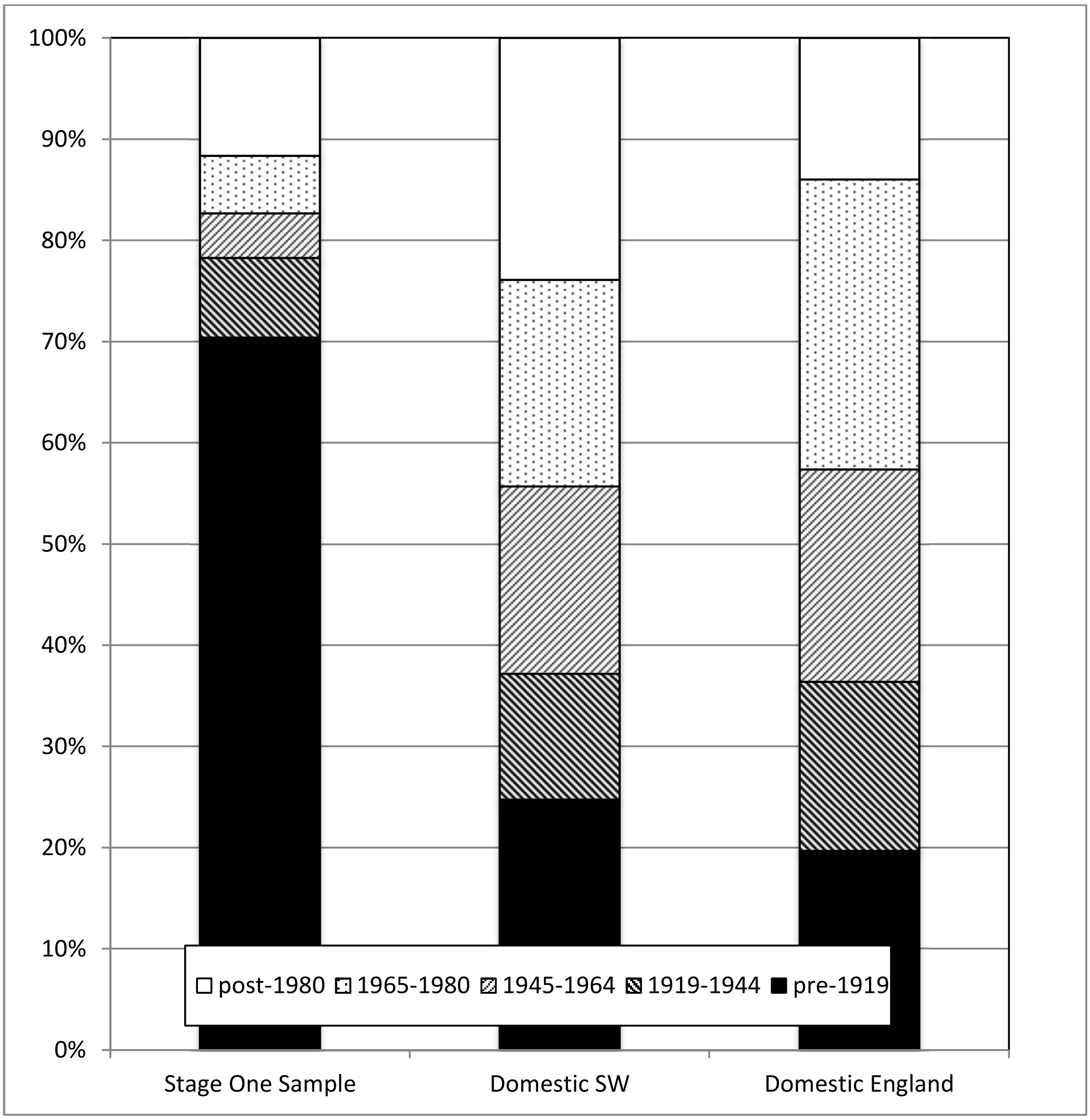
Table 1: The research programme in brief

Stage	Period	Main features of the research
1	2009-2011	Mixed methods research strategy Questionnaire survey -31 questions, 417 usable returns, 8.9% response rate, 2.8% of background population Semi-structured interviews -18 in total, range of business types, Up to an hour in length Funded by Economic and Social Research Council (ESRC)
2	2012-2014	Case-study approach Intensive in-business research over minimum of 2 days 29 participant businesses (to January 2014)* Combination of primary data (observation, measurement) and secondary data (bills, meterage etc.) Over 150 parameters measured or calculated Funded by European Regional Development Fund (ERDF)

Source: authors

Figure 1: Frequency distribution of property ages in Stage One, the South West region and England.



Source: authors (Stage 1), DCLG (2014) and O'Brien (undated)

Table 2: Basic business characteristics of the sample (Stage One)

Business Attribute	Value
Average number of employees (full-time equivalents)	3.2
Average turnover in 2009 (£k)	60
Average occupancy in 2009 (%)	53.4
Average number of bed-spaces*	15.9
% Accommodation Graded 3-Star	21.3
% Accommodation Graded 4-Star	55.7
% Accommodation Graded 5-Star	10.1
Average date business established	1980
Average length of business in current ownership (years)	10.4
Average date premises first built (year)	1919
% of premises built after 1980	11.0
Average number of process innovations made in last 10 years	4.8
Average number of planned innovation in next year	3.2
Average total investment over past 10 years (£k)*	12.6

* 5% trimmed mean (refers to roof insulation, wall insulation, efficient (water, central) heating systems, renewable technologies (solar, wind, water), efficient (i.e. A-rated) appliances, and double/triple glazing.

Source: authors (Stage 1)

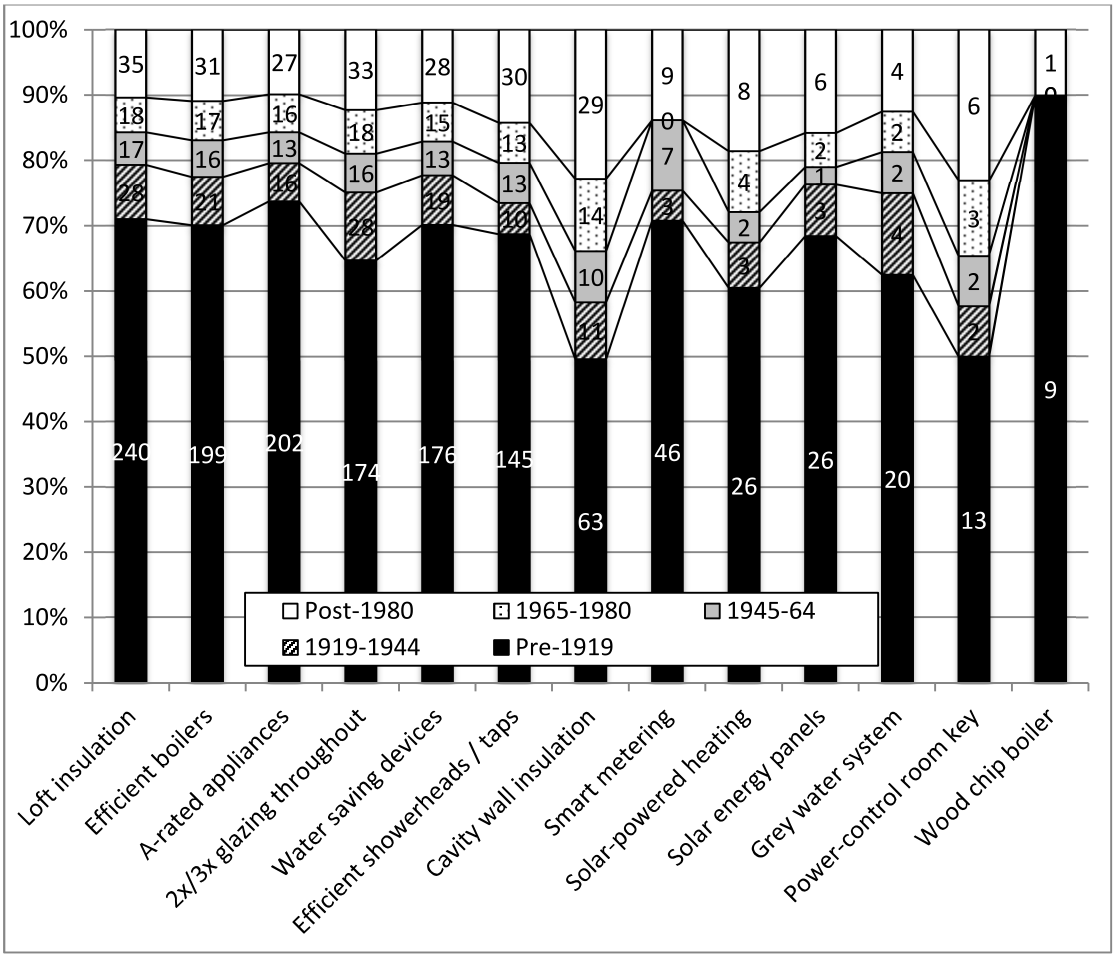
Table 3: Mitigation measures and related issues by property age group (Stage 1)

% of businesses….	Property Age						
	Pre-1919	1919-44	1945-64	1965-80	Post-1980	Sample	Test Statistic *
that had introduced:							Chi-Square
Loft insulation	82.8	87.5	85.0	85.7	77.8	82.8	1.489
Efficient boilers	68.6	65.6	80.0	81.0	68.9	69.6	2.579
A-rated appliances	69.7	50.0	65.0	76.2	60.0	67.2	6.955
2x/3x glazing throughout	***60.0***	***87.5***	***80.0***	***85.7***	***73.3***	***65.9***	**17.689**
Water saving devices	60.7	59.4	65.0	71.4	62.2	61.5	1.129
Efficient showerheads / taps	***50.0***	***31.3***	***65.0***	***61.9***	***66.7***	***51.7***	***12.024***
Cavity wall insulation	***21.7***	***34.4***	***50.0***	***66.7***	***64.4***	***31.1***	***51.113***
Smart metering	***15.9***	***9.4***	***35.0***	***0.0***	***20.0***	***15.9***	***10.994***
Solar water heating	9.0	9.4	10.0	19.0	17.8	10.5	4.927
Solar energy panels	9.0	9.4	5.0	9.5	13.3	9.3	1.344
Grey water system	6.9	12.5	10.0	9.5	8.9	7.8	1.598
Power-control room key	***4.5***	***6.3***	***10.0***	***14.3***	***13.3***	***6.4***	***8.036***
Wood chip boiler	3.1	0.0	0.0	0.0	2.2	2.5	2.360
that agreed:							H
Premises make mitigation harder	***74.5***	***65.6***	***55.0***	***38.1***	***46.7***	***70.9***	***31.022***
Planning regulations make mitigation harder	***60.8***	***34.4***	***55.0***	***33.0***	***53.3***	***56.2***	***18.736***
Total number of properties in class (n)	290	32	20	21	45	408	-

* 4 degrees of freedom for each test and **$p<0.05$ i.e. accept H_1**

Source: authors (Stage 1)

Figure 2: Levels of the implementation of technologies by age of premises (Stage 1)



n.b. numbers in bars refer to absolute number of businesses introducing innovation

Source: authors (Stage 1)

Table 4: Basic parameters of participating businesses (Stage Two)

Business	Bedspaces	Bedrooms	Annual occupancy	Sector	Quality Rating*	Location type:	Last annual revenue (£k)	Date main premises
1	2	1	83%	Self catering	-	Rural	16	1820
2	12	6	54%	Self catering	-	Rural	24	1973
3	17	9	67%	B&B	3*	Urban	114	1850
4	44	21	46%	Self catering	4*	Rural	175	1940
5	6	3	59%	B&B	4*	Coastal	36	1820
6	16	8	39%	Self catering	4*	Rural	44	1884
7	18	7	44%	B&B	4*	Coastal	85	1690
8	42	21	63%	Guest House	4*	Urban	204	1913
9	12	6	39%	Hotel	3*	Coastal	65	1895
10	32	16	71%	Self catering	5*	Rural	240	1805
11	14	7	30%	Self catering & B&B	4*	Rural	45	1840
12	12	6	48%	Self Catering	4*	Rural	44	1793
13	32	12	45%	Self catering	-	Rural	91	1750
14	8	4	55%	Self catering	4*	Rural	46	1968
15	4	2	16%	B&B	4*	Rural	7	1650

16	56	30	43%	Self Catering lodges	4*	Rural	147	2005
17	86	44	41%	Hotel	3*	Rural	1,080	1934
18	6	3	39%	B&B	4*	Coastal	30	1850
19	41	18	43%	Self Catering	4*	Rural	53	1901
20	14	7	31%	B&B/ self catering	-	Coastal	63	1856
21	12	6	39%	B&B	4*	Coastal	55	1880
22	12	5	15%	B&B	-	Rural	50	1901
23	14	7	65%	Guesthouse	-	Coastal	72	1896
24	11	6	76%	Guesthouse	-	Coastal	55	1940

* In some cases businesses had terminated their participation in grading schemes. – denotes had not subjected themselves to assessment

Source: authors' fieldwork (Stage 2)

Table 5: Energy-related operating parameters for SMTEs in Stage 2

Business	Main heating fuel	Mains gas?	Fuel Mix			kWh annual total	Energy - kWh per guestnight	Energy - kWh per m^2 (year)	HES Benchmark	CO_2 per m^2
			Electricity (bought)	Hydrocarbons	Renewables					
1	Gas	Yes	84%	16%	0%	12657	21	316	Average	79
2	Oil	No	18%	79%	3%	37212	16	124	Excellent	40
3	Gas	Yes	32%	68%	0%	66321	17	172	Excellent	51
4	Electricity	No	100%	0%	0%	120829	32	177	Excellent	170
5	Gas	Yes	26%	74%	0%	32049	24	143	Excellent	41
6	Oil	No	16%	79%	5%	58056	27	241	Good	68
7	Oil	No	30%	70%	0%	66735	30	182	Excellent	63
8	Gas	Yes	18%	82%	0%	220139	22	301	Average	77
9	Gas	Yes	11%	89%	0%	77990	48	233	Good	54
10	Oil	No	30%	70%	0%	176330	21	260	Good	93
11	Oil	No	11%	89%	0%	118527	72	444	Poor	134
12	Oil	No	12%	88%	0%	59464	30	24	Excellent	74
13	Oil/LPG	No	29%	72%	0%	88092	20	118	Excellent	31
14	Gas	Yes	24%	76%	0%	29433	18	267	Good	74
15	Oil	No	3%	97%	0%	22865	99	207	Good	63

16	Gas	Yes	21%	79%	0%	151868	18	178	Excellent	45
17	Gas	Yes	34%	66%	0%	833659	68	202	Good	61
18	Gas	Yes	46%	54%	0%	16831	7.5	43	Excellent	14
19	Electricity	Yes	100%	0%	0%	20952	3.9	27	Excellent	15
20	Oil	No	29%	71%	0%	53138	42	221	Good	78
21	Oil	No	24%	53%	23%	30923	18	121	Excellent	49
22	Oil	No	20%	41%	36%	28657	45	171	Excellent	27
23	Oil	No	17%	83%	0%	36523	16	190	Excellent	40
24	Gas	Yes	19%	81%	0%	28232	12	115	Excellent	30

Sources: authors' fieldwork (Stage 2), HES (2011: 17)

Notes: HES (2011) benchmarks for kWh per m^2 per year: Excellent (<195), Good (195-280), Average (280-355), Poor (355-450) and Very Poor (>450). These are based on quintiles i.e. a frequency distribution from a meta-analysis.

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