



## An investigation into factors influencing domestic energy consumption in an energy subsidized developing economy



Naief A. Aldossary<sup>a, b, \*</sup>, Yacine Rezgui<sup>a, 1</sup>, Alan Kwan<sup>a, 2</sup>

<sup>a</sup> BRE Institute in Sustainable Engineering, School of Engineering, 14-17 the Parade, Cardiff University, Cardiff CF24 3AA, United Kingdom

<sup>b</sup> Department of Architectural Engineering, Faculty of Engineering, Al-Baha University, Al-Baha, Saudi Arabia

### ARTICLE INFO

#### Article history:

Available online 3 February 2015

#### Keywords:

Energy consumption  
Low carbon homes  
Public perceptions and socio-cultural blockers

### ABSTRACT

The paper focuses on public perception of sustainable homes in a developing economy, namely Saudi Arabia, known for its high energy consumption and CO<sub>2</sub> emission rates. The research explores (i) public perception and knowledge of sustainable and/or low energy homes, (ii) domestic stock typology (including architectural style), (iii) energy consumption patterns, (iv) levels of satisfaction with energy (i.e. HVAC) systems, (v) cultural barriers that prevent the delivery of low energy homes, and (vi) people's acceptance of energy retrofitting and/or sustainable homes. For this purpose, a comprehensive survey ( $n = 622$ ) was conducted across the country. The findings reveal limited public awareness as well as important socio-cultural barriers to the delivery of sustainable homes, and large scale energy retrofitting of the existing domestic stock.

© 2015 Elsevier Ltd. All rights reserved.

### Introduction

Energy consumption in domestic buildings is a significant area where resources could be preserved (Brounen, Kok, & Quigley, 2012; Filippin, 1998). Over 50% of electrical energy output is used in the domestic sector in Saudi Arabia (MOWE, 2006). This large share of energy use can be attributed to full reliance on fossil fuels and limited uptake of renewables, despite largely favorable climatic conditions (Al-Saleh, 2009). Reducing energy demand, whilst relying on natural resources, would contribute to energy savings and reduction in CO<sub>2</sub> emissions. Many developed countries have enforced energy saving measures via a stringent regulatory system. However, these codes are absent in Saudi Arabia and are essential in regulating energy use (Chwieduk, 2003; Taleb & Sharples, 2011).

Related research, including work done by the authors (Aldossary, Rezgui, & Kwan, 2014a, 2014b) reveal a clear gap as to public perceptions of sustainable or low carbon homes. Moreover, in order to address the problem of domestic energy saving in Saudi

Arabia, it is important to examine factors causing high energy consumption, including public perceptions and the socio-technical barriers that prevent (a) the delivery of sustainable homes and (b) large scale implementation of energy retrofitting programs. A large scale survey was conducted, using a questionnaire distributed to members of the public with different ages, social background (including levels of education), and cities of residence in Saudi Arabia. The questionnaire focused on the existing building stock, the behavior and lifestyle of occupants and their perception of what constitute sustainable dwellings. Following this introduction, this paper is structured into six main sections: related studies, methodology, results and analysis, discussion, benefits and suggestions for large scale implementation, and finally, conclusions and recommendations.

### Methodology

In order to diagnose the factors influencing energy consumption in the domestic sector in Saudi Arabia, a public survey and perception analysis method was selected as the main approach for this study. Surveys are the most popular method used to collect data (Huang, 2006); as stated by Huang (2006), survey approaches are techniques of data collection that aim to discover exact estimations of the prevalence of significant variables. This paper addresses the following overarching research questions:

\* Corresponding author. Cardiff School of Engineering, 14-17 the Parade, Cardiff University, Cardiff CF24 3AA, United Kingdom. Tel.: +44 7715347080 (mobile); fax: +44 2920 874716. Saudi Arabia: Tel.: +966 566770007.

E-mail addresses: [AldossaryNA@cardiff.ac.uk](mailto:AldossaryNA@cardiff.ac.uk), [dr\\_naief@hotmail.com](mailto:dr_naief@hotmail.com) (N.A. Aldossary), [RezguiY@cardiff.ac.uk](mailto:RezguiY@cardiff.ac.uk) (Y. Rezgui), [kwan@cardiff.ac.uk](mailto:kwan@cardiff.ac.uk) (A. Kwan).

<sup>1</sup> Tel.: +44 2920 875719; fax: +44 2920 874716.

<sup>2</sup> Tel.: +44 2920876834.

- **Question 1:** What are the factors impacting on energy demand in the domestic sector in Saudi Arabia?
- **Question 2:** What are the socio-cultural blockers that hinder the adoption of sustainable homes and roll out of large scale retrofitting programs?
- **Question 3:** What is the level of public awareness and engagement with sustainable homes principles?
- **Question 4:** How adapted and efficient is the energy policy and regulatory framework in Saudi Arabia?

A quantitative methodology was used to address the above research questions. Comprehensive information related to building design, site characteristics, socio-cultural aspects, and public perception are needed and were sought from people of different ages, education levels, and locations, as elaborated below. A survey questionnaire was designed, piloted, and distributed to members of the public across Saudi Arabia.

Based on these considerations, the questionnaire was divided into four main categories: (i) eliciting the main factors leading to high energy consumption patterns in dwellings across Saudi Arabia; (ii) understanding levels of reliance upon, and use of, heating, ventilation, and air conditioning (HVAC), (iii) exploring people's perceptions of sustainability and their preparedness to invest in sustainable dwellings in the future and to retrofit their existing homes, and (iv) identifying cultural barriers – such as faith, social status or position in society – that affect architectural design in Saudi Arabia, preventing the development of sustainable dwellings.

The online questionnaire distribution technique was used in this study, as it is quicker compared with a manual printed survey (Stanton, 1998; Weible & Wallace, 1998), and is also less costly (Huang, 2006). The Snowball sampling technique (Biernacki & Waldorf, 1981) was used for large scale distribution of the questionnaires in Saudi Arabia. To access participants across all regions of the country, the survey was hosted with SurveyMonkey ([www.surveymonkey.com](http://www.surveymonkey.com)) (Gordon, 2002). The link for the questionnaire was distributed via email to the public in Saudi Arabia. This web tool facilitates the wide distribution of questionnaires using the Snowball technique (Biernacki & Waldorf, 1981). The authors were then able to monitor and view the responses to the survey and analyze the results.

The snowball sampling technique was used for the large scale distribution of the questionnaires in Saudi Arabia. The snowball sampling technique is an academic approach to sampling, employed in order to allow the sampled units to promote their own data as well as other units (Frank & Snijders, 1994). This approach has been considered efficient, economical and effective (Singh, Pandey, & Aggarwal, 2007). Moreover, the Snowball sampling method is elsewhere referred to as chain-referral or link-tracing (Illenberger & Flötteröd, 2012). This technique is employed by the distribution of a questionnaire by an author to participants, who then forward the study to others, who also forward it to attain a high participation rate. The snowball sampling enabled the authors to penetrate a high number of anonymous participants, while still recruiting and identifying informants with specific knowledge (Bird, 2009). The surveys were issued in Saudi Arabia and sent to potential participants by the main author using email and social networks, and, in turn, those participants forwarded the study to others as described in the snowball approach (Sadavoy, Meier, & Ong, 2004). In this study, the process was repeated between April 2013 and September 2013, in stages referred to in (Goodman, 1961), until the required number of apex had been sampled. It is worth noting that the ego-centric method is restricted to first degree associations, whereas snowball sampling creates an intricate grid (Illenberger & Flötteröd, 2012). In light of this, a direct approach is to pick random participants of different ages, genders, and

educational levels from different cities across Saudi Arabia (referred to as egos), and to then enquire about their social connections or alters. This ego-centric grid sampling method detailed by Wasserman and Faust (1994) creates star networks; a process that allows understanding of the relationships between egos and their alters.

The authors faced some limitations in this study due to a shortage in the database of similar official studies of energy demand in individual domestic buildings in Saudi Arabia. However, the main limitation of this survey relates to its reliance on computer-based participants (i.e. those with access to Internet). In 2013, 5.6% of Saudi Arabians had no access to the Internet (Central Department of Statistics and Information in Saudi Arabia). Therefore, the study involved educated people in Saudi Arabia, who in 2013 comprised 94.4% of the population, according to the central Department of Statistics and Information (Central Department of Statistics and Information in Saudi Arabia). In terms of Internet access in Saudi Arabia, use by young people is more frequent than by older people (Simsim, 2011). A survey was carried out by Simsim (2011), to determine the level of Internet service diffusion within Saudi society. He found that 11.1% of Saudis do not use email service, whilst 15.6% of the public do not use any Internet service (Simsim, 2011). Of these, a small percentage does not have access to Internet facilities due to Internet illiteracy (Simsim, 2011). According to the Ministry of Electricity in Saudi Arabia (Saudi Electricity Company, 2012), some villages in suburban areas across Saudi Arabia are not covered by the national electricity grid, relying on local energy sources; thus, the people in these villages have no Internet access and were not included in the study. Nevertheless, despite these limitations the study reached the majority of towns and cities across Saudi Arabia.

## Results and analysis

The use of the snowball technique through SurveyMonkey revealed satisfactory, the questionnaire reached 622 participants, 502 of whom (80.7%) completed and submitted the questionnaire. Table 1 presents the demographics of the completed respondents across Saudi Arabia regions in the basis of the ministry of electricity energy supply.

### *Public perception and current problems*

Through an in-depth analysis of public perceptions and review of their energy consumption behaviors, a number of factors emerged providing an initial explanation of high energy consumption patterns in the residential sector in Saudi Arabia, as elaborated below.

### *Building massing and space layout*

The questionnaire involved questions to identify, assess and determine the factors that cause high energy consumption in domestic buildings in Saudi Arabia. The results highlight a number of factors related to building size, number of rooms, as well as the number of household members in each property. Firstly, it is important to note that the majority of respondents live in one or two storey houses (52.8%), with just under half living in flats (47.6%). See Fig. 1 for more details.

This corroborates official sources (Central Department of Statistics and Information in Saudi Arabia) which state that 41.1% of properties are flats while 54.8% of properties are houses, with 4.2% in other categories. On the other hand, about half the respondents live in properties with areas of 300 up to 1000 m<sup>2</sup> (Fig. 2).

Download English Version:

<https://daneshyari.com/en/article/1047879>

Download Persian Version:

<https://daneshyari.com/article/1047879>

[Daneshyari.com](https://daneshyari.com)