European, Mediterranean & Middle Eastern Conference on Information Systems 2015 (EMCIS2015)
June 1st – 2nd 2015, Athens, Greece

THE USE OF SOCIAL MEDIA FOR IMPROVING ENERGY CONSUMPTION AWARENESS AND EFFICIENCY: AN OVERVIEW OF EXISTING TOOLS

Track: Green Information Systems

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Abstract

Raising consumers' awareness of energy consumption is one of the first steps in encouraging the adoption of energy saving behaviours that result in energy efficiency. Green information systems are becoming recognised as a solution to many environmental problems although information technology (e.g. disposal of IT devices) has also been associated with causing detrimental effects on the environment. Researchers and practitioners have begun to focus on Green ICT but there is little scholarly research on the use of ICT tools such as social media from an energy efficiency context to raise consumer awareness and improve their engagement in tackling environmental issues. Therefore, the aim of this paper is to explore the use of social media and existing tools for the interaction of people on energy saving discussions and for generating awareness and engagement (which thereby leads to energy efficiency behaviour). In this paper the authors provide a state of the art review around the concept of energy awareness, models of consumer engagement, and more importantly the use of social media in the energy efficiency context. This research is based on a desk-based normative review and seeks to provide a better understanding to both scholars and practitioners involved in the use of ICT for driving energy consumer awareness and engagement for energy efficiency.

Keywords: Information and Communications Technology (ICT), Energy Efficiency, Awareness, Consumption, Social media, Green ICT

1 INTRODUCTION

Building sustainable cities that are better connected and well managed are among the most important challenges of our time. In particular, managing the ever-growing energy consumption through energy efficiency processes and technology and the smart re-use of waste and energy is a mammoth task for any government (Hill, 2015). In the energy efficiency context, efficiency gain has to be achieved at all stages of the energy chain, from generation to final consumption. Energy consumers' awareness is a first step in encouraging the adoption of energy saving behaviours, leading to efficient use of energy by consumers (Piccolo et al., 2014). Energy consumers need to know, first of all, how much energy

they use in their everyday life practices, as well as learn the results of their saving efforts. However, energy consumption is very difficult to observe for the consumer, for various reasons (Jain et al., 2012). For instance, consumers have practically very few possibilities to effectively monitor their energy usage level, especially at the time of consumption. One of their basic options is to review their billing account, which can only take place after the consumption. Nowadays the availability of technologies for monitoring energy consumption, especially 'smart meters' can provide real time monitoring and can drill down to the consumption of individual appliances. However, they have only recently been developed and they are still a rather expensive novelty for most people. The lack of real time information on energy consumption for consumers in terms of how much energy they consume in their daily activities seems to dampen their motivation to increase energy savings. Hence, they may be careless, indifferent to energy efficiency solutions and insensitive to environmental friendly policies.

It seems rational to assume that increasing consumers' awareness about their energy consumption may influence (i.e. reduce) their consumption behaviour. However, a change of the energy consumption behaviour will not come automatically through awareness (Abrahamse et al., 2005). Awareness is often necessary, but not sufficient for energy saving. Behavioural change depends on the motivation of the consumers and their engagement; that is the conscious adoption of energy saving practices, which is developed as a result of understanding the importance of energy efficiency and being motivated to begin and continue saving energy (Jain et al., 2012). Understanding what energy consumers want to know, how they perceive and realize energy efficiency and how they can be motivated to improve their energy saving behaviour is very important for the development of energy efficiency behaviours (Sivarajah et al., 2014a). It is in this context that the use of ICT has a role to play.

Although the disposal of information technology (IT) equipment (e.g. old personal computers, laptops, etc.) and recent surge in data centres are a major cause of environmental concerns, information systems (IS)/ICT have been known to be a key contributor to productivity growth in many countries over the last century (Watson et al., 2008). The use of ICT/IS to achieve environmental objectives is viewed as Green IS (Dedrick, 2010; Watson, 2008). This view includes improving efficiency in industries that are major sources of greenhouse gas (GHG) emissions, such as the transportation, manufacturing, and energy sectors. The Green IS view sees information systems as a possible solution to many environmental problems while Green IT emphasises reducing the environmental impacts of IT production and use (Dedrick, 2010). The use of ICT tools such as social media for improved awareness and engagement of the energy consumers in energy efficiency and energy saving practices is an emerging phenomenon (Opower, 2015; Petkov et al., 2011). Nowadays, people spend a lot of time in social networking sites every day to communicate with friends, get informed, interact with others, for entertainment, etc. (Sivarajah et al., 2014b).

Even though academics and practitioners have begun to focus on Green ICT, there is little scholarly research focusing on the use of ICT tools such as social media from a Green ICT context in tackling environmental issues. Therefore, the aim of this paper is to explore the use of social media for the interaction of people on energy saving discussions and for generating awareness and engagement, which thereby leads to energy efficiency behaviour. This paper provides a state-of-the-art review of the concepts of energy awareness and energy engagement, types of feedback and most importantly the use of ICT (especially social networking and existing social media applications) for improving energy consumption. This research is based on a desk-based normative review and seeks to provide a better understanding to both scholars and practitioners interested in leveraging ICT tools such as social media for driving energy consumer awareness and engagement in order to improve energy efficiency.

The remainder of the paper is organised as follows. Section 2 and 3 presents the research approach and a literature review of the basic concepts of energy awareness and the key aspects of feedback and its effectiveness respectively. This is followed by section 4, in which the concept and the models of consumer engagement are presented. Section 5 highlights the role of social media for improving energy efficiency and the existing applications that are available are reviewed. Finally, section 6 presents the conclusions wherein the summary of the paper is reported along with the contributions and the future directions of this study.

2 RESEARCH APPROACH

This research is based on a desk-based review that has involved identifying, gathering and categorizing literature in the area of energy awareness, consumer consumption and engagement and ICT from an energy efficiency perspective. In this respect, the research approach combined the review and synthesis of literature (Vom Brocke et al., 2009) with secondary analysis of existing social media applications used in the energy efficiency context. Due to the emerging nature of the field of research, a broad literature review was needed to investigate the phenomenon of Green IS and in particular the use of social media in this context. This literature review enabled to scope the defined area of research and identify the void in literature and issues surrounding the role of social media as a Green ICT tool. It is here that this paper seeks to add to the body of literature. The selection of the social media applications was based on the following criteria: a) if and whether the social media application is used from an energy efficiency context, b) the diverse beneficiaries (e.g. citizens, building managers, etc.) and c) different functionalities between the applications. These criteria were used to: i) ensure diversity of the cases and hence the broader applicability of the research outcomes derived from the study, and ii) determine the impact of the different stakeholders and the availability of different functionalities in order to help with raising awareness and tackling energy consumption levels.

3 CONCEPT OF ENERGY AWARENESS

Awareness is related to the knowledge about how much energy is consumed. Without energy awareness, consumers do not know if they need to reduce their energy consumption and how to do it. In the literature there is abundance of evidence for the importance and effectiveness (or lack thereof) of specific energy awareness approaches (Karjalainen, 2011; Horst, 2011). In general, consumers are unaware of their consumption and there is a need for more information, especially concerning the proportional consumption of appliances to be able to make the right choices about their use of energy (Karjalainen, 2011). In particular, consumers need to know how much electricity they use, when they use it, and how much it costs to appropriately impact their monthly bill (Horst, 2011). As a general rule, the more knowledgeable they are, the more interested they are in adopting energy saving practices and in participating in energy saving policies and programmes (IBM, 2011). A number of studies reveal significant reductions in energy consumption as a result of improved energy awareness (Piccolo et al., 2014; Jain et al., 2012).

Energy awareness is the knowledge that users acquire about how and why to save energy by operating devices more efficiently. Awareness is a pre-condition for energy saving and energy efficiency: it cannot ensure that an actual engagement in energy-efficiency behaviours takes place, but it does manage to "make energy visible" (Piccolo et al., 2014). Energy awareness systems provide feedback to the consumer for the energy consumption with the objective to encourage energy efficient behaviour, reduce energy consumption and bring economic and environmental benefits to the consumers and the societies, respectively. Energy awareness systems are frequently referred in the literature as 'eco-feedback systems' (Jain et al., 2012).

Energy awareness can be developed by the delivery of information and feedback to the energy consumers. The terms 'information' and 'feedback' are often used interchangeably, as synonyms in the literature. Typically, 'information' is a general term that is used to describe the transmission or communication of some kind of knowledge concerning energy use. On the other hand 'feedback' refers to the return of information about the result of an activity that is usually employed for evaluation purposes. In energy efficiency programmes, information has a general awareness and learning purpose, while feedback refers to learning by associating actions/behaviours with the resulting energy consumption. Information and feedback helps consumers use what they learn into practice and eventually develop a routine that leads to lower energy use. So, it seems significant to provide consumers with feedback and the information about the consequences of household actions that involve energy consumption and advice tips for further or smarter energy savings. Accordingly, the interest in this section is mostly focused in feedback from energy consumption, which is discussed below.

3.1 Types of Energy Consumption Feedback

Existing literature distinguishes between two types of energy consumption feedback: direct feedback and indirect feedback (Darby, 2001; Ehrhardt-Martinez et al., 2010).

- *Direct feedback* mechanisms provide energy use information at the time of consumption (or shortly after consumption) and include: real-time feedback, appliance-specific real-time feedback, and simple automation.
- *Indirect feedback* refers basically to energy consumption bills. Bills may provide some kind of analysis on the consumption, such as comparative or historical reports, and possibly advice for energy saving; they can use statistical modelling techniques to estimate (and potentially disaggregate) total household energy usage based on a variety of parameters, such as the household type, appliance information and billing data. Indirect feedback can be given monthly or weekly (or even daily) and is based on real energy use measures gathered by a utility or third party. Delivery to the customer can take place with mailed reports (e.g. monthly bills) or via the web or email (especially for shorter period feedback).

Furthermore, Froehlich et al., (2010) distinguished between *low-level feedback,* which can provide explicit information about how to change or improve a specific behaviour, and *high-level feedback,* which is comprehensive and can help improve performance towards a goal or in comparison to others. Some of the main aspects and parameters of energy consumption feedback are presented in Table 1.

Aspects of Energy Consumption Feedback	Description	Reference(s)
Comparison	Comparisons provide a frame of reference for energy consumption levels. They can take place with historic standards or normative standards. The assumption is that consumers will be motivated to save energy if they can compare their consumption to their own prior consumption or to the consumption of others.	(Desley et al., 2013; Petkov et al., 2011)
Measurement units	Feedback on energy use and savings can be provided by the use of different measurement units, such as energy consumption (e.g. in kWh and seldom in kJ), cost (in monetary units, such as euro) and environmental impact (e.g. in carbon dioxide emissions in kg, equivalence of trees, etc.).	(Karjalainen, 2011)
Frequency of feedback	Energy consumption feedback can be provided yearly, monthly, weekly, daily, hourly basis or in real-time. Preferably, the consumer should be able to change and choose the display of energy consumption for the time period of interest.	(Fischer, 2008)
Representation of feedback	The method used to demonstrate household energy consumption feedback affects the way that this feedback is understood. The presentation method is important both for the paper-based energy bills and for the in-home displays of energy management systems. These are usually graphical, numeric and textual representations.	(Froehlich et al., 2011)
Disaggregation of feedback	Disaggregation of energy consumption allows analysing the total/aggregate household energy consumption into appliance or space specific consumption data. The main methods for doing it are the use of smart meters and sensors or the use of statistical methods.	(Darby, 2006; Karjalainen, 2011)

Table 1. Aspects of Energy Consumption Feedback

In Europe, the Directive 2012/27/EU for Energy Efficiency suggests metering systems must provide final customers with information on actual time of use. In addition, final customers must have the

possibility of easy access to complementary information on their own historical consumption. This must include at least the following information:

- Cumulative consumption data corresponding to the intervals for which frequent billing information based on actual consumption has been produced. Such data should be made available for at least the three previous years or the period since the start of the supply contract, if this is shorter.
- Detailed consumption data according to the time of use for any day, week, month and year. Such data should be made available to the final customer for the period of at least 24 months or the period since the start of the supply contract if this is shorter.

The main functions of providing feedback as per Wood and Newborough (2003) are: (a) *learning function* - energy consumers can learn about the connection between the amount of energy they use and their energy consuming behaviour; (b) *habit formation* - energy consumers put the information they have learnt into practice and may develop a change in a routine habit; and finally (c) *internalisation of behaviour* - energy consumers develop new habits and after a while they change their attitudes to suit that new behaviour.

3.2 The Effectiveness of Energy Consumption Feedback

Research has shown that the right feedback can indeed have an influence on energy savings, and that different types of feedback can have different results (Darby, 2006; Fischer, 2008). The research activity in this field has been enormous: some of the research results are highlighted hereafter to reveal the general trends on the effectiveness of energy consumption feedback.

Several meta-analytical studies concluded that consumer awareness systems are an effective tool for reducing energy consumption. A review analysis report developed by Darby (2006) found that direct feedback, alone or in combination with other factors, is the most promising single type, with almost all of the projects involving direct feedback producing savings from 5% to 20%. In addition, direct feedback in conjunction with some form of advice or information gave savings in the region of 10% in average. Indirect feedback does not produce comparably high results in energy savings, although there was also agreement between most of the studies that interest and awareness levels of consumers were raised as a result of supplying informative bills.

Fischer (2008) concluded that typical energy savings range between 5 and 12%; the most effective feedback methods include multiple feedback options (e.g., consumption over various time periods, comparisons, additional information like energy saving tips, etc.), frequently updated feedback, personalization of feedback and interactivity with the consumer (e.g. the consumer should "drill-down" into data), and disaggregation of feedback (e.g. detailed, appliance specific breakdown of the energy usage). The results in other studies favoured also the effectiveness of mixed and comprehensive methodologies. Abrahamse et al., (2005) and Chiang et al., (2012) concluded that direct feedback tends to bring better outcomes, but a greater effect might be achieved when both direct and indirect are combined and when they are provided continuously and more frequently.

Regarding the effectiveness of historic and normative comparisons, most studies favour the historic approach. Historic feedback appears to be readily understandable, relevant, and useful for consumers (Fischer, 2008). The effectiveness of normative comparative feedback, on the contrary, is quite unclear (Desley et al., 2013). Still, several studies that deployed normative comparison resulted in energy savings from the consumers, as consumers would like to compare and discuss their energy performance with others (family, friends, neighbours, etc.). Normative comparisons produces better results when it is used in conjunction with historical comparison, by contextualizing both current and historical consumption in relation to a user's peers (Desley et al., 2013). However, comparative feedback can lead to counter effects. In ten studies reviewed by Fischer (2008), there was no savings benefit with comparative standard feedback, while in certain studies the results were opposite to what was intended, as those who received the comparative standard feedback consumed more than those who did not. This phenomenon has been referred to as the "boomerang" effect (Schultz et al., 2007),

and it is typically due to the fact that people with lower-than-average consumption feel justified to consume more. The "boomerang" effect can be countered by providing not only descriptive norms, but also including injunctive norms that somehow indicate what is commonly socially acceptable (or unacceptable) within a certain culture (Schultz et al., 2007).

Concerning the effectiveness of real-time feedback, some studies have shown electricity savings in the range of 9–12% (Chiang et al., 2012) and 3 -13% (Ehrhardt-Martinez et al., 2010). Buchanan et al., (2015) comment also that only few trials have assessed the contribution of real-time feedback to energy reductions, despite the fact that such trials have the highest relevance for identifying energy savings. On the contrary, an Electric Power Research Institute report (EPRI, 2012) reviewed studies about the use of in-house displays (IHD) and it found no statistically significant impact on energy savings. Among the web-based portals that provide real-time consumption feedback, the Google PowerMeter Application was examined; it was found to produce initial and average savings, but the savings diminished to zero over time. The reason for this is probably that participants begin eagerly, but soon they lose their enthusiasm or even their motivation, because probably they do not find it 'innovative' or 'rewarding' any more. Further research is needed to understand this behaviour of participants in smart energy programs. This topic is further analysed later, in the section for consumer engagement.

Many research efforts to analyse the effectiveness of energy feedback contain problems and suffer from weaknesses and limitations. First of all, there are big differences in the results between different studies, which come from differences in study design and methodologies (Buchanan et al., 2015). A recent meta-analysis demonstrated that from a methodological perspective, less robust studies without controls yielded higher energy savings, whereas more robust studies that used either a control group and/or also took into consideration either household demographics and/or weather, yielded lower energy savings (Delmas et al., 2013). In addition, most research works consider a short-term experiment period (3 months or less), which makes unclear and difficult to ascertain to what extent these effects are temporary and consumers return to their old practices or they persist in the long term (Verbong et al., 2013). The use of multiple feedback strategies within a single intervention study obscures the results and makes it difficult to pinpoint exactly which aspect of feedback was most effective or if it only worked because a combination of strategies were simultaneously utilized. Buchanan et al., (2015) raises also concerns about self-selection bias and 'Hawthorne effects', whereby participants change their behaviour as a result of being involved in an experiment or study.

According to a report of the Electric Power Research Institute (EPRI, 2012), the challenges of energy awareness studies that remain to be answered by future research include the following topics:

- The impact of various demographics on the effect that feedback has on consumers.
- The impact of feedback on consumption reduction.
- The specific actions people are taking as a result of the feedback.
- The relative effectiveness of alternative feedback mechanisms.
- The interaction between feedback, price structures and control technology.

The key assumption underpinning the majority of the studies for energy feedback is that feedback will raise awareness and thereby encourage people to change their behaviour and engage them in energy saving practices. However, besides awareness, consumers need also *motivation* in order to be engaged in energy efficient behaviours. Therefore, the concept of consumer engagement is discussed in the next section.

4 CONSUMER ENGAGEMENT

Consumer engagement is important for energy efficiency, since energy awareness by itself may be ineffective, or lead to behaviour that cancels the saving in energy usage or even causes higher energy consumption. For instance, the 'rebound effect' (Hertwich, 2005; Gavankar and Geyer, 2010) refers to using the new appliance much more than the older one, due to its higher efficiency, and the

'boomerang effect' (Schultz et al., 2007) refers to feeling free to increase energy consumption to reach the average levels (which may happen to consumers with the lowest energy usage).

4.1 The concept of energy consumer engagement

Energy consumer engagement is a broad term that involves consumer interest, motivation, comprehension, evaluation, reflection and personal characteristics. It refers to the environmentally responsible behaviour of the energy consumers and the motivation for such behaviour (Buchanan et al., 2015). According to Abrahamse et al., (2005) behaviours related to energy conservation can be divided into two categories: efficiency and curtailment behaviours.

- Efficiency behaviours are typically performed by replacing obsolete appliances with new ones that are more energy efficient or by investing in more energy efficient methods and technologies (e.g. insulation).
- Curtailment refers to reducing energy consumption, for example by turning off lights or appliances when nobody uses them or by lowering thermostat settings. Even though efficiency behaviours are considered to have a higher energy-saving potential compared to curtailment behaviours, the former may suffer from the 'rebound effect' (Hertwich, 2005).

Froehlich et al., (2010) distinguishes between 'rational choice models', and 'norm-activation models' for consumer engagement. Rational choice models are based on a three part linear progression leading from knowledge to concern to environmentally responsible behaviour. The basic assumption here is that human behaviour is regulated by a systematic evaluation process of the expected utility. According to this, people basically act to maximize rewards and minimize costs. On the other hand, norm-activation models are based on the premise that moral norms determine the environmentally responsible behaviour of the consumers, i.e. consumers behave responsibly because this is the right thing to do. In the following section, the existing models of energy consumer engagement are discussed.

4.2 Models of energy consumer engagement

Energy consumer engagement is studied in environmental psychology. Numerous theoretical models have been developed that provide insight for consumers' motivation and for the design of tools and services for energy efficiency (Pierce and Paulos, 2012). For instance, Fischer (2008) suggests that people must realize, first of all, that there is a problem; then they must realize that their behaviour is relevant to the problem, and they must become conscious about the possibilities to influence their behaviour and its outcomes. Only then will they reflect upon changing their behaviour in order to solve the problem. Horst (2011) explains the steps of the consumer engagement process, from influence and awareness to an understanding and motivation to take action (see Figure 1). Influence refers to developing sensitivity for energy saving, especially with minimal impact to the consumer's lifestyle, and it is central to developing the interest of the people. Awareness provides feedback on energy consumption and it is the pre-condition for understanding what we consume and how we can reduce it. Only when people develop deep understanding of their energy consumption do they become motivated for taking action to change their current behaviour pattern and adopt energy efficiency practices.

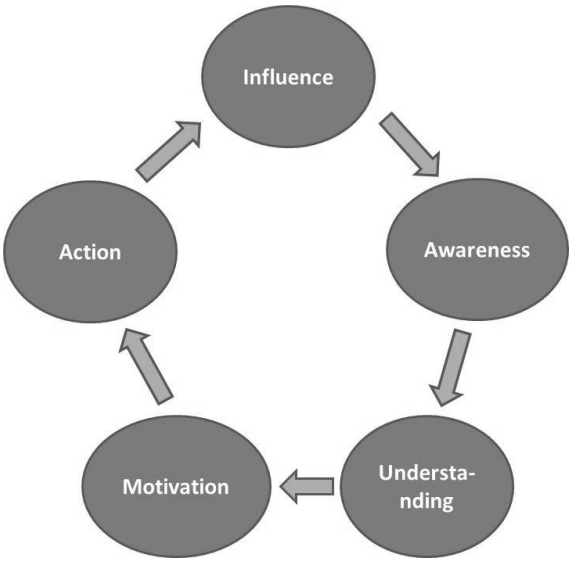

Figure 1. The steps in the consumer engagement process (Horst, 2011)

Honebein et al., (2011) agree with Horst (2011) that engagement is driven by action; it requires action by both the energy provider/ administrator and by the customer. The energy provider/ administrator can only provide the opportunity and the incentives for customers' action. Lanier and Hampton (2009) suggest the aim of engagement is to hold customer attention, and this is accomplished through experiences that unfold over time; thus, engagement goes beyond awareness and education/ understanding alone.

There are three key factors in consumer engagement: habit, technology, and friendship (Honebein et al., 2011). Habit refers to easing customers into engagement through small actions that pave the way down to larger actions. Human beings are wired to develop habits beginning by little, tentative steps, and then playing with something or 'trying it out', and then finally by taking up a particular action. People often 'get used' to doing things when they repeat them and make them part of their lives. Technology helps individuals make a routine of many complex actions, avoiding trial and error, documenting progress, and easing learning. Friendship leads to customer action and customer engagement down the social road because it is a relationship between people, and because the relationship is valuable and enjoyable for its own sake. This will be better discussed in the following section, where we focus on social comparisons between people using social media and its role in increasing energy consumer awareness and engagement for improving energy savings.

5 DISCUSSION: SOCIAL MEDIA FOR ENERGY EFFICIENCY

Comparisons between individuals or groups can be used to provide motivation to energy consumers. According to Froehlich et al., (2010) the effectiveness of social comparisons in the field of environmental psychology provides mixed reports. On the one hand, knowing the behaviour and performance of others may provide motivation to improve yourself. On the other hand, people do not necessarily change their behaviour as a result of comparisons. Very often, when a threshold is reached, further improvement over past performance or the performance of others may not be effective or regarded as critical.

In this section, social comparisons through social networks and media is discussed and in general the role and the importance of social media in increasing energy awareness and engagement and improving energy savings. This is an emerging topic in the literature, which still remains a rather unexplored terrain (Froehlich et al., 2010). The use of social media for energy awareness and engagement requires further research in order to better understand the opportunities it provides. After a brief review of the literature, the subsequent section presents and discusses some of the existing social media applications for energy efficiency available in the market.

5.1 The use of social media in energy efficiency context

Social comparisons refer to the concept of a group of households comparing to some other similar group of households (Petkov et al., 2011). Comparing the consumption of one household to that of others is said to elicit accountability and social pressure to understand why consumption levels differ and to stimulate competition and mutual improvement. Social media tools, such as Facebook or Twitter, support social comparison and sharing, as well as public commitments and competition. For instance, a Facebook application named "I am green" (launched in 2007), allowed users to display their environmental attitude as a badge on their own page which provided the opportunity for like-minded people to chat and share their opinions and provided tips and ideas for growing and improving environmental friendly behaviour (Langley and Van den Broek, 2010).

As noted by Langley and Van den Broek (2010), social media can be used to overcome two important barriers to environmentally sustainable behaviour: fatalism and busyness. *Fatalism* refers to the lack of belief that a sustainability initiative will have a significant impact, which tends to prevent people from joining energy efficiency initiatives. Social media can stimulate energy efficiency efforts by presenting evidence of the goals and achievements and by helping participants to share this information with other participants in their own social networks. The presentation of evidence on energy efficiency goals and achievements can stimulate efforts via a number of mechanisms; (1) feedback from social media can work as a form of persuasion that what people are doing is approved by their social network; (2) people are more likely to participate in initiatives which have already attracted a large number of participants; (3) social media applications make the power of small actions visible, and hence they can augment the impact; and finally (5) sharing information and experiences in social networks can exercise social-psychological pressure and stimulate others to become engaged in similar actions. On the other hand, *busyness* is the typical state of the majority of the population whereby other priorities and preoccupations do not allow them to act on energy efficiency. Social media can stimulate 'busy people' to take action by helping them sharing experiences and by reducing the effort required to act. Social media applications are used as an infrastructure to diffuse individual attitudes and life-styles. Sharing of experiences gives active members recognition of their activities, which can be an incentive to other members to become active.

Langley and Van den Broek (2010) concluded after an empirical study that there is a strong positive correlation between presentation of achievements and sharing with non-participants (i.e. potential participants), as well as between sharing with participants and behavioural change. Another main result is the strong negative correlation between the number of participants and required behavioural change. This shows that initiatives that have many participants tend to require smaller behavioural changes, while initiatives that require large behavioural changes tend to attract a limited number of participants.

5.2 Social media applications for energy efficiency

In this section, we present some of the existing social media applications for energy efficiency, trying to draw out parallels and highlight differences between them.

5.2.1 Opower Facebook Application

Opower, Facebook and the Natural Resources Defense Council (NRDC) launched a social energy app (Opower, 2015). The application combines Opower's expertise in the use of normative comparisons and games for energy savings with Facebook's global platform for connecting, sharing and interacting with others. In this way, the application aims to drive behaviour change and enable socially driven engagement. The key functionalities of the application are designed to encourage reductions based on meaningful comparisons with others. In particular, consumers can compare their energy use to similar homes, share and discover energy-saving tips and advice, compete with friends, and participate in team-related energy-reduction challenges. The application's features include a "Friend Rank," which compares the energy usage of users to that of their friends. Users can also invite friends to a "Group" with a specific energy goal. In a group, members compare energy use and communicate in a friendly manner creative energy-saving tactics. Users receive also tips and special offers, which they can share with others.

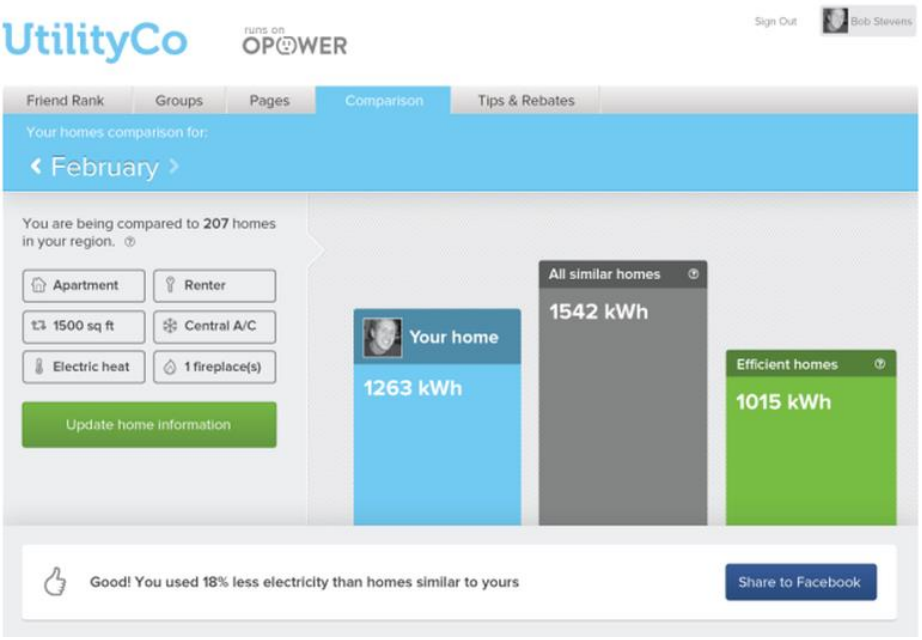

Figure 2. Opower Facebook App

5.2.2 EnergyWiz

EnergyWiz is a web-based and mobile application that operates through Facebook. It enables users to compare their energy use with their past performance, the usage level of their neighbours, of contacts from social networking sites and of other EnergyWiz users. This application was developed by Petkov et al., (2011) and includes the following main features:

- The *Live Data* feature presents the current energy consumption in the household. The design allows the user to switch between different units of energy consumption (kWh, kg of CO2 and money). To connect to the material impacts of the consumption, they employed an explanatory comparison to assess the amount of consumed energy (i.e., number of trees needed to compensate the generated CO2 emissions).
- The *History* feature allows users to analyse and evaluate their energy consumption over time.
- The *Neighbours* feature allows users to compare themselves with two groups of neighbours - efficient and inefficient neighbours.
- The *Challenge* feature allows the users 'challenge' a Facebook friend of theirs on a weeklong energy saving competition. This feature is based on the premise that people are willing to compete in online social networks and compare with real and known people. During the challenge, users are able to post the current score to their Facebook wall. Such public posts can boost the commitment of both parties, leading to discussion among the people who comment on the posts or even make them save energy following the example of their friends.
- The *Ranking* feature enables users compare themselves to similar EnergyWiz users (in terms of household and residence type) according to their consumption in the last seven days. Here, the comparison targets are similar EnergyWiz users, mainly because similarity between Facebook friends is not always given. In addition, users know they are not alone in energy saving and they can enter in discussions about energy saving with people with similar energy attitudes.

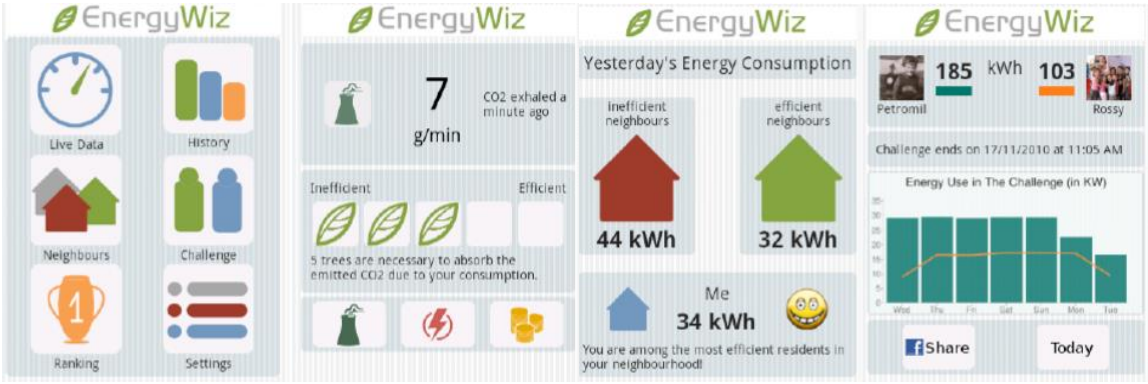

Figure 3. EnergyWiz: Main Menu, Live data, Neighbours and Challenge

5.2.3 Wattsup

Foster et al., (2010a, 2010b) describe 'Wattsup' as an application that displays live data from the Wattson energy monitor, allowing users to compare domestic energy consumption on Facebook. The application includes three core interfaces: "My Energy", "Friends" and "Rankings".

- The *My Energy* screen shows the energy consumption with a dial visualisation and a seven-day history bar chart.
- The *Friends* screen displays personal energy consumption against selected friends.
- The *Rankings* screen shows a table of highest and lowest energy users of the application.

The rankings table allow users to visualise what their standing is against others, but it does not provide tools for allowing friends to comment on their energy consumption or that of others. A "Comments Board" was added to the user interface later. The results of Wattsup suggest that social networking sites make energy monitoring more enjoyable.

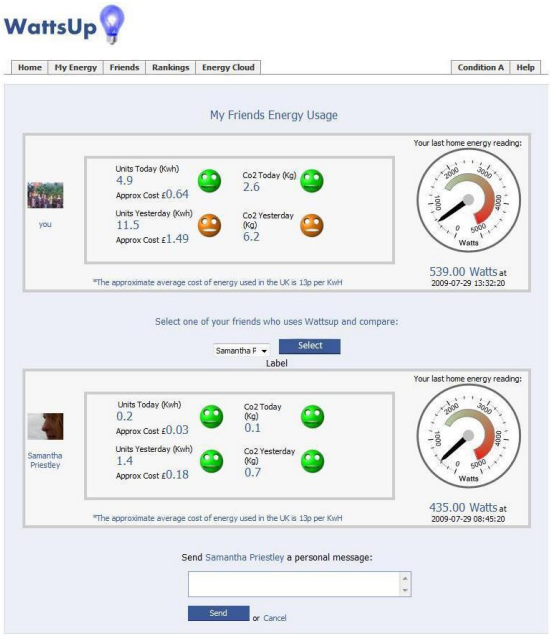

Figure 4. Wattsup menu and Friends screen

5.2.4 Green Network

Lehre and Vasudev (2011) examined how social media networks may facilitate the communication between workplace occupants and building managers. They developed a proprietary social media application ("Green Network"), which contains storyboards and various scenarios.

The user interface includes a newsfeed, profile and an inbox. The newsfeed highlights relevant activities on the network. The profile includes personal information, a billboard, groups that the user belongs to and the apps that users have added to the profile. A user's persona comprises basic demographic information, likes and interests, and social components such as badges earned on energy-related activities. The billboard displays recent posts, including problems, questions, tips, links, events and surveys. Users can send a post and comment on posts in their newsfeed, 'like' posts and comments and answer questions and problems. Each user can create and belong to groups. In general, groups provide a forum for participants with common interests to participate in related discussions and events. A tag cloud visually depicts all the existing groups to give the users an idea of current trends and popular topics.

In addition, the site uses a recommendation system to suggest groups that might be of interest to users. Users can also use various energy-related features and apps, such as "my energy goals" app, which allows users to create, search and sign up for various energy-related goals. Users can rate their performance on their goal on a weekly basis, get "green points," and perform normative comparisons of their goals with others in the network. Other apps are named "my energy use" and "group energy use" and they track individual and group energy use by pulling data from external devices, such as meters and building energy management systems, and render the results using interactive visualizations. Users have the option of customizing energy graphs by choosing the type of visualization, parameters to be graphed (e.g. cost, energy per person, comparisons to averages and other people, etc.) and the temporal granularity of the display.

5.2.5 StepGreen.org

Mankoff et al., (2010) describe StepGreen.org, a site intended to motivate people to make energy-reducing changes to their behaviours. StepGreen.org combines features such as committing to and reporting on actions and can serve information to a person's social network profile page. The site emphasizes financial savings and CO2 savings.

Users are invited by a friend or after seeing the applet on a friend's profile page. After the initial account creation, the user may install the StepGreen.org social network plugin on a preferred site. Any friend who can view the user's profile page can see the visualization and suggested actions. Thus, the visualization serves as a combination of public commitment and reminder. The reminder function is facilitated by the fact that many people visit their favourite social networking sites once a day or more. To encourage participation, suggested actions include many things that participants would like to do. StepGreen.org combines committing to actions and reporting on whether commitments are fulfilled in the "real world."

StepGreen.org uses a variety of mechanisms to advertise actions, including suggestions sent directly to a person's social network page, a table of actions, and a tag cloud. Users can explore actions on the site in one of three ways. An action browser allows users to leaf through all available actions on the site. For each action, the browser displays the action's name, projected per-year dollar savings, projected per-year CO2 savings, category, and overall popularity. Users can sort actions by any of the properties being displayed. The site prompts users to explore actions via suggested actions, as well as popular actions, which lists the names of the most popular actions in a tag cloud.

6 CONCLUDING COMMENTS AND CONTRIBUTIONS OF THE STUDY

Green ICT emerges as a new research domain that emphasises on the cross-functional role of ICT in addressing the significant issue of improving energy efficiency and environmental sustainability. This paper focuses on the opportunities of Green ICT for encouraging energy efficiency practices at the household level, by the energy consumer, as without their engagement the results of any energy efficiency programme will be ineffective. In particular, this research has examined the potential role of social media as a Green ICT tool in the effort for energy awareness and engagement of the consumer.

This paper highlighted that energy awareness is one of the initial steps towards energy efficiency behaviours, since energy consumers need to know how much energy they use in their everyday life practices, as well as to learn the results of their saving efforts. Without precise and detailed feedback on their energy consumption, consumers are not able to better understand in the first place how much energy they consume in their daily activities and subsequently they do not receive motivation for energy savings. Furthermore, this paper reveals that feedback can indeed have an influence on energy savings, and that different types of feedback can have different results. However, many challenges remain to be answered by future research, especially with regard to the motivation and the long-term engagement of the consumers in energy saving behaviours. This paper discussed that creating awareness of energy consumption is essential but not enough for achieving energy savings. This is because behavioural change depends on the motivation of the consumers and their engagement; by engagement, we refer to the conscious adoption of energy saving practices, which is developed as a result of understanding the importance of energy efficiency and being motivated to begin and continue saving energy.

This research concludes that ICT tools such as social media can potentially support both energy consumer awareness and engagement through social interaction for sharing information and learning from others consumers and their good practices. Social interaction is notably beneficial for energy awareness and engagement and it can support the change of behaviours through the adoption of more sustainable life practices. Social media plays a decisive role in understanding what energy consumers want to know, how they perceive and realise energy efficiency and how they can be motivated to improve their energy saving behaviour. Social media applications are able to help advance the social discourse and sensitisation whilst proliferating good practices amongst consumers. These conclusions have been reached by reviewing the main techniques employed in existing social media applications for improving energy awareness and promote engagement. The authors of this paper believe that the availability of such a concise and yet effective overview in itself is a valuable contribution to both practitioners and scholars.

In terms of contribution to knowledge, this study adds to the Green Information System and ICT literature on how ICT tools such as social media can be used to raise energy consumer awareness and engagement to foster energy efficiency practices. From a practical perspective, the review conducted in this paper seeks to provide a better understanding of the energy consumer awareness and engagement methods, and the use of ICT tools in methods of developing energy consumer awareness and engagement. This paper is part of research done in the context of the EU DAREED project. The project aims at the development of a web platform to improve the energy efficiency of urban districts, by providing tools to support the activities of the main stakeholders: municipalities, energy providers, and citizens. This review will serve as a guide for the design of platform components for increasing the awareness and promote the engagement of the district citizens: a clear overview of the state-of-the-art is crucial for directing future efforts and obtaining the best results.

Acknowledgements

This work evolved in the context of the project DAREED (Decision support Advisor for innovative business models and useR engagement for smart Energy Efficient Districts), www.dareed.eu, a project co-funded by the EC within FP7, Grant agreement no: 609082. The authors express their gratitude and acknowledgement to the contributions of the DAREED project partners. The content of this article

represents the view of the authors, respectively. The European Commission cannot be made liable for any content.

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