

# Two degree rise in indoor temperature: energy use behaviour of British Asians

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*ABSTRACT: The understanding of households' socio-economic characteristics and their behaviour has been acknowledged as a key factor while assessing the energy demands. There is considerable research in the area of building simulation and energy modelling; however, the representation of occupants and their behaviour needs further work. For instance, every degree rise in internal temperature settings will increase the household energy consumption by 10 %. This research investigates the energy use behaviour of a specific demographic and ethnic group, the British Asian households. A large-scale housing survey is used to gather self-reported information about the British Asian households' energy use behaviour, for instance, heating patterns, appliances use, ventilation behaviour, as well as other socio-economic characteristics. Data collected will be transformed into energy models, which includes Space heating behaviour models, electrical appliances and lighting use models, and Ventilation behaviour models. The outcome of this research demonstrates how social perception and economic aspirations limit the acceptability of sustainable design and construction strategies. This research involves active community participation and engagement; a major part of the dissemination will aim at communicating the research findings to the British Asian households, which will have a direct impact of energy reduction by informed behaviour choice.*

*KEYWORDS: Energy, Comfort, Energy behaviour, British Asian, Sustainable housing*

## 1. INTRODUCTION

The domestic sector alone contributes about 27% carbon emission and it is critical to address while resolving the UK commitment of 80% reduction in CO<sub>2</sub> emission by 2050 against the 1990 baseline [1]. Though government legislation addresses the mitigation strategies by setting stricter regulations for the new build, it is very difficult to upgrade the existing housing stock. Due to the very slow replacement cycles and long physical lifetimes, attention must also be placed upon the existing housing stock, which is expected to make up at least 70% of the UK's total housing by 2050 [2]. Among the factors affecting the energy consumption, Occupants behaviour plays a pivotal role. Underprediction of energy saving from the thermal upgrade is evident from the recent research. Further, the lack of understanding of the households' behaviour has led to assumptions which mostly predict higher energy saving compared to the actual saving [3].

There is a difference between the occupants' behaviour and assumptions at different stages and it is attributed as the prime reason for the performance gap [4]. There is considerable research to demonstrate the predicted and measured energy consumption and relate it to performance gap [5, 6]. For instance, de Wilde (2014) in a review of the core reasons behind the performance gap and the implications thereof has identified three types of performance gap; predictions vs. measurement, machine learning vs. measurement, and prediction vs. displayed energy performance. However, there is limited research to explore the correlation of the performance gap to the households'

socio-economic characteristics. While building simulation has made significant progress, the representation of occupants and their behaviour needs further work.

Lack of knowledge and household behaviour has been identified as the main reason for the gap between the energy reduction prediction to actual savings despite awareness of the climate change and increasingly stringent regulations [7]. Building users were considered as passive recipients of thermal stimuli to maintain the thermal balance reflecting the Fanger's model [8]. Recent studies have linked occupants' thermal experiences and expectations to the indoor conditions and to the climatic condition [9] and researchers have argued for understanding households' expectations and satisfying their desire for thermal comfort as one of the key drivers to reduce energy use [9].

In the domain of sustainable housing, both a qualitative approach and quantitative strategies are essential to the understanding of social and cultural dynamics as well as to measure and benchmark performance. Most of the process, from the beginning, including the Club of Rome, has relayed heavily on quantitative mathematical methods [10]. Most of the studies evaluating the performance of the energy efficient homes or refurbishment design process are quantitative and measure empirical data and most of the qualitative factors like, individual comfort variation, occupants' energy behaviour is generalised [11, 12].

Until recently, house-building targets and neighbourhood planning lacked a clear strategy to

understand households energy behaviour while developing sustainable communities [13]. Many energy efficiency initiatives including net-zero energy homes have been adopted as a financially viable, energy reduction models [14]. However, households, their expectations and its impact on energy usage are hardly considered in these models. The hierarchical approach to reducing energy consumption in buildings includes building envelop, energy-efficient equipment and renewable power. However, none of these approaches acknowledges the behaviour of households and its influence on the operation of buildings while reducing the energy consumption [15].

The implication of behaviour pattern is further complicated when energy reduction runs contrary to the prevailing practices or encouraged logical solutions. For instance, the average temperature maintained in the UK household is around 18 degree Celsius in winter [16]. All the energy prediction is calculated based on this fact; whereas expatriates from the tropical countries prefer to keep their homes warm and at 21.4 degree Celsius [17]. The difference in internal temperature of the average UK households to that of British Asians is significant as every degree of higher internal temperature will increase the household energy consumption by 10 % [18]. British Asians, also referred as South Asians in the United Kingdom, Asian British people or Asian Britons, are persons of Asian descent who reside in the United Kingdom [19] and they constitute about 5 percent of the UK population [20] and hence their behaviour pattern would have a enormous impact on the energy consumption.

For British Asians, though it appears to be way higher compared to UK average, it is perceived as a positive move to not bring down the temperature drastically and align themselves in reducing energy. In this context, this paper explores the behaviour pattern of the British Asian households, their socio-economic characteristics and its impact on the energy behaviour.

There is a strong relationship between the social-cultural practices and energy consumption behaviour of the homeowners. In particular, the way in which a homeowner perceives their residence as a vehicle for the display and maintenance of status can impact on the energy use characteristics of a home (Satish and Brennan, 2015, Satish et al., 2011). Furthermore, whilst acknowledging the role of technology, emphasis needs to be placed on the importance of lifestyle and social change (Skea and Nishioka, 2008).

## 2. METHODOLOGY

This research builds on the previous research and aims to test the energy use behaviour of a specific demographic and ethnic group, the British Asian households, in the UK and compare with that of

the Indian homeowners. This work builds on the extensive research conducted in India [21, 22], and a large-scale, citywide, socio-technical survey conducted as part of the EnerGAware project in Plymouth, the UK [23, 24]. wherein the homeowners' aspirations are mapped to the energy demand in Mysore, India and Plymouth, the UK.

This research targets the Asian diaspora and the questionnaire forms are delivered to British Asians. The contact list of British Asians is developed through snowball sampling or chain-referral sampling and by approaching various cultural and community organisations and societies. The survey questionnaire is carefully developed to overlap with the EnerGAware project and the field works carried out in India. A small- scale housing survey was conducted to gather self-reported information about the British Asian households' energy use behaviour, as well as other socio-economic characteristics. The survey questionnaires were collected from 40 households, who are British Asians living in Plymouth, the UK. Questionnaires are collected from homeowners settled in the UK from different Asian ethnic background. While distributing the questionnaires among owner-occupiers, special care was taken to ensure that different neighbourhoods were represented. This included the city central area, neighbourhoods around Derriford hospital and neighbourhoods in the villages near Plymouth. The respondents social, economic and educational background is mapped to a similar representation of respondents in India. A wide spectrum of respondents was shortlisted to reflect the occupation, different age group and 'length of residence' of the households.

Stratified Random Sampling technique was adopted to include proportional representation of sample from different age group, background and location from within Plymouth. This technique enables to achieve a higher statistical precision and hence smaller sample yields significant results [25, 26].

The outcome of the questionnaire survey triangulated with the literature studies and the surveys conducted in India on one hand and the survey outcome of the EnerGAware project on the other. More than 200 homeowners were surveyed in a South Indian city, Mysore and the same questionnaire with modification to reflect the climatic and socio-cultural conditions is used as part of this questionnaire. Similar questions to relatively similar demographics have enabled to compare the survey outcomes. On the similar lines, part of the questionnaire of the EnerGAware project is used to compare the feedback of respondents of British households and British Asian households. Respondents have reflected various energy-related issues including household preferences, ventilation, energy-related habits and energy consumption. This paper focuses on

socioeconomic preferences and energy behaviour for further analysis and discussion.

### 3. FIELDWORK ANALYSIS AND DISCUSSION

#### 3.1 Socio-economic preferences

The traditional housing typology was reflective of the social and cultural values of the homeowners. In the revised model, households' aspirations and their reflections were examined by asking them about their preferences and choices specifically related to house selection process. Asian homeowners tend to give higher priority to the family and friends, Plot size, amenities, cost and proximity to the city centre compared to their counterparts living in Plymouth, UK. However, British Asians living in Plymouth prioritise good neighbourhood, location, and school while finalising their house location.

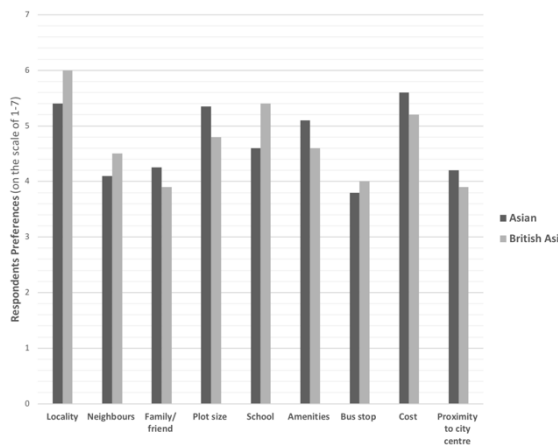


Figure 1. Respondents preferences for their house location

The distinctiveness of the new class structure has rested on a range of representational practices centred around particular characteristics of consumption, style and social distinction [27]. These have their ramification on the spatial reorganisation of neighbourhoods within cities and small towns. In this reorganisation, households have developed new suburban aesthetic identities and lifestyles that seek to change the visual signs of public spaces [27]. As scholars like Fernandes have argued, expression of the economic mobility and demonstration of newfound wealth is a key dimension of the homeowners in the emerging world [28, 29]. Whereas, living in relatively established residential suburbs, British Asians are not as keen as Asians in case of amenities, plot size and proximity to the city centre. Migrated households tend to give importance to the social and cultural values and are conscious of the cultural background as a mechanism to develop the family cultural values and explore socio-cultural activities [30]; hence they are

keen of compatible neighbours and the locality while choosing their house location (Figure 1).

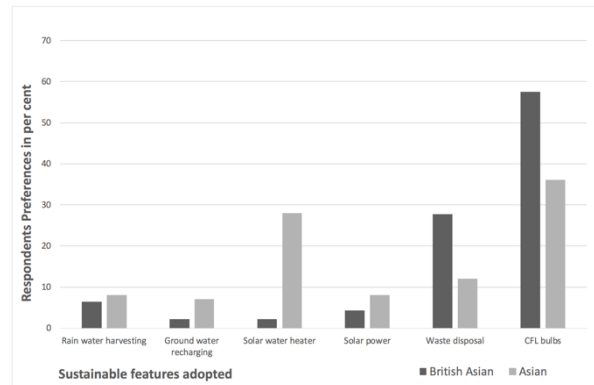


Figure 2. Sustainable features adopted

There is an acknowledgement of climate change and societies are contributing to reducing energy consumption and carbon emission. Societies tend to adapt to the local government, regulations, policy and the sustainable features they adopt would depend on a combination of government policy on one hand and cultural and social values and responsibility of the individual on the other. When asked about the sustainable features adopted, nearly 30 % of the Asians have made provision for solar power, compared to less than 3 % of British Asians. Further, a greater number of Asian households have implemented rainwater harvesting and groundwater recharging compare to their counterparts in Britain (Figure 2). Though the Indian government has put forth these in its national agenda [31], most of these initiatives are voluntary and despite the support from the government or agencies [32].

Whereas, in a regulated economy like the UK with clear top-down guidelines towards addressing climate change, When the same question was asked to British Asians, their alignment with the government policy is evident with nearly 60 percent of the households using energy saving lighting fixtures and more households are sensitive towards waste disposal compare to Asian counterparts (Figure 2).

Comparative study of Asian and British Asian households' selection process suggests a consistency in the preference for values and aspirations demonstrates, how households tend to carry the cultural values and recreate them in the migrated place.

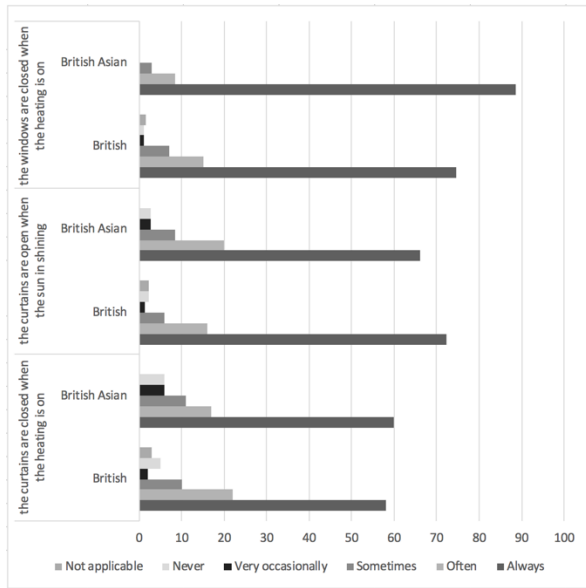


Figure 3. Respondents window usage practices.

### 3.2 Energy Behaviour

One of the key differences for British Asians born and raised in Asia would be to acclimatise to the UK climate and hence understand the difference in the energy consumption in the homes. This section analyses the energy behaviour of the British Asians in Plymouth and compare with the similar survey of British (White British) household conducted by the EnerGAware project [24].

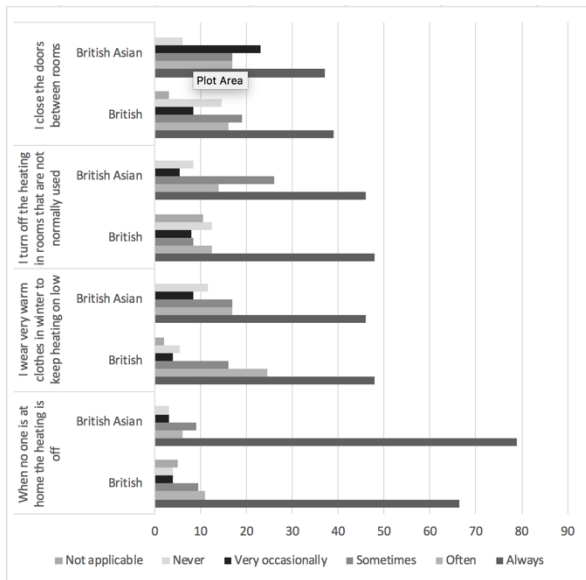


Figure 4. Respondents heating practices.

To understand the energy consumption of the households, their behaviour pattern related to energy consumption and their preferences are elicited through a series of questions. The British and British Asians tend to exhibit similar sensitivity when it comes

to window opening preferences during winter. However, British Asians tend to be more sensitive to the heat loss and most of them tend to close the windows when the heating is on (Figure 3). A similar trend can be observed in their spatial usage pattern as well, wherein more than twice the number of British tend to keep the door open between the rooms while heating is on (Figure 4). Further, a higher number of British Asians tend to shut down heating when no one is at home (Figure 4).

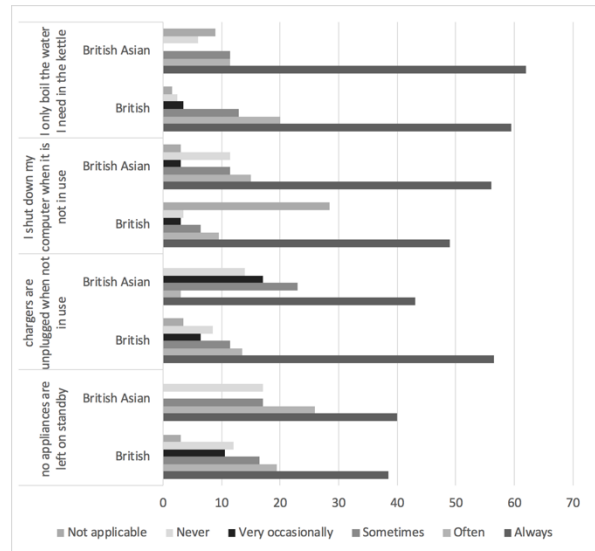


Figure 5. Respondents usage pattern.

Though there are similarity and consistency in terms of usage of electrical appliances, British Asians have shown relatively more sensitivity and inclination towards saving energy (Figure 5), which underpins the earlier research of correlation between cultural values and sustainable housing features [33]. Correlation of values and energy behaviour is further evident when nearly half of the British Asians use energy saving modes on their appliances compare to only 29 % of British use energy saving mode (Figure 6).

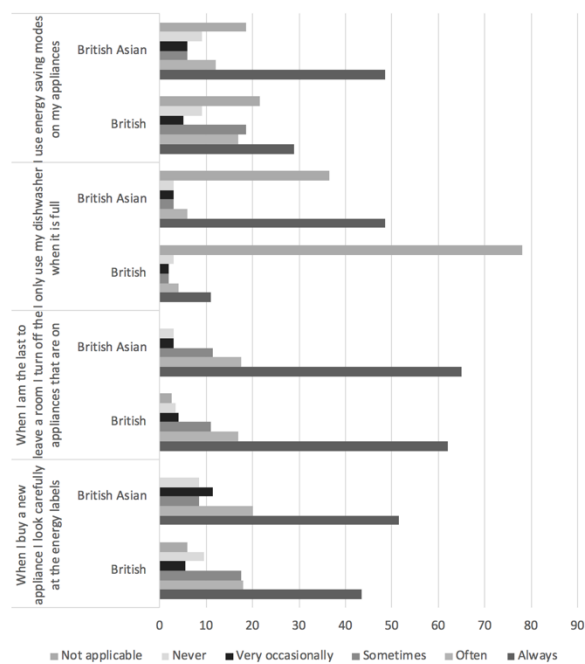


Figure 6. Energy saving measures in appliances.

## 4. CONCLUSION

### 4.1 Applications for the research

The results of this study will be of key interest to government policymakers and building industry stakeholders. The study identifies the specific areas where homeowners' preferences can be aligned with sustainable elements. While tackling the climate change, all the countries are committing for carbon reduction and this research provides a bottom-up solution as to how to achieve these targets.

### 4.2 Limitation and further research

From the outcome of the questionnaire survey, this paper examined two key aspects of Socio-economic preferences and energy behaviour. Further studies with the ethnographic survey and interview of households triangulated with environmental analysis would be helpful to further develop this research.

The research has shown that there is a direct correlation between the social and cultural values and energy behaviour of households. Further examination of specific aspects like ventilation, heating would provide greater insight into the extent of the impact of behaviour on energy consumption and would go a long way in reducing the carbon emission and develop sustainable communities for the future.

### 4.3 Summary

While acknowledging the role of policy guideline, emphasis needs to be given to the importance of lifestyle and social change. This research focuses on the sustainable built environment as social and cultural phenomena that can allow

insights in the effective formulation of localised and relevant low carbon strategies and thus provide a bottom-up tool to implement the policies and targets set by the professional bodies and the UK government.

The study in this paper, using a literature review and survey fieldwork, has highlighted the similarity and differences in the perception and socio-cultural value system of British and British Asian households. From the outcome of the questionnaire survey, this paper examined two key aspects of Socio-economic preferences and energy behaviour.

The particular points are as follows:

1. Social perception and economic aspirations limit the acceptability of sustainable design and construction strategies. Questionnaire survey both in India and the survey conducted in Plymouth, the UK, clearly demonstrate that it is crucial to align the household's aspirations in the process of developing sustainable housing strategies.
2. The difference in behaviour pattern in a regulated and unregulated economy: there is a striking difference between the behaviour pattern of respondents in India and the UK. For instance, most of the sustainable features adopted by households in India were voluntary, whereas households in the UK had engaged in the features promoted by the policy or government in the UK.
3. Some consistency in the preferences for cultural values: one of the key findings is that social and cultural values scaffold the decision-making process and households tend to emulate those preferences in migrated places.

The research has shown that there is a direct correlation between the social and cultural values and energy behaviour of households. Further examination of specific aspects like ventilation, heating would provide greater insight into the extent of the impact of behaviour on energy consumption and would go a long way in reducing the carbon emission and develop sustainable communities for the future.

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