

# Sustainability Challenges in Energy Use Behaviour in Households: Comparative Review of Selected Survey-based Publications from Developed and Developing Countries

## Zrównoważony rozwój a zużywanie energii w gospodarstwach domowych: Przegląd badań odnoszących się do krajów rozwiniętych i rozwijających się

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### Abstract

This review paper studies the differences in the energy use behaviour in households in developing and developed countries, by focus on a geographically diverse selection of publications. The study has been divided into sections in which energy use, socio-economic factors, policies and the methods used in the surveys have been investigated. The main motivation of the study was to understand user behavioural patterns influencing energy consumption (or reduction in use), and the effect of varying socio-demographic factors on the same. The methodologies adopted in the papers reviewed have been compared. Surveys were prioritized in the examined papers to see if there was an pattern in household energy use and which behaviours affected this. For the developing countries door knocking were the most used strategy to get hold of information. For the developed countries surveys online were the most effective strategy. In Japan and Norway clear differences could be seen due to the culture of the countries, which affected the households energy use. For the developing countries energy here is not predominantly electricity. Biofuels and kerosene were the most common fuels used for the daily life of the residents in the developing countries. A transition from these fuels to more modern energy is happening right now in the 21<sup>st</sup> century. The government have a big impact on the households energy use and the governments for the different countries prioritize differently as seen in Kuwait where they subsidy 90 % of the final electricity for the households thus increases the energy use significantly which have a negative sustainable development effect. While on the other hand the government in Zambia decided to shut down the whole electricity grid for eight hours per day during a two year period of time to save energy.

Effective strategies for reducing energy use, according to most of the publications, are tailor-made information and feedback to users, and clear outlining of goals by the decision-makers, for both the developed countries and the developing countries. Future research should focus on effective formulation of the feedback provided to users.

**Key words:** energy use behaviour, households, sustainable development, developed countries, developing countries

### Streszczenie

Niniejszy artykuł przeglądowy analizuje różnice w zachowaniach konsumenckich w zakresie zużycia energii w gospodarstwach domowych w krajach rozwijających się i rozwiniętych. W badaniach wyróżniono kwestie związane ze zużyciem energii, czynnikami społeczno-ekonomicznymi, polityką i zastosowaną metodyką. Celem badań było zrozumienie wzorców zachowań użytkowników oraz wpływ różnych czynników społeczno-demograficznych na zużycie energii (lub zmniejszenie jej zużycia). Z porównania metodologicznego wynika, że ankiety stanowiły główne narzędzie badawcze. W krajach rozwijających się respondenci najczęściej byli osobiście odwiedzani przez ankierów. W krajach rozwiniętych w o wiele większym stopniu wykorzystano Internet. W Japonii i Norwegii

stwierdzono występowanie znaczących różnic wynikających z uwarunkowań kulturowych tych krajów. Dla krajów rozwijających się, w codziennym życiu, nadal największe znaczenie miała nie energia elektryczna, a biopaliwa i nafta. W XXI wieku obserwujemy jednak stopniowe zmniejszenie się udziału tych nośników energii i wzrost wykorzystywania elektryczności. Rządy poszczególnych krajów mają istotny wpływ na poziom zużycia energii w gospodarstwach domowych, przy czym zakładane priorytety są różne. Przykładowo w Kuwejcie rząd subsydiuje aż 90% kosztów końcowej energii elektrycznej dla gospodarstw domowych, co nie tylko nie skłania do jej oszczędzania, ale pociąga za sobą znaczący wzrost jej zużycia, co trudno uznać za praktykę zgodną ze zrównoważonym rozwojem. Na przeciwległym biegunie znajduje się rząd Zambii, który w celu oszczędzania energii postanowiły codziennie przez dwa lata wyłączać całą sieć elektroenergetyczną na 8 godzin.

Skuteczne strategie ograniczania zużycia energii, zgodnie z większością publikacji, zarówno w odniesieniu do krajów rozwijających się, jak i rozwiniętych, muszą być dostosowane do potrzeb użytkowników i prezentować jasno określone cele. Dalsze badania warto poświęcić odpowiednio przygotowanym informacjom zwrotnym przekazywanym użytkownikom.

**Słowa kluczowe:** zachowania w zakresie zużywania energii, gospodarstwa domowe, rozwój zrównoważony, kraje rozwinięte, kraje rozwijające się

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## 1. Introduction

Challenges related to the use of energy, its impending scarcity and associated environmental impacts, confront humankind (Klöckner 2013). According to Lüning & Vahrenholt (2017), the researchers, each country has to contribute in order to avoid a 2°C rise in the average temperature on Earth.

Households, as stated in Feng et al. (2011) and Zhou & Yang (2016), can make a big difference in this regard, by optimising their use of energy. After all, they account for a substantial part of the total global energy consumption, according to Zhou & Yang (2016), and a combination of behaviour change and technological advances in energy-intensive appliances can, according to these authors, reduce energy use in households by a maximum of 27%. Klöckner (2013) and Morren & Grinstein (2016) have exhorted households to realise the positive impact that they can have, and take more responsibility for doing so. Every one of us, can quite easily, reflect over his/her energy use behaviour – related to transportation, direct household energy use and indirect energy footprints related to consumption of food and other material goods. It has been accepted by several researchers that the socio-economic and socio-demographic factors influence societal energy use to a great extent, and while understanding the links itself is a complex task, implementing interventions to bring about change is even more challenging (Morren & Grinstein 2016; Rahut et al., 2016; Nauges & Wheeler 2017).

It goes without saying that in order to understand better the energy use behaviour in a given country, one needs to first delve deep into understanding how the country has evolved over time (historical analysis) socio-culturally, socio-economically and politically; and know about the lock-ins that may hinder development in the desired direction. Lenzen et al. (2006) have also pointed out that sustainable development need not mean the same in developing countries on the one hand and developed countries on the other. Especially in the developing world, where

people are striving towards western standards of living, electricity provides security and an opportunity for socio-economic development, as argued by Kaygusuz (2011). While this right cannot be wrested away from the people in the developing world, Rahut et al. (2016) and Kaygusuz (2012) believe that one needs to strike a balance, so that global warming is not exacerbated – in other words, to *have the cake and eat it too*. In the second paper referred to in the previous sentence, the authors have pointed out that about 2.7 billion people (at the time that paper was published), were using firewood instead of electricity for cooking, and about 1.3 billion people are fatally exposed to air pollution in the kitchens from firewood combustion. Be it the developed or the developing world, energy often tends to be overused according to Camara et al. (2018), and this indicates a high saving (use-reduction) potential, if one cares to consider the same. It has been found that energy consumption differs conspicuously between rural areas and big cities (Feng et al., 2011). Usually, people living in rural households are more aware of the impacts their behaviour has on the environment, vis-à-vis people living in towns and cities (Martinsson et al., 2011). Households with a lower income generally have a more environment-friendly behaviour, compared to the higher-income ones.

In this brief review, the authors have tried to understand the factors associated with household energy-use behaviour, in selected developing and developed countries. The countries under the scanner are depicted in Figure 1.

## 2. Methodology

This study were conducted in different sections for developed respective developing countries. The different issues examined were the methods used for the surveys, energy use in the households, socio-economic factors and recommended policies. Table 1 shows research methodology for the reviewed journals and Figure 2 shows the number of journals examined and its year of publication.

Table 1. Research methodology for the reviewed papers obtained from One Search database.

Journal paper	Year of publication	Search words
A review of intervention studies aimed at household energy conservation	2005	Household energy use + Developed countries
A comprehensive model of the psychology of environmental behaviour – A meta-analysis	2013	Environmental + Sustainable + Behaviour
A comprehensive model of the psychology of environmental behaviour – A meta-analysis	2013	Psychology + Behaviour
A comparative multivariate analysis of household energy requirements in Australia, Brazil, Denmark, India and Japan	2006	Behaviour + Environment + Developing world + Energy + Household
Analysis and modelling of active occupancy of the residential sector in Spain: An indicator of residential electricity consumption	2013	Household energy use + Behaviour + Residential
Analysis: The Complex Relationship Between Households' Climate Change Concerns and Their Water and Energy Mitigation Behaviour	2017	Climate change + Household energy use + Survey
A global review of energy consumption, CO <sub>2</sub> emissions and policy in the residential sector (with an overview of the top ten CO <sub>2</sub> emitting countries)	2015	Energy consumption + Residential sector
A new method for household energy use modelling: A questionnaire-based approach	2018	Household energy use
A cross-cultural analysis of household energy use behaviour in Japan and Norway	1996	Household energy use + Economy + Environment + Behaviour
Characteristics or culture? Determinants of household energy use behaviour in Germany and the USA	2018	Behaviour + Household energy use
Cross-National Gender Variation in Environmental Behaviours'	2004	Environmental + Behaviour + Gender + Survey
Does gender make a difference in pro-environmental behaviour? The case of the Basque Country University students	2018	Discourse + Environmental knowledge + Behaviour
Enhancing household energy consumption: How should it be done?	2018	Energy behaviour + Africa
Energy consumption and activity patterns: An analysis extended to total time and energy use for French households	2017	Household energy use + Developed countries
Energy services and energy poverty for sustainable rural development	2011	Behaviour + Environment + Developing world + Energy + Household
Energy for sustainable development: A case of developing countries	2012	Behaviour + Environment + Developing world + Energy + Household
Energy saving in Swedish households. The (relative) importance of environmental attitudes	2011	Pro-environmental behaviour + Energy behaviour + Attitudes
Explaining environmental behaviour across borders: A meta-analysis	2016	Behaviour + Developed world + Developing world
Environmental knowledge, pro-environmental behaviour and energy savings in households: An empirical study	2016	Behaviour + Environment + Developing world + Energy + Household
Gender and Environmentalism: Results from the 1993 General Social Survey	1997	Survey + Environment
Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour	2015	Household energy use + Behaviour change
How households adapted their energy use during the Zambian energy crisis	2018	Behaviour + Household + Survey + Developing + Energy use
Household energy use: a comparison of household energy consumption and expenditure across three provinces	2017	Household energy use
Household energy choice and consumption intensity: Empirical evidence from Bhutan	2016	Behaviour + Environment + Developing world + Energy + Household
Household energy access and expenditure in developing countries: Evidence from India, 1987-2010.	2016	Household energy use + Developing countries + Developing nations + Third world countries
Household lifestyle effect on residential electrical energy consumption in Indonesia: On-site measurement methods	2017	Behaviour + Household + Survey + Indonesia
Human behaviour in household energy use and the implications of energy efficiency delivery : A case of Bauchi, Nigeria	2014	Household energy use + Behaviour + Developing countries
Integrated Energy Planning for the Residential Sector: The Case Study of Cyprus	2014	Household energy use + Survey

Journal paper	Year of publication	Search words
Interaction effects of building technology and resident behaviour on energy consumption in residential buildings	2017	America + Behaviour + Household energy use + Survey + Consumption
Managing the future megacity: an appraisal of knowledge about energy challenges and energy-saving attitudes among households in Dhaka	2016	Energy behaviour + Africa
Public acceptance of household energy-saving measures in Beijing: Heterogeneous preferences and policy implications	2018	Environmental + Behaviour + Household energy use + Survey
Paleo climatological Context and Reference Level of the 2°C and 1.5°C Paris Agreement Long-Term Temperature Limits	2017	Global warming + Paris Agreement
The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviours, and behavioural antecedents	2007	Household energy use + Behavioural + Information
The impact of household consumption on energy use and CO <sub>2</sub> emissions in China	2011	Behaviour + Environment + Developing world + Energy + Household
Understanding energy demand in Kuwaiti villas: Findings from a quantitative household survey	2018	Behaviour + Household + Survey + Developing
Understanding household energy consumption behaviour: The contribution of energy big data analytics	2016	Pro-environmental behaviour + Energy behaviour + Australia

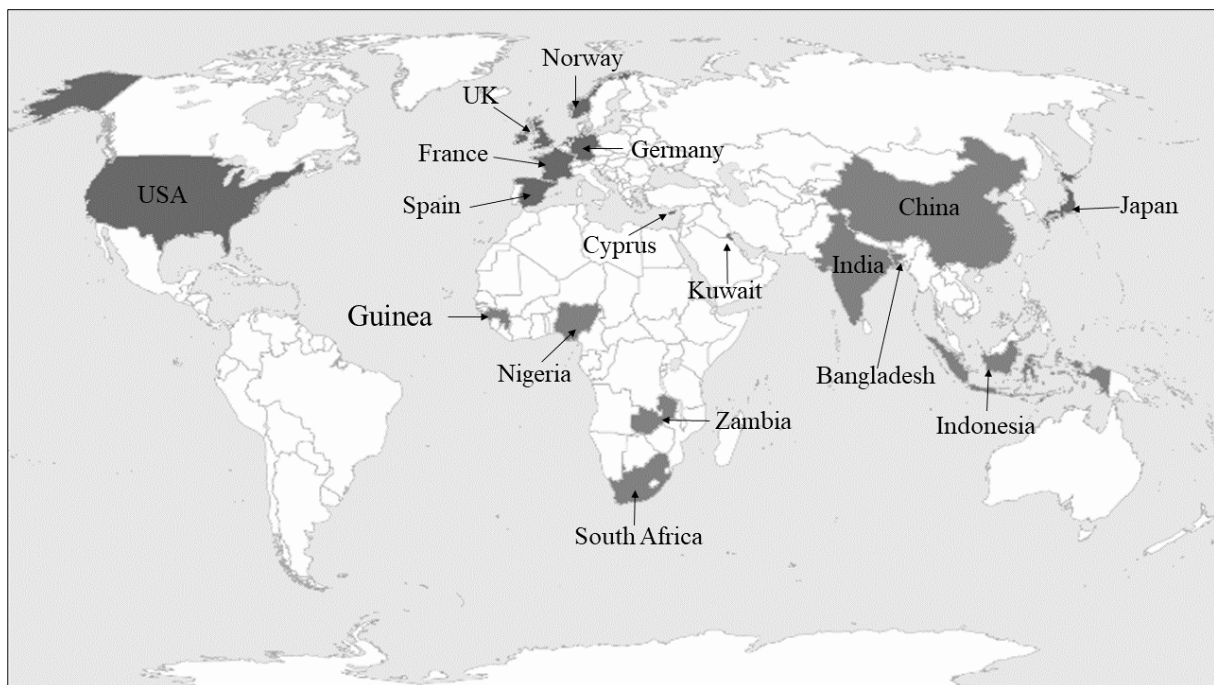


Figure 1. Countries selected for review in the paper.

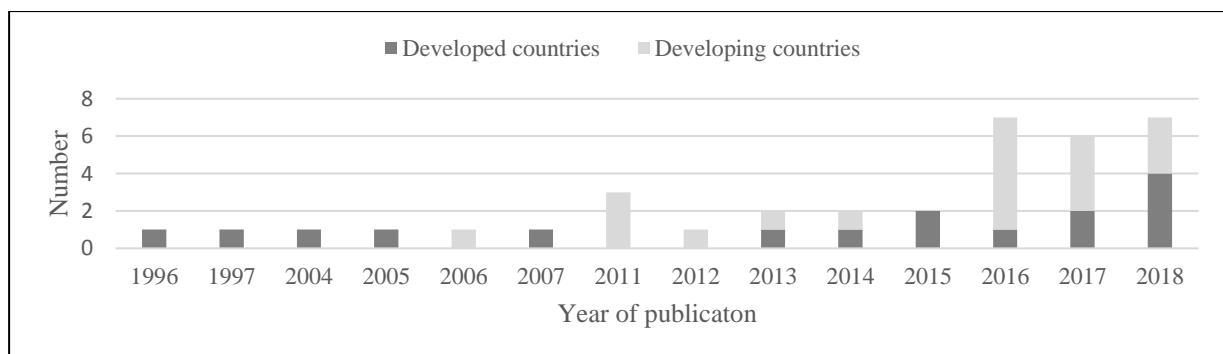


Figure 2. Distribution of the papers reviewed, developed vis-à-vis developing countries

### 3. Literature review

#### 3.1. Methods used for the surveys in developed countries

The approaches for the different surveys in the developed countries were surveys conducted based on

either direct face-to-face interviews or questionnaires that were despatched online to the households. See table 2 for the survey methods adopted in each paper, as well as a short description of its goals and foci. See figure 3 for the different research methods used in the examined papers.

Table 2. Summary of the papers reviewed for the developed countries.

Publication	Case study region/country	Sample size	Goal/Focus
Abrahamse et al. (2007)	Holland	189 households	<b>Online survey</b> to determine if <b>tailored information, tailored feedback</b> and <b>goal setting</b> reduces <b>energy use in households</b> .
De Lauretis et al. (2017)	France	27 903 individuals in 15 797 households	Survey to record <b>daily time use</b> for 8 types of <b>residential energy expenditures</b> .
Demetriou et al. (2014)	Cyprus	30 families by average 2.9 people in each household	Survey to determine <b>households' energy behaviour</b> and <b>energy use</b> alongside with the <b>residential characteristics</b> .
Jaffer et al. (2018)	Kuwait	250 households	Survey to determine <b>households' socio-demographic profile, energy behaviour</b> and <b>residential characteristics</b> .
López-Rodríguez et al. (2013)	Spain	19 295 individuals in 9541 households	Survey to record <b>daily time use</b> for the daily activities for the sample, and then relate the same to <b>corresponding energy use</b> .
Ozawa et al. (2018)	Japan	1227 individuals	Online survey to record <b>daily time use</b> in the <b>household</b> with three main focuses.
Pothitou et al. (2016)	Great Britain	800 households	<b>Mailings</b> to the households with focus on <b>socio-economic factors</b> and knowledge/attitude towards <b>sustainable development</b> to determine the <b>energy use</b> .
Vicente-Molina et al. (2018)	Spain	1150 students in the university of Basque Country	Interview to determine if <b>gender</b> have any significant result on <b>energy behaviour</b> and <b>energy use</b> .
Wilhite et al. (1996)	Fukuoka, Japan and Oslo, Norway	18 household in Oslo and 16 households in Fukuoka	<b>Ethnographic interview</b> to determine if <b>culture</b> affect <b>household energy use</b> and <b>energy behaviour</b> .

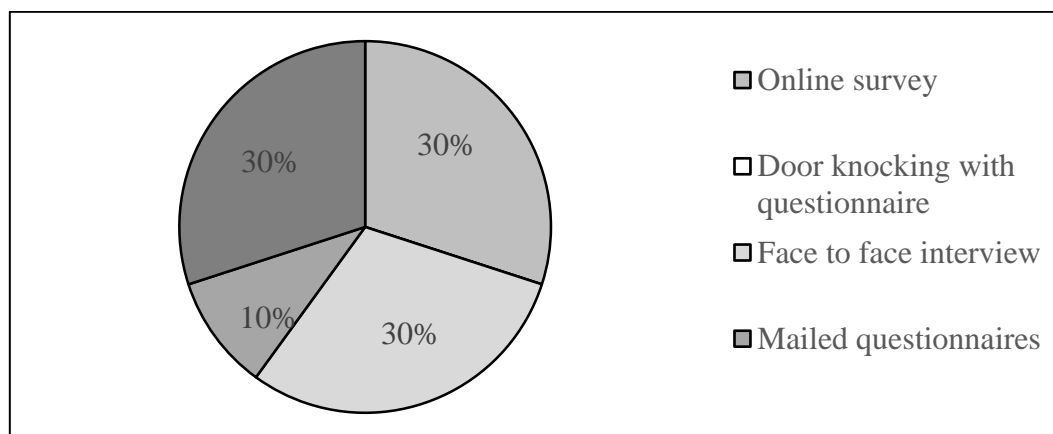


Figure 3. Different methods used for research in the papers for developed countries.

Although the authors of all papers reviewed used questionnaires, they adopted different approaches and methods. Abrahamse et al. (2007) used an online survey with three different groups (where one of the groups was the control group) and the survey took place over a period of five months. Demetriou et al. (2014) and Jaffer et al. (2018) adopted a similar approach – providing respondents with multiple-option questions and then compiling the results. Unlike

Wilhite et al. (1996) who conducted an ethnographic interview with relatively more open-ended questions, López-Rodríguez et al. (2013) and De Lauretis et al. (2017) used questionnaires constructed by the statistical institutes of the respective countries, to investigate the behaviour of energy users over a period of 24 hours. Ozawa et al. (2018) did likewise, the difference being that the sample size was much smaller. See table 2 for the examined surveys.

### 3.2. Energy use – households in developed countries

Understanding consumer behaviour is not always easy as people do not usually adhere to traditional economic theories related to decision-making. Man is of course a rational individual, but there are many nuances which need to be understood. *Being rational* can be visualised as a wide spectrum of behaviours. Many people state they worry about the environment and are aware of the importance of saving energy thus this does not mean they change their behaviour to reduce energy use in the households (Frederiks et al., 2015).

The pattern of energy use in households is different, in general, for different countries, owing to a complex mix of factors. The geographical location of a country is a key factor – perhaps the most influential one – as that determines the need for heating and / or cooling in the households. For example in Kuwait, 60% of the electricity generated in the country was consumed in the households, where air conditioners and other types of space coolers which were used, had very low operating efficiencies, as observed in Jaffar et al. (2018). In Cyprus, a country in the temperate zone, about 12% of the total electricity use was in households, and this stark difference between this EU country and Kuwait was thanks to the lavish subsidies provided by the generous Kuwaiti government. Kuwait, as readers know is an oil-and-gas producer and its electricity is entirely fossil-fuel-sourced (Demetriou et al. 2014 and Jaffar et al. 2018).

According to Demetriou et al (2014), in Cyprus, total final energy consumption has increased at an annual rate of 4.2% in the period 1990 to 2015; with the increase in household energy consumption increasing at a much brisker clip – at 11% per annum. In the United States, the corresponding percentage 21.7% - also something which deserves attention and interventions with respect to reducing the footprint and thereby the environmental impacts. In Japan, energy consumption in the households has doubled over the last four decades, according to Ozawa et al. (2018). Kuwait's household energy use per capita has been among the highest in the world, and this due to socio-demographic and economic aspects, with the discovery of oil in 1938 led to a period of high economic growth, increased the stock of households in the country, and contributed to laxity as regards efforts to optimise energy use, as reasoned by Jaffar et al. (2018). In the UK, households accounted for a large part of the country's energy consumption, about a quarter of the energy produced was transmitted to the housing sector. High energy consumption in the UK has been attributed to behavioural inflexibility, climatic conditions that prevail in the country, socio-demographic characteristics and also the physical features of the buildings themselves, by (Pothitou et al., 2016).

López-Rodríguez et al. (2013) pointed out five years ago that a spurt in the purchases of household elec-

trical appliances has contributed to a marked increase in household energy use in Spain – where 17% of the total energy produced and 25% of the total electricity generated, is consumed in the housing sector. If all the countries of the world are taken together (both developed and developing world), the housing sector accounted for about 17% of the total energy use. Though this is much less than the industrial and transportation sectors, it must not be overlooked as an attractive niche for intervention to reduce energy use and thereby mitigate climate change concerns (Ozawa et al., 2018). Of course, work in the housing sector needs to be complemented simultaneously by interventions in the other energy-using sectors of the socio-economies of the world.

Wilhite et al. (1996) deciphered that there were clear differences how cultural traits affected energy use in households. The authors of the said paper compared Oslo, Norway and Fukuoka, Japan with respect to energy used for space heating and electricity for lighting. Oslo has a long and cold winter with a moderate summer while Fukuoka has a moderate winter with a warm summer, and this is a factor which introduces the differences in energy use for space heating. In Oslo on a cold winter evening, one tends to warm up all the rooms in the house, even if some of them were not occupied or used. The purpose here – comfort. However, in Fukuoka, comfort was perceived from a different standpoint and only rooms which were being used were warmed up. In other words, the Japanese would wait for some time, before occupying a room as it slowly warmed up to the pre-set temperature. This preoccupation with cosiness and comfort has resulted in an increase in energy use in Norwegian households. Interestingly, cultural ablution habits in Japan result in the use of a lot of warm water for bathing, vis-à-vis Norway. This paper was written by Wilhite and colleagues over two decades ago and thereby it would be necessary to find out if things have changed over time. That necessitates further research.

Demetriou et al. (2014), analysing the Cypriot case, deduced that approximately 46% of the total energy use in households can be attributed to space heating and cooling. Electric household appliances accounted for 16% of energy use, electricity (e.g. lighting) for 12%, washing and drying machines, fridge and freezer stood for 7% each, while cooking appliances used up 5%. Similar trends were seen in households in the United States and most Western-European countries. where energy use was dominated by cooking, followed by water heating, and thereafter electricity use for refrigerators, freezers, lighting and air-conditioning (Abrahamse et al., 2005).

### 3.3. Socio-economic factors – developed countries

The Cypriot case study also found out that energy use is correlated to income – the higher the income, the greater the tendency to spend on energy-using appliances and subsequently, energy bills. In Cy-

prus, the majority of the households had poor insight into the energy classes of their household appliances. This shows that residents must be provided with more and better information about energy use and how it can be optimised. About 75% of the respondents were willing to save more energy and 90% claimed that the most important source of information they relied on was the television. Over 86% of the respondents in this study claimed that they were willing to pay a little more for energy-efficient appliances and captive renewable energy installations as long as the payback period (return on investment) was attractive enough (Demetriou et al., 2014).

A study was conducted at a university in Spain where differences in energy use based on gender were investigated. According to Vicente-Molina et al. (2018), previous surveys have shown significant attitudinal differences towards energy use between men and women, with women being more keen on reducing energy use (Blocker & Eckberg 1997 and Hunter et al. 2004) believe that the gender of the individual may influence attitude, beliefs, opinions, behaviours, etc. towards the environment. In this Spanish study, it was revealed that men had better knowledge of environmental issues, while women showed much greater motivation to be environment-friendly in practice (Vicente-Molina et al., 2018). Knowledge of household energy consumption is linked to two things according to Pothitou et al. (2016) – the fact that reduction in household energy use helps the environment and also that this saves the household money which can be put to use for something else. The economic aspect – saving money – was, by and large, the main reason why households in the UK were willing to install smart monitors to keep track of their energy use. It was also shown that interventions which were relatively easier and less-strenuous (like switching off the lamp in a room while leaving it) were adopted readily, but those which tended to compromise the levels of comfort (like reducing the thermostat setting to reduce the warmth in the room slightly) were overlooked. In this context, the four cognitive behaviours in human beings propounded by Frederiks et al. (2015) – shown in Table 3 – are of interest.

### 3.4. Recommended policies – developed countries

Decision-makers and politicians play a crucial role in bringing about top-down changes in energy use in households. Jaffar et al. (2018) have discussed the role the Kuwaiti government has to play in this regard. A reduction in the size of villas built in the country is called for by the authors. The villas are reportedly very big (relative to the number or occupants) and there is tremendous wastage of energy thereby, in space heating. Such a diktat will at once lead to a perceptible reduction in the energy use per capita in the country. Also proposed is the introduction of maintenance and replacement plans for air

conditioners in the country, as most of them are old and inefficient on date. In the US, negative effects were observed by a government that chose to ignore the environmental impact of energy consumption (Long et al., 2018). In 2015, the US entered the Paris agreement under the Obama administration only to leave it two years later under the Trump administration. This has led to increased energy consumption and concomitant greenhouse gas emissions. According to Long et al. (2018), the citizens of the USA are influenced by the opinions of their politicians about energy use and related environmental issues. While Wilhite et al. (1996) recommend better billing methods to enable households to track their energy use better, Abrahamse et al. (2007) and Nejat et al. (2015) have pointed at the importance of providing tailormade information as feedback to households continuously. The second paper referred to in the previous sentence also touted providing tax benefits to those living in energy-efficient households and using energy-efficient appliances to encourage similar behaviour among those who do not, as a powerful instrument which responsible governments must wield.

Table 3. Four cognitive behaviours’ in human beings – influencing energy use habits (Frederiks et al., 2015).

Psychological factor	Description
Inertia, unwillingness to change	Resisting the need for behavioural changes
Settling for <i>good enough</i>	Sacrificing the best for the <i>good enough</i> . Not taking time to evaluate and choose the optimally best alternative
Loss-aversion	Focussing more on the costs and risks associated with the change of behaviour, instead of the potential profits.
Comparing with others around in society	Following the behaviour of others – good or bad – and trying to <i>match the Joneses</i> , so to say.

### 3.5. Methods used for the surveys in developing countries

The approaches for the different surveys in the developing countries were surveys conducted based on either direct face-to-face interviews or questionnaires that were despatched online to the households. See table 4 for the survey methods adopted in each paper, as well as a short description of its goals and foci. See figure 4 for the different research methods used in the examined papers.

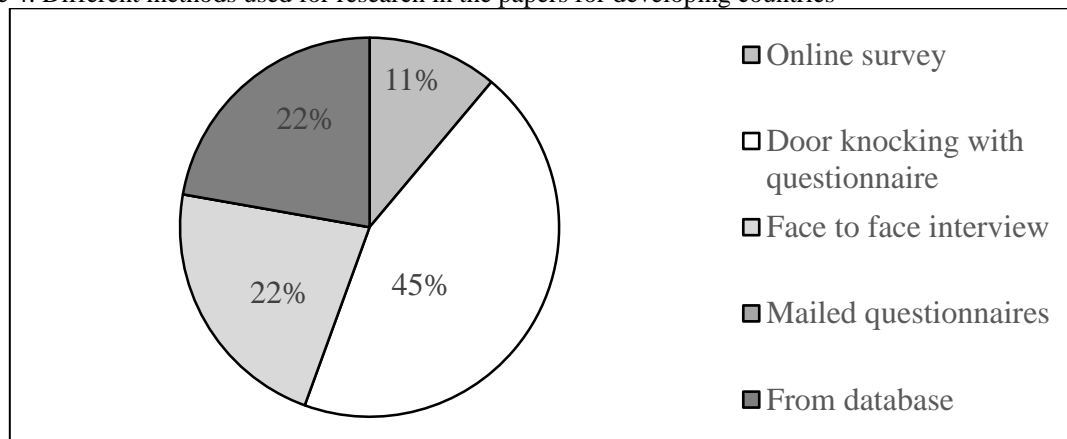
### 3.6. Energy use – developing countries

To understand the household energy consumption of developing countries, one must first think a bit outside the box – energy here is not predominantly electricity, as may be the case in most of the western world households. Biomass (biofuels of various types, firewood especially) accounts for a significant share of the fuels used (Camara et al., 2018). Alkon

Table 4. Summary of the papers reviewed for the developing countries

Publication	Case study region/country	Sample size	Goal/Focus
Aitken (2017)	South Africa	743 households	<b>Home visits in villages with no electricity</b> to analyse the <b>socio-demographic profile</b> of the <b>household</b> and the <b>energy use</b> with a <b>survey</b> .
Al Mamun et al. (2016)	Bangladesh	400 individuals	Survey to determine <b>households' energy behaviour</b> and <b>the socio-demographic profiles</b> in the households.
Alkon et al. (2016)	India	578 066 individuals	Surveys made under the period 1987-2010 to determine the <b>households' energy use</b> and <b>socio-demographic profile</b> .
Camara et al. (2018)	Guinea	20 individuals	Online survey to determine <b>households' energy behaviour</b> and <b>the socio-demographic profiles</b> in the households.
Jia et al. (2018)	China	569 randomly-selected households	<b>Door-to-door visits</b> . Asked the households to answer a <b>survey</b> to determine the <b>households' energy use</b> and <b>socio-demographic profiles</b> .
Ngoma et al. (2018)	Zambia	261 households	<b>Survey</b> to investigate if the <b>households</b> had changed their <b>energy behaviour</b> with the eight hour electricity shut down. <b>The socio-demographic profile</b> were also investigated.
Sukarno et al. (2017)	Indonesia	210 randomly-selected households	<b>Door-to-door visits</b> . Asked the households to answer a survey to determine the <b>households' general knowledge</b> about <b>energy use</b> and the <b>socio-demographic profile</b> .
Udale Hussaini Ibrahim & Hanita Abdul Majid Noor (2014)	Nigeria	365 households	<b>Door knocking</b> to analyse the <b>socio-demographic profile</b> of the <b>household</b> and the <b>energy use</b> with a <b>survey</b> .

Figure 4. Different methods used for research in the papers for developing countries



et al. (2016) have observed that 91% of the cities in the world and over 60% of rural households have access to electricity. Hence, a transition (which is underway in many parts of the developing world) from biomass as the primary source of energy to electricity (generated from a wide variety of sources) is both a cause and an effect of the process of economic development (Alkon et al. 2016 and Camara et al. 2018).

Access to electricity opens up a market for electricity-using appliances of different types, which reduce the tedium which especially women in the developing world have to endure on a daily basis. The transition phase is ripe for interventions with respect to providing information about energy saving at home as observed by several researchers – Udale Hussaini Ibrahim & Hanita Abdul Majid Noor 2014; Al Mamun et al. 2016; Camara et al. 2018; Jia et al. 2018). Ibrahim and Noor (2014) and Al Mamun et al. (2016) found out from their surveys in Bangla-

desh and Nigeria respectively that energy users in households were fully aware of the role of energy supply as the engine of socio-economic development, and that the environmental impacts associated with energy use ranged from local (acidification and toxicity) to global (climate change and abiotic depletion). Over 91% of the Bangladeshis surveyed were aware of the energy scarcity issues which may turn out to be a major obstacle to the country's development in the years to come. The men were more aware than the women about these issues, owing obviously to the high rate of female illiteracy in the country. Both in Nigeria and Bangladesh, younger people who were better-educated, thanks to the access to information (Internet and social media), demonstrated much greater awareness of energy-related issues.

The Guinean study by Camara et al. (2018) was far from comprehensive and the striking drawback was the very small sample set chosen – 20 respondents, as shown in Table 4. Here, there is a need to expand



the sample size before any generalised inferences could be drawn about the energy use behaviour in this west African country. Meanwhile, in China, people with a lower level of education, quite surprisingly, preferred to invest in energy-efficient appliances at home, vis-à-vis the better-educated ones. Perhaps, scepticism accompanies a higher-level of education? Well, this is a question which could be mulled over by readers. Ji et al. (2018), in this Chinese study, reasoned out that the users who were better-educated already had a *good-enough* equipment and so were less willing to invest in new energy-efficient equipment, as they thought that the benefits would be marginal (also refer to the Frederiks et al. (2015) and Table 3 ). Quite intuitively, homeowners were more willing to invest in energy-saving devices compared to tenants, and younger people more than older ones. Interestingly though, the conservative older people were more willing than the younger Chinese to change their behaviour to reduce energy use, quite contrary to the general belief that *one cannot teach an old dog new tricks*.

Alkon et al. (2016) has observed that in Indian rural households, energy used increased over the period 1987 to 2010, thanks in part to an expansion of the power grid to reach more remote areas, and in part to LPG availability (the latter being used for cooking). Owing to supply constraints on the other hand, the energy use in urban Indian households did not increase much over this period of time. The Indian population is composed of a sizable middle class (income and savings in between the stratum of poor people at the bottom of the ladder, and the rich at the top), and it is this stratum of society which contributed to the lion's share of the increase in household energy use. Sukarno et al. (2017), studying energy consumption in Indonesian households, found out that cooking dominated energy use, and was followed by space cooling (electric fans and air conditioners), appliances (washing machines, water pumps for bore wells, ironing etc.), entertainment (TV, computer, etc.) and indoor lightning. Rural households tended to use more energy than their urban counterparts.

When it comes to energy saving (the what and the how), Ibrahim and Noor (2014) found out from their Nigerian study that 40% were in the know, 50% knew a little and 10% were ignorant. The economic aspect of energy use in households is also a crucial factor which determines how energy will be valued and used/saved. The households in South Africa who had no access to electricity had energy bills which accounted for somewhere between 6.6-18.1% of their income. Liquefied natural gas and kerosene were used as the primary sources of energy for cooking, heating and water heating. Between 76-98% of the households surveyed used biomass as a supplement in cooking primarily (Aitken 2017).

In Zambia, in June 2015, as informed by Ngoma et al. (2018), electricity supply was cut off for eight

hours daily. This regulation as occasioned by several factors – a rapid rise in demand, with a rise in population, dilapidated infrastructure, inadequate management of power production and the drop in the availability of water to drive a large hydroelectric power plant in the country. When this regulation was implemented, about 50% of the users shifted their times of use to adapt to the disruption in power supply. However, total electricity use did not decrease much. Thus, the intended purpose was not fulfilled. Though the electricity supply to households decreased by 33%, the use by the members of the households decreased by only 10%. People simply shifted the locations of their use of electricity to offices and public places, for instance. Zambia thus has provided useful lessons to governments planning to use controlled power outages as tools to induce reduction in household energy use.

### 3.7. Socio-economic factors

User willingness to reduce energy use must be complemented by the flow of adequate and timely information to households about the potential impact of their behavioural patterns and choices on energy-related challenges (Al Mamun et al., 2016). It is generally seen that this top-down flow of information is extremely poor in most developing world countries, and that can be blamed for the indiscriminate and profligate energy use behaviour witnessed in many households, as argued by Ibrahim and Noor (2014), Camara et al. (2018) and Al Mamun et al. (2016). The last-named publication inferred from the survey carried out in Bangladesh that there was reliance on television for information related to energy use and environmental policy, disseminated by the Government. Half of the respondents informed the authors that they obtained information from friends, colleagues and manufacturers. However, contact with experts and researchers was minimal, and it can be seen as a vacuum which needs to be plugged. While the Guinean study, as mentioned earlier, suffered from a small sample size as a drawback, it was seen from the survey of 20 households, that over half of them had absolutely no knowledge of energy-saving behaviour. Seventeen of these respondents stated that they would prefer access to websites with information at cyber cafes in the neighbourhood. Jia et al. (2018) found that in China, campaigns and advertisements served their desired purpose quite well, emerging as potent instruments for change.

The Indian study showed that users complained actually about poor accessibility to energy supply, indicating that they were actually not over-consuming at all. They also were willing to change over to alternate sources of energy at home in order to minimise the negative health effects associated with the use of charcoal and firewood. Clean-burning fuels, according to Alkon et al. (2016) have a big market in rural India. In Indonesia, Sukarno et al. (2017) have observed, if users could refrain from having electronic

items on standby mode instead of shutting them down completely when not in use, a lot of energy saving is possible (considering the population of Indonesia). In South Africa, Aitken (2017) observes, investments in developing the energy infrastructure could result in effectively reducing energy demand. The author claims that efforts made by the government in regulating household energy use are paying off, but losses associated with the transmission and distribution infrastructure and lower efficiency of power generation on the upstream need to be focused on, at the same time in order to maximise the life-cycle savings.

When power shortage was enforced by the government in Zambia, people simply shifted their routines to adjust but at the same time, they also tended to move over to other locales where they could continue using energy (spending more time in public places, offices etc.). Ngoma et al. (2018) observes that habits die hard and even if top-down approaches are adopted and implemented religiously, the bottom-up needs to work in tandem to achieve the desired goals.

### *3.8. Recommended policymaking – developing countries*

The government in Bangladesh has taken steps to disseminate information to the people about energy efficiency and renewable energy sources – solar PV especially - according to Al Mamun et al. (2016). About 64% of the population expressed an interest to invest in solar PV while the remaining cited the high initial cost as an obstacle. The Government could not do much to subsidise solar PV installations in households, and thereby the end-result was far away from what it had expected. On the contrary, in the last decade, the government provided incentives to households which were willing to replace incandescent lamps with energy-saving alternatives, and this plan was met with great success.

After the Government in Guinea built a new artificial reservoir to enhance the generation of hydroelectricity, it started an awareness generation campaign on TV and radio. Camara et al. (2018) have opined that this was a good initiative, but the fact that the campaign lasted for only a month did not result in the expected and desired end-results in the country. A lot is still to be done in Guinea, and the political will seems to be lacking.

In China, there are some taxes and subsidies which enable households which otherwise cannot afford to spend more, to purchase energy-efficient devices and appliances. Government-initiated advertising, as mentioned earlier, did go a long way to inform and encourage users to change their habits. In India, the challenges are not associated with educating households to optimise their energy usage, but rather with bringing electricity to as-yet-unelectrified remote areas of the country, as stated in Alkon et al. (2016).

That then is a different type of sustainability challenge – while lack of access to electricity may be good for the environment as supply need not be scaled up, the socio-economic drawbacks are immense, and this is where one must learn not to put the cart before the horse, to cull a proverb.

The Indonesian government, Sukarno et al. (2017) avers, must encourage users to replace energy-intensive appliances in households with energy-efficient newer ones, and institute subsidies to overcome the economic hurdle which household willing to do so, may have to face. In Nigeria, the government, instead of taking the energy companies into confidence, entrusted the task of researching user behaviour and educating them on issues related to energy and environment to academics in universities. This turned out to be a faux pas and the desired effects have not been realised. The South African government on the other hand, as written by Aitken (2017), experienced reasonably good success with the proposal to allow households to rent solar PV panels. The Zambian fiasco with the managed power outage, leads one to recommend taxing energy-intensive appliances and subsidising renewable energy products like solar cells.

## **4. Discussion**

A major similarity between developing countries and developed countries was that most households were willing to invest in energy-efficient household appliances, but, in general, viewed the expensiveness as a hurdle. Even though an investment in a new, more-efficient device has a greater profitability over time (after the payback period), very few were willing to take this risk. The risks were magnified and in the process, the financial gains which would accrue courtesy the lowering of energy use, shrunk in the background.

Information is key. Knowledge is power. This was an important aspect in both the developing and developed countries. While residents of the developed world were, on average much better-informed, those in the developing world were clueless and often ignorant of the possibilities of reducing energy usage in households and thereby contributing to truncating the global carbon footprint. In countries like Kuwait, where there is relative abundance of energy supply, there was overuse and wastage, while in Zambia for instance, the government had to cut off access to electricity for eight hours daily, in order to induce changes in user behaviour (which as we discussed, did not happen to the extent desired).

The economic factor was critical and the main reason for the differences perceived in the studies in the developing countries on the one hand, and the developed world on the other. The Kuwaiti government, instead of subsidising energy, can try removing these subsidies and instead directing them towards energy-

saving appliances and investments in solar PV panels on rooftops – it goes with saying that desert-land Kuwait has tremendous potential for solar energy.

In developing countries, an investment in new household appliances can increase the living standards of households (socio-economic benefits) while exacerbating climate change concerns (at the cost of the environment). At the same time, new energy-efficient appliances are a better bet than the older, energy-guzzling ones. Many electricity-powered devices are used in the developing world to improve comfort levels (a social aspect, or rather a socio-cultural aspect of sustainable development). It follows that if all the developing countries would reach the same standards as the developed world, global energy use will skyrocket and be impossible to sustain for a long time.

A key point however is the value the households in the developing world, on average, place on energy. They are careful and aware and mindful of not over-consuming (due to either the expenses incurred, or the recurring power cuts). The behaviour in the developed world can be labelled as more of *taking for granted*.

## 5. Conclusion

The aim for this paper were to understand the factors associated with household energy-use behaviour, in selected developing and developed countries and to show the differences between these selected countries. In total 35 papers were reviewed in 17 different countries, nine of them were from developing countries and eight of them from developed countries.

### *Developed countries*

Household energy use in the developed countries accounted for a significant percentage of the total energy use in the world, and is a usage-sector that needs to be investigated further. Abrahamse et al. (2007) found out that information along with tailor-made feedback and communication of targeted goals will be good strategies to adopt if governments need to induce reduction in energy use in households in developed countries. Of course, residents of the developed world are more informed vis-à-vis those of the developing world, as regards issues related to energy use efficiency. Yet, there is scope for improving user-relationship management in order to achieve more.

### *Developing countries*

After studying eight developing countries energy behaviour, it was clearly concluded that there was too little information available that made households aware of the energy situation. For many of the countries studied, there was no reliable access to electricity grid. Hence, they had to find substitutes in the form of liquefied natural gas, charcoal, firewood and biofuels of different kinds, and there was a general

lack of awareness of the adverse health impacts associated with the use of some of these alternate sources, as observed by Kamil (2012). This points to a drastic need for expanding modern infrastructure in the future to replace traditional sources of energy. A general willingness to change was also seen in some households (Alkon et al., 2016) when the right information was provided to them.

### *Recommendations and further research*

The developed countries can, if they wish to, learn from the way of life in the developing world. They can then realise that the energy supply which they take for granted in their own countries is a luxury and must be used judiciously. The decision-makers in the developing countries on the other hand, can learn how developed countries have instituted communication channels between energy users on the one hand and energy producers/distributors on the other. The power of information and the potency of knowledge which the developed world has harnessed cleverly, needs to be put to good use by the developing countries. There will be households in the rural parts of the developing world, for which electricity may be a *new thing*, when rural electrification gains momentum. It is of utmost importance to generate awareness about the role energy plays in socio-economic development and the need for using it wisely and optimally.

Further research must focus on communication channels and information provision to households, and the socio-cultural, economic and environmental dimensions of sustainability which both affect and are affected by energy use behaviour in households.

### *Note*

The paper is based on a group assignment from the course *Forskning och Utveckling* (Research and Development) offered at the Department of Engineering and Chemical Sciences of Karlstad University (Sweden), in the autumn semester of 2018. The work for this paper were divided equally between the authors, where T. Johansson examined the developing countries and P. Pirouzfard the developed countries.

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