Carbon Villains? Climate Change Responses among Accommodation Providers in Historic Premises

T.E. Coles[1]*, C.R. Dinan[1] and N. Warren[1,2]

[1] *University of Exeter Business School, Department of Management.*

Streatham Court, Rennes Drive, Exeter, Devon, EX4 4PU. United Kingdom.

[2] *Centre for Business and Climate Solutions, Unit M1 – Innovation Centre (Phase 1),*

Rennes Drive, Exeter, Devon, EX4 4RN. United Kingdom

* Corresponding author. Email: t.e.coles@exeter.ac.uk

Funding

The authors would like to acknowledge the support of the Economic and Social Research Council for funding Stage One of this programme (RES-185-31-0046). The European Regional Development Fund (2007-13) supported the detailed research conducted with individual businesses which forms the basis for Stage Two.

Carbon Villains? Climate Change Responses among Accommodation Providers in Historic Premises

Abstract

Building stock is a major anthropogenic source of emissions contributing to global warming. Older buildings are conventionally portrayed as performing worse environmentally than more recent buildings. For a sector like tourism, which relies heavily on historic building stock, this raises questions about its ability to contribute to emissions reductions moving forward. This paper explores the relationship between the age and environmental performance of historic premises for small accommodation businesses in South West England, first by correlation analysis and then three extensive case-studies. It argues that the failure to integrate heritage buildings in tourism scholarship on climate change is a major lacuna. Empirically, no statistically significant relationship is found between environmental performance and the date when the original premises were first built. Far from being carbon villains, several accommodation providers in older premises perform very well against environmental benchmarking schemes. Three types of heritage accommodation providers are identified on the basis of their perceived and actual levels of environmental performance. The paper concludes that heritage building stock of itself is no impediment to action on climate change. Guidance to tourism businesses in such properties should make them aware of this, and provide tailored advice to help them realise potential opportunities.

Keywords:

Climate change; heritage; tourism; accommodation; lodging; energy

Carbon Villains? Climate Change Responses among Accommodation Providers in Historic Premises

Introduction

The recent 5th Report of the Intergovernmental Panel on Climate Change (IPCC) restated the need for urgent and significant action. Just as before (Levine, Urge-Vorsatz, Blok, Geng, Harvey, Lang, Levermore, Mongameli, Mirasgedis, Novikova, Riling, and Yoshin, 2007), once more building stock was identified as one of the principal anthropogenic sources of emissions contributing to global warming (Lucon, Urge-Vorsatz, Ahmed, Akbari, Bertoldi, Cabeza, Eyre, Gadgil, Harvey, Jiang, Liphoto, Mirasgedis, Murakami, Parikh, Pyke and Vilarino, 2014). Set against this backdrop, several studies of tourism buildings have appeared. Mostly these have focused on the environmental performance of individual accommodation units (Deng 2003; Beccali, La Gennusa, Lo Coco, and Rizzo, 2009; Xuchao, Priyadarsini and Eang, 2010; Lu, Wei, Zhang, Kong, and Wei, 2013) and across hotel estates (Bohdanowicz and Martinac 2007; Bohdanowicz and Zientara 2012), emissions throughout the life-course of built fabric (Rossello-Batle, Moia, Cladera and Martinez, 2010; Filimonau, Dickinson, Robbins, and Huijbregts, 2011) and the performance of innovative technologies in premises (Kariagiorgas, Tsoutos, Drosou, Puffray, Pagano, Lara, and Mendes, 2006; Chan, Mak, Chen, Wang, Xie, Hou and Li, 2008; Michalena and Tripanagnostopoulos 2010; Cheung and Fan 2013). However, much older buildings -especially those originating before 1900- have been largely overlooked in a detailed sense, as recent texts on carbon management (Gössling 2010) and reviews of sector-wide climate change responses (Kaján & Saarinen 2013) indicate. This is notwithstanding heritage buildings are central to the product offer in many destinations as attractions and venues, for instance in their own right as hotels and resorts (Ertugal and Dincer 2003; Goh 2010; Ong 2015;

Chhabra 2015), or in combination as historic precincts and quarters (Graham, Ashworth and Tunbridge, 2000; Wu et al. 2015). Furthermore, older buildings, especially in the UK (DECC/BRE/EST 2007), are in general portrayed as performing worse than more recent buildings on key environmental metrics (Levine et al. 2007; Lucon et al. 2014). In some instances they have even been decried as 'carbon villains' (Retrofitbuildings undated). Logic of this nature implies that a sector like tourism that relies on historic building stock, has a poor starting point for emissions reduction. Moreover, there needs to be a move to new, purpose-built stock and/or more radical changes among older buildings.

This paper presents an examination of these propositions. Specifically, it explores the relationship between the age of premises and environmental performance among small heritage accommodation businesses in South West England. Within the European Union small- and medium-sized enterprises (SMEs) are defined as those with fewer than 250 employees and/or turnover less than €50 million (EC 2014). Such businesses dominate the tourism sector globally (Thomas, Shaw and Page 2011) and in this region (BIS 2013). Although now somewhat dated, estimates suggest that in 2005 the tourism sector contributed around 5% of global anthropogenic CO_2 emissions but this 'may be higher (from 5% to 14%) if measured as radiative forcing' (Simpson, Gössling, Scott, Hall and Gladin 2008). Of that, accommodation (hotels, motels, bed & breakfast, camping, apartments and second homes) accounted for 21% via energy throughput only (Simpson et al. 2008 p. 77). The relationship is examined first by correlation analysis prior to the presentation of three case-studies. The term 'case-study' is much used (and abused) in the social sciences. Here it is used in the original sense (Yin 2014) as the delivery of extensive empirical data about the case(s) in order to generate insights that have much wider generalizability (not representativeness). Mitigation efforts, experiences and effects are examined for three emblematic accommodation businesses that trade on their heritage premises. Before that the next section considers how historic properties have featured in recent tourism discourse, in particular as related to climate change.

Literature review

Although heritage tourism has become one of the most prominent subjects within tourism studies (Timothy and Boyd 2006), accommodation and lodging in heritage premises, or 'heritage hospitality' (Elghani 2012), has not attracted as significant or sustained academic attention. This is curious because brochures, guide books, social media (cf. Yoo and Lee 2015) and the grey literature all indicate that heritage accommodation is popular with visitors. This is the case in both urban and rural environments whether in the form of converted cottages, town houses and homesteads or purpose-built, but nevertheless long-standing guest houses and hotels. Historic fabric –used for accommodation and other uses- also contributes positively to destination popularity (English Heritage 2010 p. 5), to destination iconography and greater visibility, and to enhanced attraction mixes (VisitBritain 2010).

Recently, there have been signs of an upturn in academic interest (Murzyn-Kupisz 2013; Ren, Shih and McKercher 2014), not least in this journal (Cheer and Reeves 2015; Chhabra 2015; Joliffe and Aslam 2015; Wu et al. 2015). A central feature of the recent research effort has been analysis of the ways in which existing fabric has been reused and the various challenges this creates. For instance, from their examination of Fiji, Cheer and Reeves (2015) observed the redevelopment of historic buildings can re-politicise otherwise benign colonial histories and aggravate tensions in already fragile ethnic landscapes. Often reuse involves conversion from one distinctive land use into another (accommodation) for which it was not always intended (Ong 2015). Within Sri Lanka's Hill Country, the transformation of planters clubs and managers clubs into boutique accommodation has maintained the rich tea heritage, distinctive landscape characteristics and ecosystem services associated with the region (Joliffe and Aslam 2015). In many cases, conversions have been funded by private investors as commercial ventures first and foremost, not always with beneficial outcomes for local communities. For instance, Murzyn-Kupisz (2013) has identified a series of largely elitist projects, or 'one-of-a-kind gentrification processes' in rural settings within Lower Silesia (Poland). Her examination of the social politics provides a counterpoint to Ertugal and Dincer's (2003 p. 23) overtly urban focus. Buildings in historic Istanbul were in high demand. They were encumbered with heavy financial burdens, and subject to 'bureaucratic impediments' during renovation and once operating.

Ertugal and Dincer (2003 p. 24) reveal how the effort and extent of work to convert, renovate or adapt older buildings as hotels and restaurants is often greater than for more recent premises. This is for reasons like the state of preservation or functional suitability of the buildings. More specifically here, their work resonates with the challenges faced by those owning or managing older buildings in responding to climate change. Difficulties in retrofitting, establishing the necessary levels of investment and determining payback periods, as well as planning, regulation and governance are common are common to the latter (Dalton, Lockington and Baldock 2008, 2009; Chan 2011; Coles, Zschiegner and Dinan 2013). Yet, just as historic premises have been largely overlooked in research on heritage tourism, so too they have been in discourse on tourism and climate change (Gössling, 2010; Kaján & Saarinen 2013).

This is curious because, as the IPCC has argued, much of the world's built fabric was not constructed with the demands of climate change in mind (Levine et al. 2007). Rather, there is a considerable legacy of historic buildings of varying ages, styles and appointment that require renovation, renewal and retrofit. In this respect, building age connects to environmental performance through two key parameters: the age of the built fabric, and the installations that make it liveable. In general, newer buildings should benefit from the latest advances in building technology, construction techniques, and environmental management which are more thermally- and energy-efficient. In fact, as far back as the IPCC's Fourth Report, there was 'high agreement' and 'much evidence' that the largest savings in energy use (75% or above) are associated with new buildings that make use of the latest technologies and management processes, in particular as part of whole building contexts. Notable savings from older buildings can be secured but they are not as straightforward. Retrofitting, replacing energy-using equipment, and low stock turnover are significant impediments to overcome (Levine et al. 2007 p. 389).

Hence, it is somewhat surprising (and disappointing) that there has not been far greater examination of the potential (or not) of historic stock to impact on tourism sector targets for emissions reduction. In a wide-ranging analysis, Gössling (2013) identified a range of systemic reasons why the tourism sector may struggle to achieve these. Interestingly, excluded from his analysis was the preponderance of historic premises with their potentially higher total energy demand and energy use intensity (EUI). Where the age of premises has been considered as a variable in environmental performance, the predominant focus has been on those constructed in the relatively recent past since 1945. Property age has only been an explicit variable of interest in four studies, the results of which hardly present a compelling relationship between age of original construction and environmental performance. For instance, Bohdanowicz and Martinac (2007 p. 89) observed extremely low correlation co-efficients (r^2 [sic] = 0.0056 and 0.02 – no p values) for the relationship between energy consumption and construction year for properties in the Hilton and Scandic estates. The median building ages were 1976 and 1988 respectively. For a sample of 16 hotels in Hong Kong built from 1969 to 1994, Deng and Burnett (2000 p. 10) found 'no noticeable pattern relating the year of construction to EUIs'. Priyardarsini, Xucao and Eang (2009), working on a sample of 29 hotels in Singapore, found EUI declined with age ($r = -0.205$). With one exception (1929), the hotels originally dated from 1969 to 2004. Finally, Wang (2000) examined a sample of 200 hotels of varying service and quality grade in Taiwan constructed between 1959 and 2009. Moderately positive, statistically-significant correlations for energy consumption ($r=0.236, p<0.01$) and EUI ($r=0.283, p<0.01$) with (later) year of construction. However, when entered in multiple regression analysis, age was a significant predictor only for EUI, but explaining just 1.3% of the variance (Wang 2000 p. 274).

Possible explanations as to why much older properties have been overlooked are to be found in building life-course assessments. Rossello-Batle et al. (2010 p. 557) have noted that around 78% of total energy is consumed during the operational phase of the assumed 50-year life of hotels. This is also 'where it is possible to achieve the biggest reductions in energy', for instance through retrofitting and renovating 'ageing' properties. Be this as it may, 'traditional buildings' in the UK are usually understood to be those erected before 1919 (DCLG 2010), even dating to the nineteenth century and much earlier. Indeed, western European building stock is being demolished and replaced at slower than expected or desired rates (Lowe 2007). As Kohler and Yang (2007 p. 356) have noted of Germany, 'from the analysis of the survival functions of other stocks it appears that the older age classes have much higher survival probabilities, and that the newer age classes will disappear before the older ones'.

In light of the much higher proportion and greater persistence of older buildings in developed countries, their contribution to emissions reduction is coming under renewed scrutiny. For instance, Moran, Natarajan and Nikolopoulou (2012 p. 225) examined energy use from pre-1919 dwellings in the World Heritage City of Bath, a major heritage tourism destination that also makes use of the same fabric in its accommodation stock. Their qualified view was that although 'energy use in historic dwellings in Bath is lower than the national and regional average, this does not indicate that historic buildings are energy efficient' while 'the lower levels of energy use from energy efficiency retrofitted historic dwellings have been demonstrated'. This caution is understandable and, as they note, their results may be a function of sampling. Alternatively, the aggregated data or modelling systems may be suspect, or there may be distinctive behavioural aspects in operation by the occupants (Moran et al. 2012 p. 225-226). In the case of the latter, Fouseki and Cassar (2014 p. 97) have argued that 'studies of occupants' attitudes and behaviour with regard to energy-efficiency interventions are critical. How people use a building often will be more important than the type of energy-efficiency technologies selected'. In the case of the former, some practitioners have argued that the orthodox position on historic buildings is too reductionist in nature (cf. May & Rye 2012), and it results in simplifications that have the potential to be dangerously misleading (CIBSE 2012). Not all historic buildings perform badly (Wallsgrove 2008). Some older, more traditional building techniques perform reasonably well (May & Rye 2012). Many older buildings have been developed incrementally over time in a piecemeal fashion using multiple construction technologies (Cook 2009). Nevertheless, many contemporary interventions represent one-size-fits-all solutions that are inappropriate to implement in older buildings (May & Rye 2012). Instead, they are geared to, and derived from, newer and residential buildings (EST, 2011).

Research design and methods

From this review a picture emerges of buildings as critical in the response to climate change. There is, though, significant but as yet unresolved conjecture about the role of historic buildings in emissions reduction. Although the tourism sector is reliant on older fabric, building age as it relates to environmental performance or measures to mitigate climate change has been largely overlooked.

This knowledge gap has provided the rationale for an extended programme of research on climate change mitigation among tourism SMEs in South West England. As a long-established destination (Shaw and Williams 1991; Morgan and Pritchard 1999), the region has a large, enduring stock of visitor accommodation. Over the past two decades a major trend has been the renovation of redundant buildings for tourism accommodation, especially in rural environments (Lane 2009; Coles 2009). Properties have been restored –in some cases by capital grant- that would have otherwise become derelict and recent visitors have been attracted through the appeal of distinctive local vernacular architectures and built heritage.

A five-year programme of work has been conducted in two stages. The first (2009-11) employed a mixed methods strategy to establish the nature and extent of mitigation activity. A questionnaire survey of 417 accommodation businesses was accompanied by 18 semi-structured interviews with business owners and/or managers. The survey interrogated *inter alia* the date when the main premises were first built; the nature of the technological innovations introduced as mitigation as well as the date and level of investment; and the extent to which the nature of the premises and the planning regime had acted as barriers to mitigation. The results of this stage have been reported in detail elsewhere (Coles et al 2013; Coles, Zschiegner and Dinan 2014; Coles, Dinan and Warren 2014). Of relevance here is that there was no significant difference in the number of, and level of total investment in, pro-environmental innovations among properties of different age. This result exposed the need for micro-level, in-business investigations.

Thus, the second stage (2012-14) employed the case-study approach (Yin 2014) to compile extensive, business-specific profiles of carbon management, environmental performance and mitigation behaviours. These provided the means to identify possible common denominators among SMTEs. By the end of the research, 49 'case-histories' had been compiled, 34 businesses among which delivered a mix of serviced and self-catering accommodation but, crucially, within fixed premises. Yin (2014 p. 59) recommends purposive sampling as best practice. This sample was drawn from businesses wanting to participate in – what became- an extremely demanding review of their environmental resource use and management. Businesses in historic premises in a variety of rural, urban, coastal and inland settings comprised the sample, both on and off mains energy- and water-supply grids.

Each business was investigated in two episodes. These were intended to be day-long but in practice required longer. Open access was provided to premises, staff and otherwise confidential, commercially-sensitive data. 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 meterage data related to energy and water use. Environmental procedures were surveyed, the performance of energy-related technologies was examined, in-business practices were observed, and notes of short, unstructured interviews with owners, managers and other employees were taken. These were not audio-recorded for reasons of anonymity and feasibility. Preliminary analysis was conducted after the data had been entered in a database, comprising several matrices of quantitative and qualitative material. A series of standard metrics of resource use, energy efficiency and commercial performance were calculated. In the second episode, initial findings were presented to, and discussed with, the owners and/or managers to 'sense test' the findings. Additional data was also collected, especially where initial calculations required verification.

There has been protracted discussion of the number of cases that should be compiled and/or reported in a research programme (Eisenhardt 1989; Siggelkow 2007; Eisenhardt and Graebner 2007; Barratt, Choi and Lim 2011). Central to this debate is the principle that the case-study approach, when executed properly, should generate large volumes of very rich data through intensive research on or within organizations. Hence it is neither desirable nor practical to report (too) many cases in the extensive detail they deserve. Depth and scope should be reconciled: reporting should allow the full extent, intricacies and nuances of particular cases to be revealed adequately, while the number of cases should be emblematic of the particular phenomena they are intended to portray. Although there is no single ideal number of cases, Eisenhardt (1989 p. 545) recommends 4-10 which she contends 'usually works well'. Four or more cases allow the generation of theory and presentation of complexity. As Barratt et al. (2011 p. 337) demonstrate, this has effectively become an orthodoxy and actually the solution is context-dependent.

During Stage Two, the technique of 'pattern matching' (Yin 2014) was used to finalise the number and choice of cases. As we describe below, commonalities among businesses were identified through, and justified by, a combination of statistical analysis, a detailed inspection of metrics and indices, and a close reading of each case-history. Three types of accommodation businesses occupying historic premises were ultimately identified based on their perceived and actual environmental performance. In the next section, three emblematic businesses are presented. These had premises that were assumed to be performing badly but in reality were performing well; premises that were believed to be performing well, but were not; and premises whose owners thought may be operating well and indeed were.

[Insert Table 1 near here]

Results

A striking initial result from Stage Two was that there was no statistically-significant correlation between age of the original premises and environmental performance in terms of EUI (r=0.326, p=0.060) or emissions intensity (r=0.097, p=0.585) for the 34 businesses. Not only did these results reinforce findings from Stage One of the programme but also they confirmed the view in the extant literature of a weak and indeterminate relationship between property age and environmental performance (Deng and Burnett 2000; Wang 2000; Bohdanowicz and Martinac 2007; Priyardarsini et al. 2009).

The original age of the premises was cross-tabulated against benchmarks from a major international scheme intended to assist European small- and medium-sized hotels sector with energy efficiency (HES 2011 p. 2). The First World War is identified as a major transitional point in the urban history of the United Kingdom (Power 1993), and properties built before that point are termed 'traditional' by the UK government (DCLG 2010). As Table 1 demonstrates, all of the more recent properties performed exclusively at good or excellent levels. Similarly, the majority of 'traditional buildings' operated at excellent or good levels, although a minority (n=4, 11.8%) exhibited average or worse performance. A Fischer's Exact Test revealed no statistically significant difference (p=0.273) among traditional and (relatively) more recent properties in terms of their benchmarked performance.

[Insert Table 2 near here]

Thus, in terms of pattern matching, two conclusions could be drawn: first, the original age of the premises was not a differentiator; and second, most businesses in the sample performed to at least a good standard. In fact, the proportion was higher than may have been anticipated by chance, a result to which we return later. This was somewhat unexpected since, as Table 2 demonstrates, across the sample there was variability not only in energy use and performance, but also the performance of energy as a factor of production.

Each business profile was re-read in light of these observations. Special attention was afforded the reasons for participating in Stage Two. In most cases, this was because managers and/or owners lacked detailed knowledge of environmental resource consumption and costs. Lack of time, capacity and/or expertise have been variously reported as reasons for low levels of engagement with environmental issues within SMTEs (Vernon, Essex, Pinder and Curry, 2003; Tzenschtke, Kirk and Lynch, 2008; Sampaio, Thomas and Font 2012). Within this sample, these were common reasons too. Nevertheless, many businesses had taken pro-environmental initiatives and some had even invested in renewable technologies. In fact, actions precipitated two broad perceptions about environmental performance. Some reported that they had taken measures and believed they must have had a beneficial effect on environmental performance. Others were sceptical about their performance, largely because they lacked understanding of precisely what measures they had enacted and the effects they were having. Of course, the juxtaposition of perceived and actual environmental performance presents four possible permutations. We did not encounter businesses that perceived and exhibited poor environmental performance but instances of the three other types, exemplars which we now present.

[Insert Table 3 near here]

Case-study A – historic premises performing better than expected.

Business A provides self-catering accommodation, sleeping up to 26 guests in a Grade 2 Listed property in a village (Table 3). The property is a converted farmhouse dating to the 17th Century and combines a basic stone structure with thatch roof. With its 9 bedrooms it offers 2 lounge areas, a dining room and kitchen, and a games room. The large garden has a hot tub. Unit occupancy is 48% or is marginally below the average (51%) for self-catering properties in the region (SWT 2010). However, its use does not follow the usual seasonal patterns. It has lower occupancy in the summer, with groups instead using it predominantly in the shoulder months (March-April and September-October) or low season. Most lets are for long weekends with a small number of week-long stays. Although the property is rural, it is on mains gas which is the primary fuel source for space and water heating. This is supplemented by a wood burner in one guest lounge. Electricity is sourced from the grid for lighting and appliances.

Before the research commenced, the owner expressed concerns that energy costs and consumption were 'bad'. This assumption was based on the age of the property and several aspects connected with its construction. At first inspection, these concerns appeared justified by: poor draught-proofing; single glazed windows (some with leaded lights), not in the best state of repair; the presence of a hot tub; and the operation of an AGA oven as well as connected boilers without proper or efficient synchronisation of their operation. While monthly bills could be provided for our analysis, the majority related to estimations by the utility company. There was little in-business awareness of how much energy was being used. Rather, the managers were content to overlook energy use, effectively obviating responsibility by paying their bills each month automatically by direct debit.

Against this backdrop, the analysis of consumption, costs and emissions revealed some surprising and welcome results. Energy consumption was 197kWh/m^2 (Table 3). This is ranked as 'Good' according to the UNWTO's Hotel Energy Solutions benchmarking (HES 2011). This was marginally above the sample average and median of 188 and 180kWhm^{-2} respectively (Table 2). Energy consumption per guestnight of 24kWh was below the project average (34kWh). The carbon emissions of the business were also better than average for project participants at 40kg/m^2 and 6 kg/guestnight. Better than expected performance was also reflected in financial metrics with the average cost of £1.03 per guestnight which was under two-thirds the average of £1.71.

Several factors contributed to better than expected environmental performance, including their being on main gas grid and using a wood burner for supplementary heating. This resulted in an average unit price for all energy used of 4.2p/kWh which was among the lowest in the sample (Table 2). In a rural location, the option to use gas (CO_2 factor 0.184kg/kWh -Carbon Trust 2013) -rather than other common choices of oil (0.246kg/kWh), LPG (0.215kg/kWh) or electricity (0.445kg/kWh)- enabled the property to achieve much lower carbon emissions . Group use contributed to enhanced performance. An average of 19 people occupied the ground floor where all the communal areas were situated. Finally, building construction, which was initially perceived to be a source of concern, performed much better than anticipated. Thatch generally has good insulation properties particularly if straw is used (as here). Wall construction was favourable in terms of its thickness (0.5 metres), composition (rubble stone walls containing air voids, lumps of earth and lime-based mortars perform better) and internal lining (lath and plaster). As Figure 1 indicates, not only are there significant differences in the performance of different building materials used in traditional buildings but also they often perform better in-situ than in modelled situations.

[Insert Figure 1 near here]

Case-study B - historic premises performing worse than anticipated.

Business B is a small residential conference and education centre in a rural setting converted by the owners from a complex of 18th-century farm buildings. In line with their prevailing ethos, the conversion was conducted to high environmental and building quality standards. Significant effort was made to use traditional construction methods, including the repair of stonework, roof tiles and timbers. A biomass boiler and small solar thermal panel array were installed while a green tariff was deliberately selected for electricity sourced from the grid.

As a consequence of this approach, the organization was awarded silver level (i.e. second highest) in a sustainable tourism accreditation scheme. It also received an award for sustainability from the local destination management organisation. Hence, before the research commenced, the manager anticipated that environmental performance would be comparatively high, especially when compared to others in our research. In other words, in their eyes one imperative was to quantify exactly how well their business was performing and to position it versus its comparator group. A further focus was to identify potential areas for (perhaps marginal) gains in the environmental performance of the complex. Or so they imagined.

Exceptionally, this organization was among the minority that regularly monitored environmental resource use. Nevertheless, we collected a full array of environmental data for review as per our standard operating procedures. This was necessary because the organization lacked an overall perspective on total consumption or performance. Unfortunately, their positive perceptions and expectations for the results were not warranted by the findings. Instead, energy efficiency was classified as 'Very Poor' at 462kWh/m2 while per guestnight consumption was 60 kWh (Table 3). Fuel bills revealed a similar consumption of biomass and electricity (on a kWh basis). As the unit cost of electricity (10.84p/kWh) is much higher than biomass fuel (4p/kWh for wood pellets), annual energy costs were significantly inflated .

Clearly, these initial results were extensively discussed and then verified. Subsequent detailed investigation turned to establishing the reasons for such (relatively) poor performance. A review of monthly electricity data showed that demand increased significantly in the winter. Further investigation with managers and employees revealed that during the winter months, electricity was being used as the primary space and water heating source rather than the biomass system. This problem was compounded by flaws in the design of the system. Although it had been designed to heat several buildings simultaneously, the controls were not sufficiently flexible to heat just one part of the property. The result was an 'all or nothing' operation that prompted the switch to electricity which, instead, could target heating around the complex but was significantly more expensive .

Renovation had been assumed to incorporate key insulation measures. In fact, some of the buildings had minimal, if any, roof insulation; there was no wall insulation; single glazing had been retained; and draught-proofing was minimal. A desire for incorporating the latest and most eye-catching (renewable energy) technologies had been at the expense of more fundamental approaches to energy efficiency. Although solar thermal panels had been installed, they were not on the roofs of the buildings where hot water was being used. Aesthetic concerns had triumphed over best practice for installation. Instead, the panels had been ground-mounted some distance away, with the consequences of heat loss from the pipework and much reduced efficiency.

The analysis revealed a major disconnect to the owners. They had tried to be environmentally-responsible in their practices, they were motivated to continue on that path, and they had attempted to measure the effects of their actions. Ultimately, though, they lacked context or reference points to be able to evaluate either the real situation or relative progress. Their internal benchmarking had resulted in ignorance of the unnecessary, over-consumption of environmental resources and the inflated costs that ensued. Our external benchmarking offered an additional perspective and, in the process, catalysed the need for a more fundamental review of practices and operations. In short, energy management was at best partial, at worse misguided. Actions had not been accompanied by a proper understanding of outcomes.

Case-study C – performing well, as expected

As has been a long-standing trend in the region (Shaw and Williams 2004), Business C was established by lifestyle entrepreneurs. As former senior corporate executives, the couple moved to a rural setting in the South West to establish their first tourism enterprise. The owners had a strong business backgrounds as well as the financial resources required for a high quality restoration of a redundant set of farm buildings dating to 1805. This resulted in 32 bedspaces with 71% occupancy throughout the year, assured by a 5-star quality rating (Table 3).

The couple also had a strong commitment to making sustainability a core value in the creation and operation of a complex of three self-catering cottages on-site. During conversion, the intention was to incorporate the latest pro-environmental measures alongside the use of local materials. This would enable the property to blend into the surrounding (protected) landscape. Particular emphasis was placed on maximising insulation. In most cases this was achieved by using natural materials such as sheep's wool which combines breathability and thermal performance (English Heritage, 2012). Low energy lighting was used throughout. Appliances were chosen for the highest efficiency. Nevertheless, the property was not connected to the main gas grid. As a result, the owners elected to employ the most efficient condensing oil boilers for a combination of space and water heating across the complex. An air source heat pump was employed for the swimming pool.

Perhaps not surprisingly then, the business has won several local and regional awards for its sustainable practices while obtaining 'Gold' level (i.e. the top) in a national sustainable tourism accreditation scheme. It has used these awards to engage with customers. By demonstrating the efforts they had taken and their credentials, the owners felt more confident in encouraging customers to act more pro-environmentally during their stays. Like Business B, the owners were confident that their business exhibited strong environmental performance. Like B, they monitored and measured but at a fairly basic level. Their confidence was justified by a close examination of their resource use. Average consumption was 21 kWh per guest-night which was well below the sample average (Table 2).

Nevertheless, despite the demonstrably strong performance of the business, the owners remained committed to further pro-environmental action. During the course of this research, they were in the process of replacing the oil heating and air source heat pumps with a 150kW biomass system. This was expected to reduce the carbon emissions of the business further from 63 tonnes to 16 tonnes per annum. As a result, the carbon emissions per guest-night would be just 1.8 kg (compared to a project average of 9.0 kg and 7.6 kg before the change) This final measure demonstrates clearly the important role that renewables can play for tourism businesses in historic properties. Consumer expectations of services and facilities have been increasing and these expectations have been fuelled and reinforced by quality standards (VE, 2010). Basic efficiency measures and their associated gains may be easily negated by new patterns of demand, as the domestic context has already revealed (EST 2011). Hence, the only realistic means of making serious reductions in the carbon emissions of older properties is through switching to fuels with low or zero carbon emissions. In rural contexts, such renewable sources have the added advantage of reducing dependency on more expensive power sources to those off the mains gas grid.

Business C therefore provides an exemplar of how major progress can be made in cutting emissions in a traditional property offering a luxurious experience within a protected landscape. Its strategy, which commenced with a focus on sensitively implemented energy efficiency measures and guest engagement, provided the foundation that was absent from Business B. It was then able to consolidate this by adopting renewables. This represented a move from first accepting the emissions they generated to making significant progress in reducing them.

Discussion: the present may not always be a key to the past

Through their detail, these case-studies expose several more widely generalizable points. Before turning to these, it is worth recalling that each case is illustrative of several other businesses that participated in Stage Two. The case-study approach does not set out to establish the degree of representativeness but rather to raise issues that have much wider resonance. In this regard, a first observation is the extent to which accommodation providers using older premises have attempted to, and have in some case achieved, notable progress towards emissions reduction. In two cases, relatively strong environmental performance (according to an international benchmarking scheme) had been achieved. In another, environmental performance was very poor (and poorer than expected) but could be remedied. Through several relatively simple adjustments, this business (and others like it) will perform much stronger in the future. Taken together, this evidence should be viewed as encouraging. Recent research has questioned the extent to which the tourism sector *per se* may be able to deliver on its ambitious targets for emissions reductions (cf. Gössling Hall, Peeters, and Scott 2010; Scott, Peeters and Gössling 2010; Gössling 2013). Several sector wide-barriers have been identified, including the continued growth of demand and the expectations of customers (Hall 2010; Coles et al 2014). However, historic premises nor building age *per se* need not necessarily of themselves be an impediment to action.

Indeed, the three businesses did not adopt especially innovative or radical approaches, nor measures that were unique to older properties. They were following patterns of innovation evident across the sector (Coles et al 2014). There was ample evidence of the three businesses taking relatively easy-to-implement, low cost measures. This type of decision-making was consistent with other studies of pro-environmental change (Vernon et al. 2003; Hall 2006; Tzschentke et al. 2008; Sampaio et al. 2012). Similarly, predictable (and highly sensible) choices of renewable technologies had been taken as part of more progressive approaches. Property age was not a bar to the introduction of new technologies nor the effectiveness of its functioning. Technologies used by the three businesses could just as easily have been used in more recent buildings. Businesses A and C demonstrate that these can be introduced to historic buildings with reasonable success. Older buildings present important challenges in terms of retrofitting and carefully considering the choices that are made. However, they do not necessarily preclude pro-environmental innovations, as stereotypical view and the use of the term 'Hard To Treat' (HTT) for all solid wall properties would suggest (CSE 2011). As Business B demonstrated, aesthetics and tradition may be desirable but they require careful consideration alongside performance of new technologies and the built fabric. Indeed, it seems perverse to invest in renewable technologies that operate partially and inefficiently because aesthetics are privileged over environment.

This view risks being somewhat unfair to the managers of Business B. In their defence (and like Business C) they felt they were acting as pioneers by taking what they perceived as a progressive approach and one which was at odds with the stereotype of older buildings. As they pointed out, there is a general lack of understanding of, and guidance on, the performance of older buildings in policy and practice (cf. May & Rye 2012). In particular, they bemoaned –and their unexpectedly poor performance was a manifestation of- the lack of connectivity between high quality, evidence-based research on older buildings and guidance documents which inform retrofitting in the tourism sector and more widely.

Indeed, much of the general, business-facing guidance on renewables and retrofitting directed at small businesses, ignores the issue of building age and the distinctive issues this can sometimes introduce (Carbon Trust, 2011). This is despite the fact that older buildings dominate building stock in the developed world, and they have different construction techniques and associated thermal characteristics. For instance, older buildings in the UK are often less prone to heat loss through fabric than standardised prescriptions, informed by newer buildings, articulate (Rye 2012). This means that the payback on some retrofit measures, such as solid wall insulation, may be much less than advertised. Actually, some measures are at best counter-productive, at worst potentially damaging. For example, older buildings require different assessment and practice for moisture control which is vital to the health of the fabric and the human inhabiting it (CIBSE 2002). Older properties were not designed for the temperatures now expected by guests nor for the humidity levels generated by showers and commercial kitchens (Cook 2009), and the need to maintain a property's 'breathability' is central to its effective management (May & Rye 2012). Modern approaches for insulating, ventilating and heating traditional properties, which are typically advocated in contemporary energy management advice may, at best, be irrelevant and, at worse, do more harm than good if implemented. Put another way, they threaten the long-term resilience of the historic fabric that many visitors wish to experience.

Finally, other research has focussed on in-situ tests of the thermal performance of a range of materials typically used in traditional buildings (Rye 2012). These studies reveal that in-situ energy performance in older buildings is often significantly better than simulated in software models and benchmarking schemes (Figure 1). Simply put, such an observation raises doubts about whether generic methods for assessing buildings, which are built on such technical foundations, are entirely appropriate for assessing older (tourism) properties? In turn, the prospect is raised that their application may yield –or indeed has yielded- incorrect data, misdirected results, and false confidence in the potentially erroneous interventions that follow. Conversely, they raise important questions about whether existing benchmarking models and their thresholds are entirely fit for purpose. For instance, in this research 30 of the 34 businesses (88.2%) were rated as good (n=11) or excellent (n=19). Thus, the favourable performance of buildings may be a function of the sampling technique. Equally, it is important to note that the most widely applied benchmarking model was developed mainly for hotels, not with smaller accommodation businesses nor historic premises in mind (HES, 2011).

Conclusion

Climate change is not a selective phenomenon: it impacts upon, and is affected by, human activities and human-related behaviours in buildings of all ages and histories. Meta-narratives of climate change may conclude that buildings represent the main anthropogenic source of emissions, and that older buildings contribute disproportionately more than younger ones. However, for a sector like tourism that relies on older building stock, such generalisation has not been thoroughly examined or irrefutably justified through previous studies. This paper is one of the few to have examined the relationship between the age of original premises and environmental performance, and the only paper to have explored this for buildings that date back centuries rather than decades. Like other studies dealing with more recent fabric, there was not a strong statistical relationship between (declining) environmental performance and (greater) building age. Quite the opposite: heritage accommodation providers in this research were not always the 'carbon villains' as some would perhaps portray them. Older premises are not of themselves an impediment to improvements in environmental performance and emissions reduction. Put another way, there should be no exemption from pro-environmental action for accommodation providers by virtue of building age alone. Three types of providers were evident based on the juxtaposition of their perceived and actual environmental performance, but further improvements were possible from all.

There are important implications for future research. First, conceptually at least, we cannot discount the possible existence of the fourth type: accommodation business characterized by poor perceived and actual environmental performance. However, their possible existence should be investigated further. Second, clear opportunities exist for robust, energy-efficient and cost-effective retrofit measures to be taken in heritage accommodation.

Disappointingly though, guidance is mainly designed for purpose-built, modern premises. While some of the overarching principles are applicable, many elements require a different approach to balance comfort, character and efficiency. In order to make strong(er) environmental gains, more dedicated, differentiated guidance is needed for accommodation businesses in older properties. Allied to this and as a third area for attention, there is a need to revisit and verify benchmarking schemes. In this research, so many businesses had achieved 'good' or 'excellent' environmental performance even by taking apparently simple and straightforward measures. Of course, this may be a consequence of the qualities imbued in the buildings and their operations. It may, though, be a function of benchmark thresholds, especially for excellence, and whether they are appropriately set for older and the oldest properties. Continuous improvement, not the status quo, is vital to long-term emissions reduction (Stern 2007), in particular for a sector like tourism where demand growth is the dominant imperative (Hall 2011). Benchmarks set at the wrong levels not only misdirect future action but they also inspire complacency because businesses have 'done their bit'. Larger sample sizes, wider variations in property characteristics, and a greater emphasis on historic premises are clearly necessary in this task. Indeed, more widely one of the outcomes of such work may be to address the lacuna on historic accommodation providers in studies of heritage tourism.

Funding

The authors would like to acknowledge the support of the Economic and Social Research Council for funding Stage One of this programme (RES-185-31-0046). The European Regional Development Fund (2007-13) supported the detailed research conducted with individual businesses which forms the basis for Stage Two.

Short biographies

Tim Coles is a professor in the Management Department at the University of Exeter Business School. His research interests on sustainable business practices in travel and tourism organizations, most recently with a focus on innovation and smart solutions.

Claire Dinan is a senior teaching fellow at the University of Exeter Business School. She was previously a sustainable tourism manager for the English Tourism Council and freelance consultant in sustainable tourism business practices. Her interests are in sustainable tourism policy, indicators and measurement.

Neil Warren is Business Engagement Specialist for the Centre for Business and Climate Solutions based in the Business School at the University of Exeter. He was previously Sustainability Strategist for South West Tourism, the former regional tourist board, and a freelance consultant.

References

Barratt, M., Choi, T.Y. and Li, M. (2011). Qualitative case studies in operations management: trends, research outcomes, and future research implications. *Journal of Operations Management*, *29,* 329-342

Beccali, M., La Gennusa, M., Lo Coco, L. and Rizzo, G. (2009). An empirical approach for ranking environmental and energy saving measures in the hotel sector. *Renewable Energy*, *34,* 82-90.

Becken, S. and Hay, J. (2012). *Climate Change and Tourism. From Policy to Practice.* Earthscan: Abingdon.

Bohdanowicz, P. and Martinac, I. (2007). Determinants and benchmarking of resource consumption in hotels – case study of Hilton International and Scandic in Europe. *Energy and Buildings*, *39,* 82-95.

Bohdanowicz, P. and Zientara, P. (2012). CSR-inspired environmental initiatives in top hotel chains, in D. Leslie (Ed.) *Tourism Enterprises and the Sustainability Agenda across Europe* (pp.93-121). Farnham: Ashgate.

The Carbon Trust (2011). *Heating, Ventilation and Air Conditioning.* Online document. Available from: http://www.carbontrust.com/media/7403/ctv046_heating_ventilation_and_air_conditioning.pdf [Last accessed: 02/12/14]

The Carbon Trust (2013). *Conversion Factors.* Online document. Available from: http://www.carbontrust.com/resources/guides/carbon-footprinting-and-reporting/conversion-factors. [Last accessed: 26/11/14]

Centre for Sustainable Energy (2011). *Analysis of Hard-to-treat Housing in England. Internal Research Paper.* Online document. Available from: http://www.cse.org.uk/downloads/file/analysis_of_hard-to-treat_housing_in_england.pdf [last accessed: 26/11/14]

Chan, E.S.W. (2011). 'Implementing environmental management systems in small- and medium-sized hotels: obstacles', *Journal of Hospitality and Tourism Research*, *35(1)*, 3-23.

Chan, W., Mak, L., Chen, Y., Wang, R., Xie, H., Hou, G. and Li, D. (2008). Energy saving and tourism sustainability: solar control window film in hotel rooms. *Journal of Sustainable Tourism*, *16(5),* 563-574.

Cheer, J. and Reeves, K. (2015). Colonial heritage and tourism: ethnic landscape perspectives. *Journal of Heritage Tourism*, in press.

Cheung, M. and Fan, J. (2013). Carbon reduction in a high density city: a case study of Langham Place Hotel, Mongkok, Hong Kong, *Renewable Energy*, *50*, 433-440.

The Chartered Institution of Building Service Engineers (CISBE) (2002). *Guide to Building Services in Historic Buildings.* London: CISBE.

Chhabra, D. (2015). A cultural hospitality framework for heritage accommodations, *Journal of Heritage Tourism*, in press.

Coles, T.E., Zschiegner, A-K. and Dinan, C.R. (2013). Climate change mitigation policy and the tourism sector: perspectives from the South West of England. *Journal of Policy Research in Tourism, Leisure and Events*, *5(1),* 1-27.

Coles, T.E., Zschiegner, A.-.K. and Dinan, C.R. (2014). A cluster analysis of climate change mitigation behaviours among SMTEs. *Tourism Geographies, 16(3)*, 382-399.

Coles, T.E., Dinan, C.R. and Warren, N. (2014) Energy Practices among Small- and Medium-sized Tourism Enterprises: a Case of Misdirected Effort? *Journal of Cleaner Production*, published online, DOI information: 10.1016/j.jclepro.2014.09.028

Cook, G. (2009). *Energy Efficiency in Old Houses.* Marlborough: Crowford Press.

Dalton, G., Lockington, D. and Baldock, T. (2008). Feasibility analysis of stand-alone renewable energy supply options for a large hotel. *Renewable Energy*, *33,* 1475-1490.

Dalton, G., Lockington, D. and Baldock, T. (2009). Case study feasibility analysis of renewable energy supply options for small to medium-sized tourist accomodations. *Renewable Energy*, *34*, 1134-1144.

Deng, S. (2003). Energy and water uses and their performance explanatory indicators in hotels in Hong Kong. *Energy and Buildings*, *35,* 775-784.

Deng, S. and Burnett, J. (2000). A study of energy performance of hotel buildings in Hong Kong. *Energy and Buildings*, *31,* 7-12.

Department for Business, Innovation & Skills (2013). *Business Population Estimates for UK and the Regions.* Online document. Available from: https://www.gov.uk/government/statistics/business-population-estimates-2013 [Last accessed: 26/11/14].

Department for Communities and Local Government (DCLG, 2014). *English Housing Survey. Headline Report 2012-13*. Online document. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/284648/English_Housing_Survey_Headline_Report_2012-13.pdf [Last accessed: 26/11/14].

Department for Communities & Local Government (DCLG, 2010). *Building Regulation's Approved Document Part L1B&L2B Conservation of Fuel and Power. Online document.* Available from: http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/approved [Last accessed: 26/11/14]

Department for Energy & Climate Change (DECC). Building Research Establishment (BRE) and Energy Saving Trust (EST) (2007) *Energy Use in Homes.* Online document. Available from: http://www.bre.co.uk/filelibrary/pdf/rpts/Energy_Efficiency_2007.pdf [Last accessed: 27/11/14]

Eisenhardt, K. (1989). Building theories from case study research. *Academy of Management Review*, *14(4),* 532-550.

Eisenhardt, K. and Graebner, K. (2007). Theory building from cases: opportunities and challenges. *Academy of Management Journal*, *50(1)*, 25-32.

Elghani, M.A. (2012). *Heritage and hospitality links in hotels in Siwa, Egypt: towards the provision of authentic experiences.* Unpublished Doctoral Thesis, University of Waterloo.

Energy Saving Trust (EST) (2011). *The Elephant in the Living Room: How Our Appliances and Gadgets are Trampling the Green Dream.* London: EST.

English Heritage (2010). *Heritage Counts 2010*. London: English Heritage.

English Heritage (2012). *Energy Efficiency & Historic Buildings – Insulating Roofs at Rafter Level.* Online document. Available from: http://www.english-heritage.org.uk/publications/eehb-insulating-pitched-roofs-rafter-level-warm-roofs/eehb-warm-roofs.pdf [Last accessed: 26/11/14].

Ertugral, S.M. and Dincer, F.I. (2003). Economic impact of heritage tourism hotels in Istanbul, *Journal of Tourism Studies*, *14(2)*, 23-34.

Field, A. (2009). *Discovering Statistics using SPSS.* London: Sage, 3rd edition.

Filimonau, V., Dickinson, J., Robbins, D. and Huijbregts, M. (2011). Reviewing the carbon footprint analysis of hotels: Life Cycle Energy Analysis (LCEA) as a holistic method for carbon impact appraisal of tourist accommodation. *Journal of Cleaner Production*, *19,* 1917-1930.

Fouseki, K. and Cassar, M. (2014). Editorial: energy efficiency in heritage buildings – future challenges and research needs, *The Historic Environment*, *5(2)*, 95-100.

Goh, D.P.S. (2010). Capital and the Transfiguring Monumentality of Raffles Hotel, *Mobilities*, *5(2)*, 177-195.

Gössling, S. (2010) *Carbon Management*. Abigndon: Routledge.

Gössling, S. (2013). National tourism emission from tourism: an overlooked policy challenge? *Energy Policy*, *59,* 433-442.

Gössling, S., Hall, C.M., Peeters, P. and Scott, D. (2010). The future of tourism: can tourism growth and climate policy be reconciled? A mitigation perspective. *Tourism Recreation Research, 35(2),* 119-130.

Graham, B., Ashworth, G.J. and Tunbridge, J.E. (2000). *A Geography of Heritage. Power, Culture and Economy.* London: Arnold.

Hall, C.M. (2006). New Zealand tourism entrepreneur attitudes and behaviours with respect to climate change adaptation and mitigation, *International Journal of Innovation and Sustainable Development*, *1(3),* 229-237.

Hall, C.M. (2011). Consumerism, tourism and voluntary simplicity: we all have to consume, but do we really have to travel so much to be happy? *Tourism Recreation Research, 36(3),* 298-303.

Hotel Energy Solutions (HES, 2011). *Energy Efficiency and Renewable Energy Applications in the Hotel Sector.* Madrid: Hotel Energy Solutions.

Joliffe, L. and Aslam, M. (2015). Repurposing colonial tea heritage through historic lodging. *Journal of Heritage Tourism*, in press.

Kaján, E., & Saarinen, J. (2013). Tourism, climate change and adaptation: A review. *Current Issues in Tourism*, *16*(2), 167-195.

Kariagiorgas, M., Tsoutos, T., Drosou, V., Puffray, S., Pagano, T., Lara, G. and Mendes, J. (2006). HOTRES: renewable energies in the hotels. An extensive technical tool for the hotel industry. *Renewable and Sustainable Energy Reviews*, *10,* 198-224.

Kohler, N. and Yang, W. (2007). Long-term management of building stocks, *Building Research & Information*, *35(4),* 351-362.

Lane, B. (2009). Rural tourism: an overview. In T. Jamal, & M. Robinson (Eds.), *The SAGE Handbook of Tourism Studies.* (pp. 355-372). London: SAGE

Levine, M., Urge-Vorsatz, D., Blok, K., Geng, L., Harvey, D., Lang, S., Levermore, G., Mongameli, A., Mirasgedis, S., Novikova, A., Riling, J. and Yoshin, H. (2007). Residential and commercial buildings. In: B. Metz, O. Devidson, P. Bosch, R. Dave and L. Meyer (Eds.) *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge and New York: Cambridge University Press.

Lu, S., Wei, S., Zhang, K., Kong, X. and Wei, W. (2013). Investigation and analysis on the energy consumption of starred hotel buildings in Hainan Province, the tropical region of China, *Energy Conversion and Management*, *75,* 570-580.

Lucon, O., Urge-Vorsatz, D., Ahmed, A., Akbari, H., Bertoldi, P., Cabeza, L., Eyre, N., Gadgil, A., Harvey, D., Jiang, Y., Liphoto, E., Mirasgedis, S., Murakami, S., Parikh, J., Pyke, C. and Vilarino, M. (2014). Buildings. Draft Final Report of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Online document. Available from: http://report.mitigation2014.org/drafts/final-draft-postplenary/ipcc_wg3_ar5_final-draft_postplenary_chapter9.pdf [Last accessed: 15\05\14].

Lowe, R. (2007). Addressing the challenges of climate change for the built environment, *Building Research & Information*, *35(4),* 343-350

May, N. and Rye, C. (2012). *Responsible Retrofit of Traditional Buildings. A Report on Existing Research and Guidance with Recommendations.* London: Sustainable Traditional Buildings Alliance.

Michalena, E. and Tripanagnostopolous, Y. (2010). Contribution of the solar energy in the sustainable tourism development of the Mediterranean islands. *Renewable Energy*, *35,* 667-673.

Moran, F., Nararajan, S. and Nikolopoulou, M. (2012). Developing a database of energy use for historic dwellings in Bath, UK. *Energy and Buildings, 55*, 218-226.

Morgan, N. and Pritchard, A. (1999). *Power and Politics at the Seaside. The Development of Devon's Resorts in the Twentieth Century.* Exeter: University of Exeter Press.

Ong, C.E. (2015). The historic hotel as 'Quasi-Freedom Machine': negotiating utopian visions and dark histories at Amsterdam's Lloyd Hotel and 'Cultural Embassy', *Tourism Geographies*, in press.

Onut, S. and Soner, S. (2006). Energy efficiency assessment for the Antalya Region hotels in Turkey. *Energy and Buildings*, *38,* 964-971.

Power, A. (1993). *Hovels to Highrise. State Housing in Europe since 1850.* London: Routledge.

Priyardarsini, R., Xucao, W. and Eang, L.S. (2009). A study on energy performance of hotel buildings in Singapore. *Energy and Buildings*, *41,* 1319-1324.

Ren, L., Shih, L. and McKercher, B. (2014). Revitalization of industrial buildings into hotels: anatomy of policy failure, *International Journal of Hospitality Management*, *42,* 32-38.

RetrofitBuildings.com for Climate Change (undated). Carbon villains – very misleading! Online document. Available from: http://retrofitbuildings.com/featured-articles/90-carbon-villains-very-misleading.html [Last accessed: 27/11/14]

Rossello-Batle, B., Moia, A., Cladera, A. and Martinez, V. (2010). Energy use, CO_2 emissions and waste throughout the life cycle of a sample of hotels in the Balaeric Islands. *Energy and Buildings*, *42,* 547-558.

Rye, A (2012). *Short Paper on the Conventions and Standards that govern the understanding of heat loss in traditional buildings.* Online document. Available from: http://www.sdfoundation.org.uk/downloads/STBA-Short-Paper-on-heat-loss-FINAL.pdf [Last accessed: 27/11/14]

Scott, D., Peeters, P. and Gössling, S. (2010). Can tourism deliver its 'aspirational' greenhouse gas emission reduction targets? *Journal of Sustainable Tourism*, *18(3)*, 393-408.

Scott, D., Hall, C.M. and Gössling, S. (2012). *Tourism and Climate Change. Impacts, Adaptation and Mitigation.* Abingdon: Routledge.

Sampaio, A.R., Thomas, R. and Font, X. (2012). Small business management and environmental engagement, *Journal of Sustainable Tourism*, *20(2)*, 179-193.

Shaw, G. And Williams, A.M. (1991). From bathing hut to theme park: tourism development in South West England. *Journal of Regional and Local Studies*, *11,* 16-32.

Siggelkow, N. (2007). Persuasion with case studies. *Academy of Management Journal*, *50(1)*, 20-24.

Simpson, M.C., Gossling, S., Scott, D., Hall, C.M. and Gladin, E. (2008). *Climate Change Adaptation and Mitigation in the tourism Sector: Frameworks, Tools and Practices.* Paris: UNEP, University of Oxford, UNWTO, WMO.

Stern, N. (2007). *The Economics of Climate Change: the Stern Review*. Cambridge: Cambridge University Press.

Suhr, M. and Hunt, R. (2013). *Old House Eco Handbook. A Practical Guide to Retrofitting for Energy-efficiency and Sustainability.* London: Francis Lincoln.

Thomas, R., Shaw, G. and Page, S.J. (2011). Understanding small firms in tourism: a perspective on research trends and challenges. *Tourism Management*, *32(5)*, 963-976.

Timothy, D.J. and Boyd, S.J. (2006). 'Heritage tourism in valued traditions and new perspectives', *Journal of Heritage Tourism*, *1(1)*, 1-16

Tzschentke, N.A., Kirk, D. and Lynch, P.A. (2008). Going green: decisional factors in small hospitality operations, *International Journal of Hospitality Management*, *27,* 126-133.

United Nations World Tourism Organisation (2012). *Hotelenergysolutions.net.* Online document. Available from: http://www.hes-unwto.org/hes_root_asp/index.asp?LangID=1 [Last accessed on 02/12/14]

Vernon, J., Essex, S., Pinder, D. and Curry, K. (2003). The "greening" of tourism micro-businesses: outcomes of focus group investigations in South East Cornwall, *Business Strategy and the Environment*, *12(1)*, 49-69.

VisitBritain (2010). *Culture and Heritage. Topic Profile 2010*. London: VisitBritain.

VisitEngland (2010). *Common Standards Review – Self Catering Consumer Research.* Online document. Available from: http://www.visitengland.org/Images/Self%20catering%20summary%20for%20internet_Layout%201_tcm30-23812.pdf [Last accessed: 26/11/14].

Wallsgrove, J. (2008). *The Justice Estate's Energy Use.* Online document. Available from: http://www.ihbconline.co.uk/context/103/files/assets/pages/page0021.swf [Last accessed: 02/12/14]

Wang, J.C. (2012). A study on the energy performance of hotel buildings in Taiwan. *Energy and Buildings*, *49,* 268-275.

Wu et al. (2015). The evolution and space patterns of Hutongtels in Beijing Historic Districts, *Journal of Heritage Tourism*, in press.

Xuchao, W., Priyadarsini, R. and Yang, L (2010). Benchmarking energy use and greenhouse gas emissions in Singapore's hotel industry, *Energy Policy, 38,* 4520-4527.

Yin, R.K. (2014). *Case Study Research. Design and Methods.* Thousand Oaks: Sage, 5th edition.

Yoo and Lee (2015). Use of Facebook among U.S. heritage accommodations: an exploratory study, *Journal of Heritage Tourism*, in press.

Table 1. The relationship between environmental performance benchmark and original age of premises.

HES Benchmark	Pre-1850	1850-1919	1919-1945	Post-1945
Excellent (<195 $kWh/m^2/year$)	4	6	2	7
Good (195 – 280 $kWh/m^2/year$)	5	3	2	1
Average (280-355 $kWh/m^2/year$)	1	1	0	0
Poor (355 – 450 $kWh/m^2/year$)	1	0	0	0
Very Poor (>450 $kWh/m^2/year$)	1	0	0	0

(Source: authors' fieldwork)

n.b. Fischer's Exact Test performed on two age categories -for before and after 1919- and for two HES benchmark categories for good or better and average or worse

Table 2. Key parameters and their variation across the entire sample

Parameter	Mean	Median	Maximum	Minimum
kWh – Annual total	207,960	55,597	3,994,340	4,868
Annual total bill	£11,251	£3,759	£188,439	£516
Energy - £/kWh	7.17p	6.56p	16.14p	3.73p
Cost as % of revenue	6.7%	5.3%	21.8%	2.3%
£/guestnight	£2.16	£1.71	£6.25	£0.50
kWh/guestnight	34	23	108	4
kWh/m^2	188	180	462	24
CO_2/m^2	58	50	170	12

Source: authors

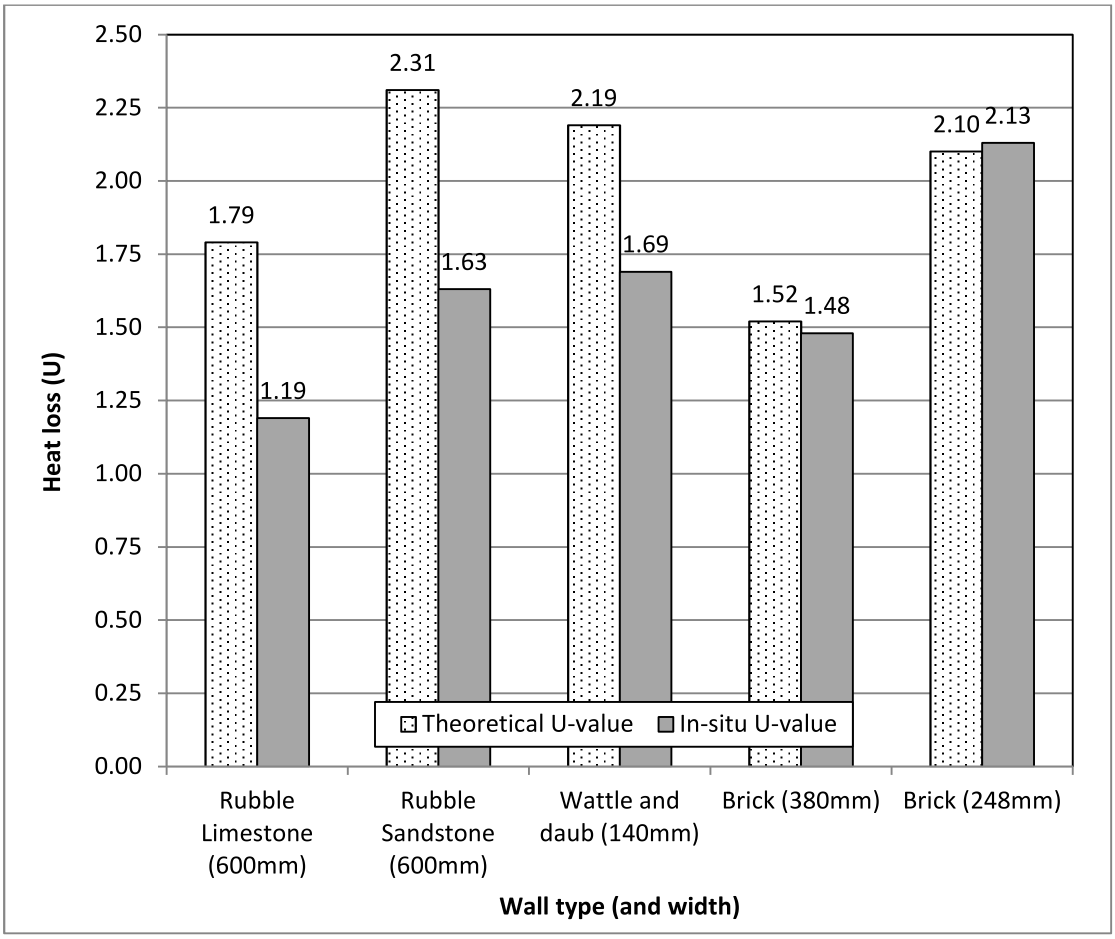
Table 3. Thumbnail sketches and indicative parameters for the case-study businesses

Attribute	Business A	Business B	Business C
Premises first date back to (year):	1600s*	1780	1805
General performance type:	Better than Expected	Worse than Anticipated	Performing well, as expected
Bedspaces	26	45	32
Occupancy	48%	30%	71%
Quality Assurance Rating	None	None	5 Star
Fuel mix	2% electricity 89% gas 9% wood (log burner)	43% electricity 9% LPG 46% woodchip, 1% solar thermal	20% electricity 80% woodchip
Solar?	None	1% solar thermal	None
Biomass boiler (%)	None – but 9% log burner	46% woodchip	80% woodchip
Swimming Pool?	No	No	Yes
Hot tub?	Yes	No	No
Energy Use Intensity (kWh/m^2)	197	462	229
EE HES Benchmark	Good	Very Poor	Good
Energy per bednight	24 kWh	60 kWh	19 kWh

* Year cannot be specified. Earliest documentary record suggests existed before.

Source: authors

Figure 1. Theoretical and in-situ heat loss through thermal conductivity for different types of traditional wall constructions



(Source: derived from Suhr and Hunt 2013 p.101)

n.b. The higher the U-value, the greater the heat loss.