Are people the problem or the solution? A critical look at the rise of the smart/intelligent building and the role of ICT enabled engagement

Richard Bull
Institute of Energy and Sustainable Development
De Montfort University
Leicester, LE1 9BH
United Kingdom

Paul Fleming
Institute of Energy and Sustainable Development
De Montfort University
Leicester, LE1 9BH
United Kingdom

Katherine N. Irvine
Institute of Energy and Sustainable Development
De Montfort University
Leicester, LE1 9BH
United Kingdom

Martin Rieser
Institute of Creative Technologies
De Montfort University
Leicester, LE1 9BH
United Kingdom

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Abstract

Almost 20 % of the UK's energy consumption and CO_2 emissions arise from non-domestic buildings. Behaviour change initiatives could have a significant impact given current estimates that around 30 % of energy in buildings is currently wasted. Most recently, the role of ICT and the digital economy has been championed as offering significant potential to contribute to carbon reduction targets within buildings. The creation of smart or intelligent buildings and increasingly sophisticated (and expensive) building energy management systems (BEMS) are viewed as step forward in cutting energy use by limiting the role of the building user.

This paper takes a reflective stance in seeking to question the faith being placed in smart or intelligent buildings through asking, what role then for the building-user? The smart building approach appears to view the behaviour of users as a hurdle to overcome, rather than a resource to be utilized. At times it has had a narrow view of how technology and user-engagement can sit together. This paper suggests lessons can be learnt from other disciplines that champion the role of citizens and the benefits for user-engagement, participation and, increasingly, using digital technologies (such as smartphones and social media) to harness the co-creation of knowledge, collaboration and empowerment.

A critical review of recent thinking in this area is presented before discussing the possible options available for organisations seeking to reduce the energy demand. Reflections are offered from a range of academic disciplines that shed light on the wider possibilities and opportunities digital technologies can offer for behaviour change and energy demand reduction in the non-domestic setting. For example, through enabling building users to both *understand* the environmental impact of their activities and to *act* in networks through social media applications of the digital technology.

Introduction

It almost goes without saying now that if national and international governments are serious about tackling increasing carbon dioxide (CO_2) emissions then non-domestic buildings must be targeted. Academics and policy-makers agree that buildings across the European Union represent approximately 40 % of the gross energy consumption in Europe and account for approximately 35 % of Carbon Dioxide emissions (Dascalaki, Droutsa et al. 2010). European legislation in the form of the Energy Performance and Buildings Directive (REF) has made inroads into this aim (Bull, Chang et al. 2012) and in the UK, the introduction of the Climate Change Act in 2008 has established a clear mandate for action. The Climate Change Act enshrined legally binding and ambitious targets for greenhouse gas emissions, specifically a reduction of at least 80 % by 2050. Addressing the often hidden environmental impacts of the built environment is of paramount importance.

Increasing faith has been placed in technology-based solutions to achieve these targets and lessen the impact of buildings both in terms of how new buildings are designed and commissioned, and how they are controlled once people start using them. Information and communication technologies (ICT), referred to as the 'digital economy,' offer significant potential to contribute to these carbon reduction targets within buildings through more 'intelligent' systems of managing the energy demand of the building. These systems can remove control and choice from the building users through, for example, increasing automation of heating, ventilation and lighting.

Of course the notion of a 'smart', or 'intelligent' building is not new. Ever since the increase in information technology in the 1980s and the rise of the personal computer, building engineers and architects have explored the potential of emerging technologies to manage buildings. Latest research in to the digital economy, for example, SMART 2020: Enabling the low carbon economy in the information age (2008), highlights significant opportunities for ICT to facilitate a step-change in a more sustainable world in terms of both technical enhancements and user-engagement. The report boldly proclaims, "better building design, management and automation could save 15 % of North America's building emissions" (2008: page 9). This vision encompasses logistics; Smart grids and buildings that use increasingly sophisticated (and expensive) building energy management systems (BEMS) to centrally manage the thermal comfort of buildings. These automated systems vary in capability, but the use of automated meter readings, sensors (and pre-determined 'set-points'), thermostats, window controls and cameras afford energy managers the opportunity to manage everything from the heating, ventilation and air conditioning systems to lighting controls and security systems without the ordinary building user – visitor or employee having to do anything. Depending on the scale and complexity of the local controls available to building users, the building user (for example, staff member or visitor) does not have to worry about opening windows if it is too hot, switching on a light if it is too dark; the BEMS, centrally managed via the energy manager, takes care of everything. Alongside the technical advances the report does highlight the need for improved engagement and involvement from users. This is encouraging, yet research shows that to date, user-engagement tends to compromise top-down information provision in the form of energy visualisation tools and feedback mechanisms.

But, if Janda (2011) is correct when she asserts that buildings don't use energy, people do, should we reframe the problem in some way and look to them for the solution? The smart or 'intelligent' approach to buildings can appear to imply or suggest the behaviour of the people is a hurdle to be overcome rather than a resource to be utilized. This is an accepted and substantiated view – the vast literature and theories around behaviour change[1] lends weight to the prevailing view that ordinary citizens are reluctant to embrace pro-environmental behaviours in the home or the workplace, whether that is driving less, recycling more or switching off a light when leaving a room. It is understandable then that a lot of faith is placed in smart, or intelligent buildings to reduce their environmental impact by removing control from the user.

However, a wider literature review, for example of the risk communication literature, shows that expert-led, top-down techno-centric solutions rarely deliver on their promises (Fioriono 1990; Renn 1992; Leach, Scoones et al. 2010). Within buildings, user-experience and the literature tells us that around 30 % of energy in buildings is wasted through the behaviour of the building-users (Brown, Bull et al. 2012). Such waste is in part due to the technical limitations and flaws inherent within BEMS such as the reliability of sensors, the quality of algorithms alongside human error.

The view of smart building and the digital economy presented above is a rather techno-centric view. However there is another school of thought that also resides within the notion of what constitutes the digital economy. One that champions the role of citizens and the benefits for user-engagement, participation and, increasingly, using digital technologies (such as smartphones and social media) to enhance collaborative empowerment. It aligns well with findings over the last ten years from theories and research in risk communication, public engagement and deliberative democracy and offers a fascinating perspective of the role of ICT in buildings and the potential to empower people, rather than disempower them. The digital economy refers to much more than simply technologies to control buildings.

This paper explores these two perspectives of the digital economy with specific reference to how such tools are applied to the built environment. First, the concept of a smart or intelligent building will be unpacked and explored before considering how research into the digital economy, public engagement and behaviour change could inform and critique this approach. These two literatures will be brought together in a series of reflections at the end.

The rise of the smart-intelligent building

HISTORICAL OVERVIEW

The smart, or intelligent building has emerged over the last 25 years and is synonymous with the associated opportunities that digital technology has afforded the building community. Technological advances in the early 1980s saw the introduction of what Drewer and Gann (1994) refer to as the first generation of smart buildings. These first generation buildings implemented the control technologies known as building energy management systems (BEMS) which enabled the core aspects of a building – heating, ventilation and air conditioning (HVAC) and lighting to be controlled by computers through the installation of sensors, time-switches and optimisers.

Technical definitions have dominated early understandings of what makes a smart or intelligent building. Clements Croombe (1997) notes the definition of an intelligent building by the Intelligent Building Institution in Washington is "one which integrates various systems to effectively manage resources in a coordinated mode to maximise: technical performance; investment and operating cost savings; flexibility" (1997:396). Wong et al (2005) chronicle the history of intelligent buildings and note that these early definitions of intelligent buildings were heavily biased towards technical solutions to building management. For example, an intelligent building is one that simply has a 'fully automated building service control system'. Others, Wong et al (2005) argue, have tried to asset that an intelligent building 'must respond to user-requirements', a concept which Drewer and Gann (1994) referred to as the second generation of smart buildings. They argue that second generation smart buildings started to consider increased adaptability and user-response. However, the literature seems to suggest that there is not such a clear-cut historical time-line of developments. Wong et al (2005) notes for example that differences existed between the different building institutes with the American ones tending to focus on a 'productive and cost effective' environment whereas the European ones are more user-focused, for example, they cite the European Intelligent Building Energy Group which defined an intelligent building as one that creates an environment that 'maximises the effectiveness of the building's occupants'.

Whilst there is an obviously significant technical dimension to what defines an intelligent or smart building, it is clear that for many, the technological advancements go hand-in-hand with increased responsiveness and better building-user experience (Clements-Croome 1997; Kroner 1997). Clements Croombe (1997) suggests that technology should be the enabler of intelligence, not an end in itself. In 1996, CIBSE – the UK's Chartered Institute of Building Services Engineers formed an Intelligent Buildings working group and suggested the following six key attributes to intelligent buildings:

- Connectivity
- Holistic thinking.
- Systems.
- Social, economic, environmental values.
- Convergence.
- Ubiquitous networks/cities.

The ideal system, observed Parsons and Chatterton (2011) "links the building systems within it and the occupants so that they have some degree of personal control (2011:3)." However, whilst these approaches by CIBSE and Clements Croombe (1997) strongly imply both a social and technical definition of intelligent buildings, current trends within the literature and policy show that a technical approach has dominated. Clements Croombe (1997:398) observed this gap between what building users understood by an intelligent building, and one the construction industry actually delivered, noting that an "intelligent building has generally been defined in terms of its technologies, rather than in terms of the goals of the organisations which occupy it." For example, integrated systems and thinking, connectivity and convergence are often interpreted technically in terms of the joining up a building's management system. Kroner (1997) echoed this same perspective, noting "designers continue to build essentially static buildings that are centrally controlled systems, unable to be fine tuned by individual users, and often produce environments of moderate quality that can leave a large percentage of the occupants dissatisfied and sometimes even ill" (1997:385). The technical approach has then been found to be lacking at times – failing to deliver on a fully integrated user-experience. This has also been seen to be case at the European level where insight is gained by looking at future research priorities in this area and it is clear that the digital economy is a key emphasis.

CURRENT EU PERSPECTIVES

In the European Commission's roadmap for Horizon 2020 Energy-Efficient Buildings is one of three research priorities, along with Factories of the Future and Sustainable Process Industry through Resource and Energy Efficiency.[2] After an initial public consultation, the final version of the Energy-efficient Buildings PPP roadmap beyond 2013 was published by the Energy Efficient Buildings Association (E2BA).[3] It sets out three key priorities:

1. Renovation of the existing stock;
2. Demand side reduction and step towards a higher scale level of energy efficiency (i.e. district level, fully integrating decentralised energy generation and renewable energy sources);
3. The full exploitation of ICT as key enabler in all segments of the value chain.

Appendix 4 of the document outlines the summary of the roadmap for ICT supported energy efficiency of buildings and categories the actions into five key areas, only one of which is user-awareness and support, the others being: Tools for EE Design & Production; Intelligent Control; Energy management & trading; Integration & technologies. A further analysis of the latest round of successful FP7 proposals to the European Commissions roadmap for Horizon 2020 Energy-Efficient Buildings theme illustrates the dominance of technical solutions – only 10 % – three out of 33 proposals suggest anything other than a non-technical approach.[4] The SMART 2020 report document (2008) considers the role of the ICT industry in the delivery of a future low-carbon society with reduced greenhouse gas emissions. 'SMART' here refers more broadly to a management approach: 'Standardise Monitor Account Rethink Transform'. The report details the whole range of possible interventions from occupancy-based lighting, better building modelling and controls, remote building management and increased automation alongside improved user-engagement and improved human-to-machine interfaces. Examples are given of more efficient buildings as a result of these technologies, alongside a desire to see greater engagement with building users and the potential of ICT to "enable us to 'see' our energy and emissions in real time" (2008: p. 7). The emphasis here appears to be on the area where the digital economy, engagement and behaviour change has been increasingly researched – visualisation techniques.

THE USE OF VISUALISATION TECHNIQUES

This then has become the predominant way that the digital economy and user-engagement has been explored within the built environment, and most commonly, in the domestic context. The last few years have seen an explosion in research on energy visualisation tools or 'feedback' mechanism that provide the building user with information or 'feedback' on the consumption within the particular building type. Of course domestic building users – household residents – have always received feedback via 'standard' meters, for example in the UK home owners are able to read meters and receive information on price and consumption on their energy bills in the form of a monthly, quarterly or annual bill. But technology has enabled a more dynamic, regular, and in many cases, real-time feedback. Through the installation of either simple wireless transmitters on the electrical cable coming in the building, or through more sophisticated 'smart' meters – live electrical data can be sent to a display unit that present the consumptions to the resident in a range of formats. Much research has been undertaken by Oxford's Environmental Change Institute into the best ways to re-connect people to energy through the use of systems that show the price, unit-cost or CO_2-cost through a live feed or half-hourly metering, and what effects this had had on the building-users (Darby 2010). The findings showed that whist feedback offers potential in reducing consumption, between 5–15 % on average (Burgess and Nye 2008), any conclusions are limited because the implementation of smart metering at the household is in its infancy and varies greatly depending on the type of feedback (Darby 2010).

What is also clear is that there is no simple cause and effect between installing new forms of domestic energy metering and subsequent behaviour change by the householders. Hargreaves et al (2010; 2013) conducted qualitative research as part of the 'Visible Energy Trial' researching the impacts of domestic real-time displays in 15 households. They concluded that these displays could be as much a source of conflict within the household as well as providing opportunities for collaboration between energy users in the home. They make the opportunity for savings easily quantifiable and 'normal' within households. And whilst these units do help in making consumption 'visible', the study confirmed that these units confirm that patterns of household energy consumption are indicative of the "complex relationships between people, the built environment and systems of provision and consumption" (2010: 6118).

If the use of digital tools are complex in the domestic setting, where the user-pays the bills and has, to a greater or less degree, 'control' over their consumption, the non-domestic is even more so. First, there is greater complexity in the technical challenges in how to actually meter large-scale buildings and at what scale: – the whole building level, floor level, department or even individual appliance or even person level? Implicit is the need to capture and then represent accurate and meaningful data in the system; secondly information needs to be corrected for weather and climatic changes, and finally, there are issues around occupancy and hours of usage. This is notwithstanding the social and cultural challenges around who is actually responsibility for energy consumption in the workplace, who is paying the bills and the variations potentially exacerbated within the range of different non-domestic buildings – schools, hospitals and universities are just three examples.

Daniel Lehrer and his team at the Centre for the Built Environment in California (Lehrer and Vasudev 2010) have researched the use of visualising energy information in commercial buildings. They found that the majority of buildings have access to some form of energy management information 'BEMS' systems and are increasingly experimenting with forms of energy dashboards, in the style of those in domestic settings, which represent simplified patterns and trends of energy consumption data to building users. The Institute of Pervasive Computing in Zurich has adopted a slightly different approach, exploring the technical possibilities, challenges and opportunities of using mobile phones as consumption feedback devices to increase energy awareness (Lehrer and Vasudev 2010; Weiss, Loock et al. 2010). They have shown that it is possible to create a systems' architecture to capture the energy data from devices and enable smartphones to receive it.

Research at the Institute of Energy and Sustainable Development at De Montfort University (DMU) has looked at these issues within the university sector and reached similar conclusions around both the challenges and opportunities for energy visualisations in the workplace (Bull, Brown et al. 2011; Brown, Bull et al. 2012). Two research projects, Duall and Greenview, have explored opportunities to present energy data to building users. All of DMU's buildings have half-hourly metering for gas, electricity and water. Data was relayed via a low-power radio network to a central receiver, and then uploaded to a MySQL database server. This data could then trigger a range of different energy visualization tools.

DUALL utilised a socio-technical approach to the design of a simple web based information-feedback tool that could report electrical consumption of ICT equipment back to users. Progress was positive inasmuch as a small group of building users were engaged and a simple dashboard using Yahoo widgets developed. Greenview aimed to refine the ICT tool further into a more sophisticated smart phone application that would connect staff and students in DMU to the energy consump-

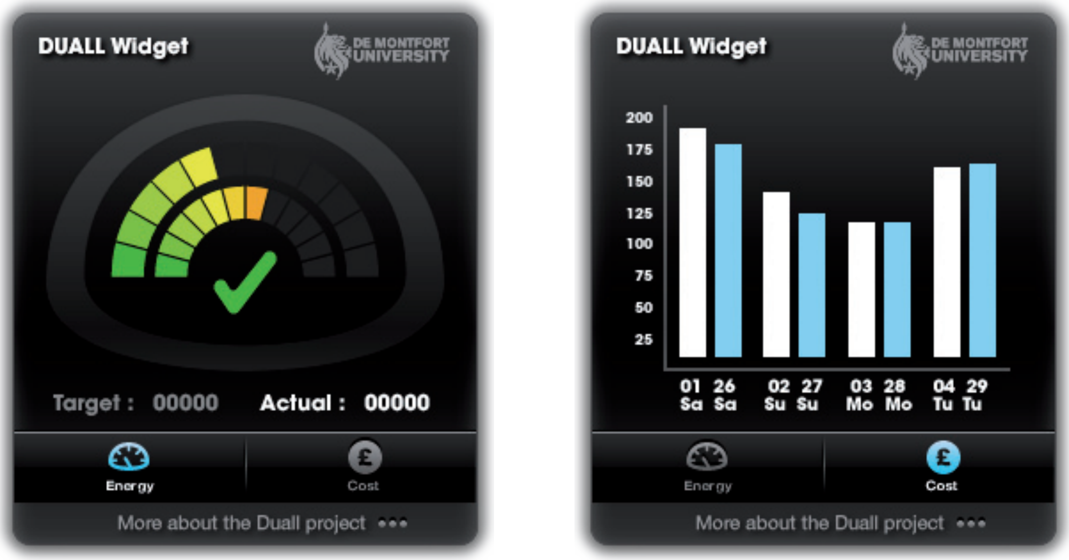

Figure 1. Screenshots from the DUALL project.

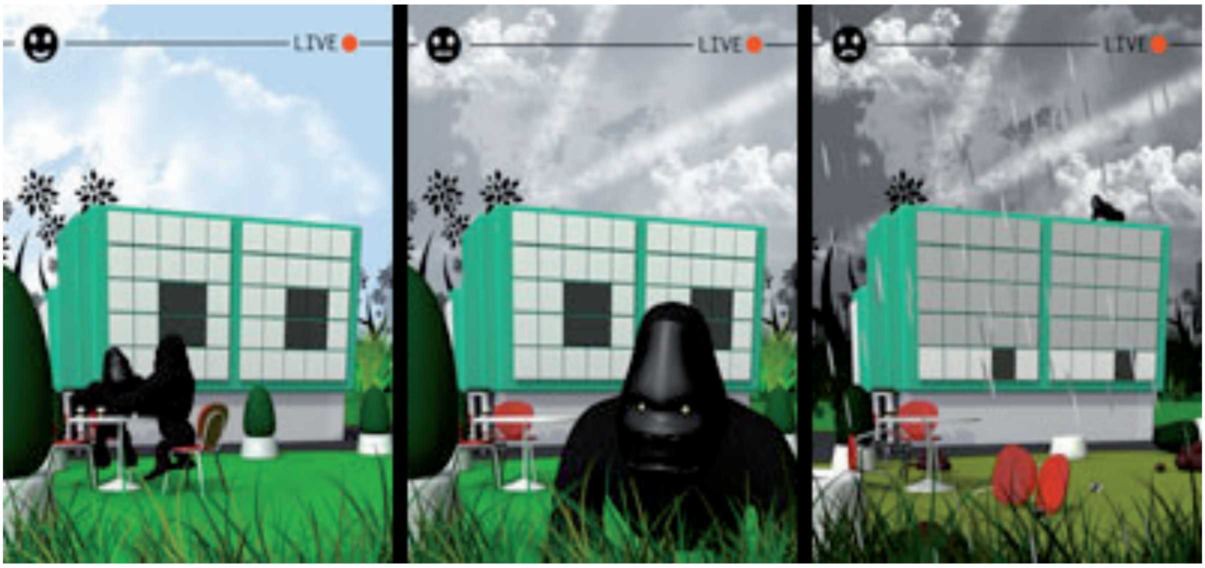

Figure 2. Screenshot from the Greenview Application.

tion of their buildings. We succeeded in developing an iPhone 'app' which was launched in March 2012. The app visualised energy use in buildings on the DMU campus through creating a narrative of buildings as habitats for animated cartoon avatars of endangered species which responded to the energy data and triggered different animations, with a view to moving away from numerical ways of data presentation and testing a fun and engaging way to look at how we can look after our environment (see Figure 2).

Common to these three different institution's research findings, despite the clever or creative animations, is the limitations of mere information feedback, especially in the complex and contested workplace environments where, depending on the building type, people have limited control and agency around their own environments. Bauman (1999) notes that modern BEMS and HVAC systems offer little opportunity for users to influence the thermal comfort of their own spaces. Whilst many of these interventions to change behaviours are noble, well meaning and, sometimes, effective, they are based on a particular 'information-deficit' or rational approach to behaviour change – if 'they' have the right information 'they' will change behaviour. The need for increased user-feedback and engagement is recognised by all the authors, but still the prevailing tone of this literature and research errs towards the paternalistic with someone, the 'expert' (or management or government) – influencing other people (residents/staff/non-experts) to stop behaving one way and start behaving another. Underpinning these approaches are often a range of environmental psychology models that attempt to unpick an individual's attitudes (A), behaviour (B) and context (C) in relation to energy (Stern 2000). This 'ABC' approach to behaviour change is criticized by academics (Shove 2010) who argue that behaviour is more complex and the result of deeply engrained social practices, values and institutional and organizational barriers that undermine or limit the impact an individual may have.

Exhorting us to an alternative, more complex approach that sidesteps the polarised debate between the ABC versus Social Practice school of thought, Owens and Driffill (2008) argue for a reframing of the relationships between those responsible for energy management and those using the energy via "a more interactive, deliberative communication between decision-makers, technical experts, other stakeholders and the public" (2208: 4414). This approach will be unpacked shortly alongside the parallels and opportunities social media and the digital economy afford this goal of participation but first a wider consideration of the digital economy and Web 2.0.

The digital economy explored

The term digital economy has so far been discussed in terms of buildings and visualising energy and has been used almost interchangeably with ICT – information and communication technology. 'Digital Economy' refers to more than technical solutions, however, the wider opportunities of the Internet, mobile technologies and social media would be impossible without the commensurate technological advances. This section explores the other fundamental aspect of the digital economy that computing technology has facilitated notably the Internet and Web 2.0, before considering the rise and role of new/social media and the smartphone and finally, the parallels between the participatory nature of new media and public engagement theory.

INTRODUCING WEB 2.0

The Internet is a global system of interconnected networked computers. Back in the late 1970s computing specialists were creating worldwide systems to connect computer users and enable them to post messages (Kaplan and Haenlein 2010). The term Web 2.0 was first used in 2004 to describe the core values underpinning how software developers and ordinary users were using the Internet: decentralisation, user-focused and user-led (O'Neill and Boykoff 2011). Kaplan and Haenlein (2010) note that whereas Web 1.0 was characterised by content and applications produced by individuals or organisations by a top-down or expert-led agenda, Web 2.0 saw the creation of material being "continuously modified by users in a participatory and collaborative fashion" (2010:61) Specifically this technology includes both software, such as Adobe Flash for enabling interactivity and RSS (Really Simple Syndication) for aggregating content; and hardware – users need to be able to access the Internet via a computer, or increasingly, web enable mobile phones, commonly referred to now as 'smartphones'.

Currently 30 % of the UK population use smartphones and this is expected to rise to 80–90 % within 10 years (Google/MMA 2011). The modern smartphone is web-enabled, has access to social media sites such as Twitter and Facebook, has a camera (often with video capability), global positioning systems (GPS) and is able to send emails and text messages (and even make calls!). They can gather data as well as share it in an instant. Further to this is the plethora of bespoke applications ('apps') designed to run on smartphones, especially Apple iPhones and Android phones. There are currently over 50,000 apps available for the iPhone on topics ranging from games, travel, social networking, and sport. They have fundamentally shifted the boundaries between ourselves and each other through the opportunities that the digital technologies afford. A shift that is by no means considered as a 'value-neutral' (see for example Sherry Turkle and her latest book, Alone Together, 2012). Nowhere is this more evident that in the rise of new social media.

THE RISE OF NEW SOCIAL MEDIA

> Our electronic networks are enabling novel forms of collective action, enabling the creation of collaborative groups that are larger and more distributed than any other time (Shirky 2008, p. 48).

Social media has emerged as a worldwide phenomenon with applications like Facebook and Twitter credited with everything from Obama's 2008 election victory (Zhang, Johnson et al. 2009), to the Arab Spring (Ghonin, 2012). A starting definition for social media is a "collection of internet based applications that facilitate social interaction via the creation and exchange of user-generated content" (Stewart, Ambrose-Oji et al. 2012: 8). The first sites classified as 'social media' were the music-based site MySpace (started in 2003), and Facebook, launched by Mark Zuckerberg in 2004 (Kaplan and Haenlein 2010). Devised on the principles of Web 2.0 – user-generated content and collaboration – these sites have witnessed incredible success and popularity. Social media is not a homogenous term though. Kaplan and Haenlein (2010) differentiate between six groupings, each with their flavour and features. (1) Collaborative projects which allow for individuals to contribute to the content of sites, the prime example being Wikipedia. (2) Blogs which are generally maintained by a single person but allow for interaction through the addition of comments. (3) Content communities for sharing media content such as YouTube (the sharing of videos), Flickr (photographs) and Slideshare (presentations). (4) Social networking site, e.g. Facebook and Twitter, (5) Virtual game worlds and (6) virtual social worlds such as Second Life.

Clay Shirky (2008) cites numerous examples of social media to connect and mobilize people for collective action. such as the ability of people to self-organise photographs on Flikr, contribute their knowledge on shared documents such as Wikipedia and engage in social activism. Groups like the American Red Cross (Briones, Kuch et al. 2011), the UK based Forestry Commission (Stewart, Ambrose-Oji et al. 2012), and business leaders (Fischer and Rebecca Reuber 2011) are all using social media, especially the micro-blogging site Twitter. 'Twitterers' (or 'Tweeters') can send messages of 140 characters (tweets) to people who follow you, but are also publicly available. Through these interactions messages, information can spread – or go viral – in a matter of minutes to hundreds and thousands of users. Messages can be searched and identified using a #hashtag and enable messages to be aggregated and searched. Alongside the banal and gossip laden tweets, there are numerous examples of news stories breaking on Twitter before the formal news channels (Rheingold 2002). So, what Ghonim (2012) referred to as 'Revolution 2.0' has cemented the argument for many that the dawn of the internet, and now the web-enabled capacity of smartphones, has changed the nature of how people connect and interact, share knowledge and act in a way that 'amplifies' individual actions.

Insights from the public engagement/risk communication literature

Digitally enabled user-engagement, predicated on ideas on co-creation and 'drawing upon the knowledge of the community' to challenge, test and create sources of knowledge go much deeper though than a Web 2.0 'modern fad'. At its core, Web 2.0 is about participation and it is here that the link between social media and theories of public engagement emerge. These twin attributes of the digital economy find their home in the public engagement literature which in-turn evolved out of the risk communication literature (Fischoff 1995; Jaeger, Renn et al. 2001) theories of deliberative democracy (Habermas 1979; 1984; Dryzek 1990; 2000) and citizen science (Irwin 1995; Wynne 1996).

> When citizens become involved in working out a mutually acceptable solution to a project or problem that affects their community and their personal lives, they mature into responsible democratic citizens and reaffirm democracy. One way of describing this phenomenon is to use the term social learning. (Webler et al 1995:444.)

Back in 1969 Arnstein's (1969)'ladder of participation' (see Figure 3) defined steps to empowerment. At the bottom was information provision a predominantly one-way form of communication, moving up the steps, consultation is usually conceived as a relatively passive process asking for people's opinions but not necessarily engaging them in debate. Participation is normally used to refer to processes, which allow people to participate in a decision by putting forward their views verbally whereas engagement goes further, suggesting an innovative and interactive, two-way process of discussion and dialogue (i.e. deliberation) to ensure that people's views inform a decision, alongside those of the expert and/or decision-maker. This is still one-step removed, however, from Arnstein's top step of her ladder that defines empowerment as people taking control of decisions and their implementation. In a parallel (e)ladder (Figure 4), Forrester Research (cited (Ferro and Molinari 2010) have mapped levels of (e)participation within society in the United States. In this new 'e-ladder' of participation, Ferro and Molinari (2010) note the key features of web 2.0 and social media, notably the idea that people can move from being inactive (at the bottom of the ladder) to be creators (at the top). This maps across to Arnstein's ladder and the theme of increasing control.

Public engagement methods have previously been tried and tested in the siting of controversial facilities such as waste facilities (Bull, Petts et al. 2010), transport planning (Bickerstaff and Walker 2005) and urban river restoration (Petts 2006). The basic premise is that by engaging all those involved in the specific issue, the decision-making process is enhanced (Apostolakis and Pickett 1998) and decisions are more legitimate and lead to better results (Fioriono 1990). The theoretical underpinnings find their roots in Habermas' theory of communicative competence which was successfully mined in the early 1990s by Thomas Webler (1995). Webler (1995) explored how language functions to form key foundational principles for the management of deliberative practices within the school of risk communication. Working from the premise that participation is "interaction among individuals through the medium of language" (Webler 1995, 40), Habermas (1979) argues that any communication between two individuals would fail without cooperation. An individual's ability to use language to create understanding and consensus is referred to as 'communicative competence'. Habermas (1979) outlined a set of ideal conditions in which communicative competence would be best served, known as his 'ideal speech situation'. Webler (1995) applied these principles of communication to the formulation of a set of criteria and rules that would transform democratic ideals of deliberative democracy into practice.

Increasingly, links are made between public engagement and learning, increased environmental citizenship and behaviour change (Bull, Petts et al. 2008). A successful process of engagement is normally predicated on an ideal of dialogue as a means to 'induce reflection upon preferences in a non-coercive fashion' (Dryzek 1990; 2000) and emphasises the importance of drawing upon the knowledge of all members of a community (Healy 1992). The transformative power of effective dialogue should promote learning of new ideas, different peoples' views and the difference that people (individually and collectively) can make (Forester 1999). Practically this means that through the interactions between a diverse group of individuals, lay and experts in particular, then knowledge and ideas can be tested, verified and challenged with impressive results (Irwin 1995; Wynne 1996; Bull, Petts et al. 2008).

The parallels are clear then between the risk communication/public engagement schools of thought and the social media gurus: people (lay and expert) talking and working together can generate new forms of knowledge and contribute to more effective governance. In short, people can be a valuable source of knowledge and wisdom and, if given the opportunity, capable of handling complex information and resolving complex problems. Yet, whilst these perspectives on behaviour change are clear throughout the wider body of digital economy literature, it is found lacking within the smart/intelligent building literature where a predominantly technical approach is found, alongside a niche body of literature on feedback mechanisms.

Social media, energy and buildings

How does this relate to energy and buildings? It is *not* being argued here that building users should switch off their BEMS and take over control of their buildings. It *is* being gently suggested however that a review of the literature to date in this area suggests an over-reliance on purely technical solutions that has led to building users being inactive and under-utilised in the management of non-domestic buildings. This in turn has meant that smart/intelligent buildings have yet to reach their full potential. Whilst much work has been done to explore the technical side of using mobile phones as consumption feedback devices and increase energy awareness, for example, The Insti-

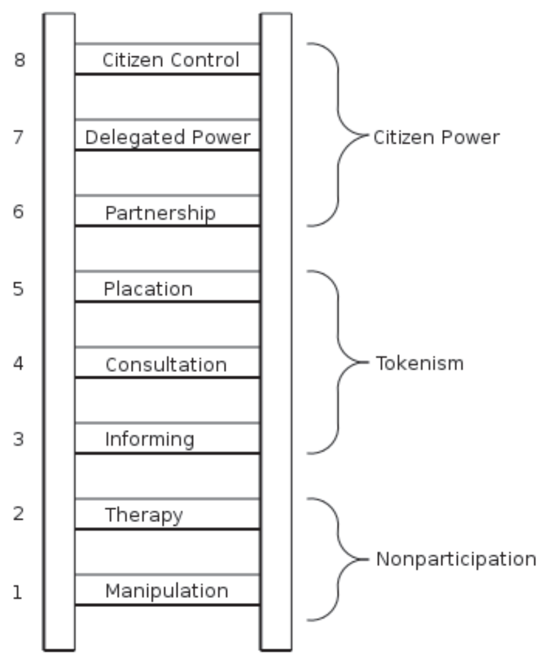

Figure 3. Eight rungs on the ladder of citizen participation (Arnstein, 1969).

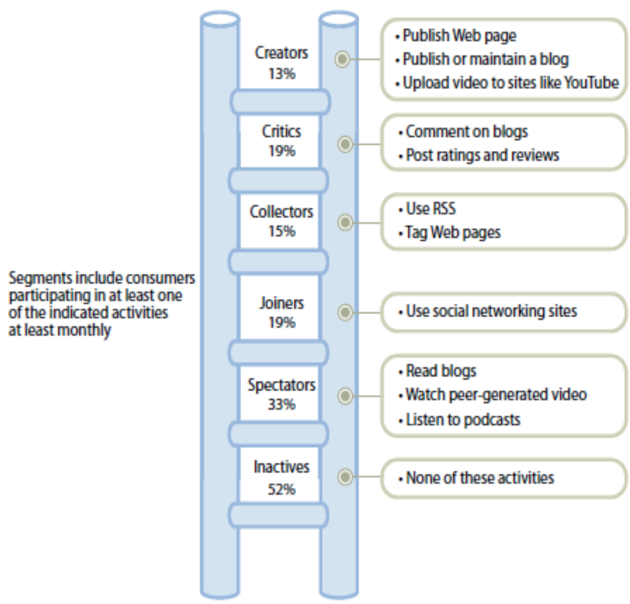

Figure 4. The new e-ladder of participation (cited in Ferro and Molinari 2010).

tute of Pervasive Computing in Zurich (Lehrer and Vasudev 2010), less research has been done to utilise the social media and collaborative potential of Web 2.0 and smartphones. Two examples have been found at the Social Computing Research Centre at Lincoln has explored the use of Twitter and energy visualization tools to share information in the workplace (Foster, Lawson et al. 2010). Lehrer and Vasudev (2011) have recently started to research the role of social media applications to help users track their consumption and engage with their peers activities (Lehrer and Vasudev 2011). These are welcome but seem to still fall short of fully embracing the, at times disruptive, nature of web 2.0 and social media that hints at changing the relationship between those in control and those who are not.

At De Montfort University research has begun into exploring these more fully. Gooddeeds (EPSRC – Grant no. EP/K012312/1) aims to research the impact of Web 2.0 and social media on building user-behaviour and energy demand reduction in non-domestic buildings in Leicester. It will enable users to both understand the environmental impact of their activities and collaborate through social media applications to manage their buildings better and reduce energy consumption. It builds on two previously mentioned projects funded through JISC[5], DUALL (Bull, Brown et al. 2011) and Greenview (Bull, Everitt et al. 2012) and will test these new trends and claims within the digital economy and explore how smart buildings can truly embrace all aspects of the digital economy, not just sophisticated BMS.

One specific and practical example of what this may look like is this. Social media platforms offer building-users the ability to view the energy consumption of the building and offer comment if the consumption is unexpectedly high. Photos or video can be taken and posted of any issues or problems; knowledge can be shared on how best to manage a room's temperature; visitors can share their views and energy managers can share best practice and gain insight from building-users if their BEMS is flagging up an alert. We know for example that more sophisticated control systems do not necessarily reduce energy consumption. They may provide a more constant temperature and also provide this at specific times but more often than not, take the control away from the user; for example, the temperature set points remove any user interaction with the local temperature of a room. An example is given (Figure 5) of how we tested one such approach. Upon entering one of the University buildings the author noticed that the lights were all on, even though these should be controlled through the BMS, and given how bright it was, should have been off. A photograph was taken on an iPhone and posted on Twitter – the following interaction took place on Twitter between other building users and the university's sustainability team (@sustainabledmu – which includes the energy manager) after which the fault was identified and lights were switched off.

Conclusions and Reflections

Given the high-energy demand and carbon footprint of the built environment there is a pressing need to implement effective and affordable energy demand reduction strategies in non-domestic buildings. Notwithstanding the valuable contribution increasingly technical sophistication can bring to our buildings a wider review of the digital economy literature would suggest that there are wider options available to us.

Innovation is required not just in advanced controls but in affordable tools that offer increased engagement and participation so that building users can collaborate, share knowledge and mitigate some of the errors inherent in the solely technical approach. In the context of the built environment this may impact on the established organisational culture of how BEMS are installed, commissioned and (most importantly) managed and how building users experience and perceive buildings. It may involve re-shaping the effectiveness of public services through changing the relationship between building energy managers and building users.

Of course the obvious question is this – do building-users want greater control of their buildings? In non-domestic buildings where the users are often employees with busy working lives, over-flowing in-trays and complex organisational cultures, is there an appetite to help reduce energy demand? We have seen the role social media plays in people's social lives, and we have seen positive examples of public engagement but engaging people around energy in the workplace is notoriously difficult. Given the current economic climate people would be forgiven for having other things on their mind. The aforementioned Gooddeeds project is going to be researching these questions over the next 18 months.

The built environment and the digital economy have had a close relationship over the last couple of decades. Original conceptions of smart or intelligent buildings envisaged buildings that would take into account the preferences and experiences of the building-users. In many cases though it seems this vision has not come to pass, as the techno-centric approach has tended to dominate. Designers have looked to technology to remove control and choice from the building-users in an effort, sometimes understandably, to mitigate against human nature. Yet, whilst much of the technological advancements are impressive and welcome, this approach, in isolation, is out of step with research from two distinct bodies of literature (public engagement and digital economy) that shows that engagement and participation can draw out the best in people, improve learning and knowledge and enable more effective governance. Further research is obviously needed to substantiate whether these themes of co-creation and participation can be effectively applied within the built environment and deliver on the promises contained in the literature. Listening to all the voices within the digital economy and allowing building-users to become co-creators of their environments, may result in smart and intelligent buildings finally reaching their full potential – technology becoming our servant rather than our master – but for now the jury is out.

References

Apostolakis, G. and S. Pickett (1998). "Deliberation: Integrating Analytical Results into Environmental Decision Involving Multiple Stakeholders." *Risk Analysis* 18(5): 621–635.

Arnstein, S. (1969). "A ladder of citizen participation." *Journal of the American Institute of Planners* 35: 216–244.

Bauman, F. (1999). Giving Occupants What They Want: Guidelines for Implementing Personal Environmental

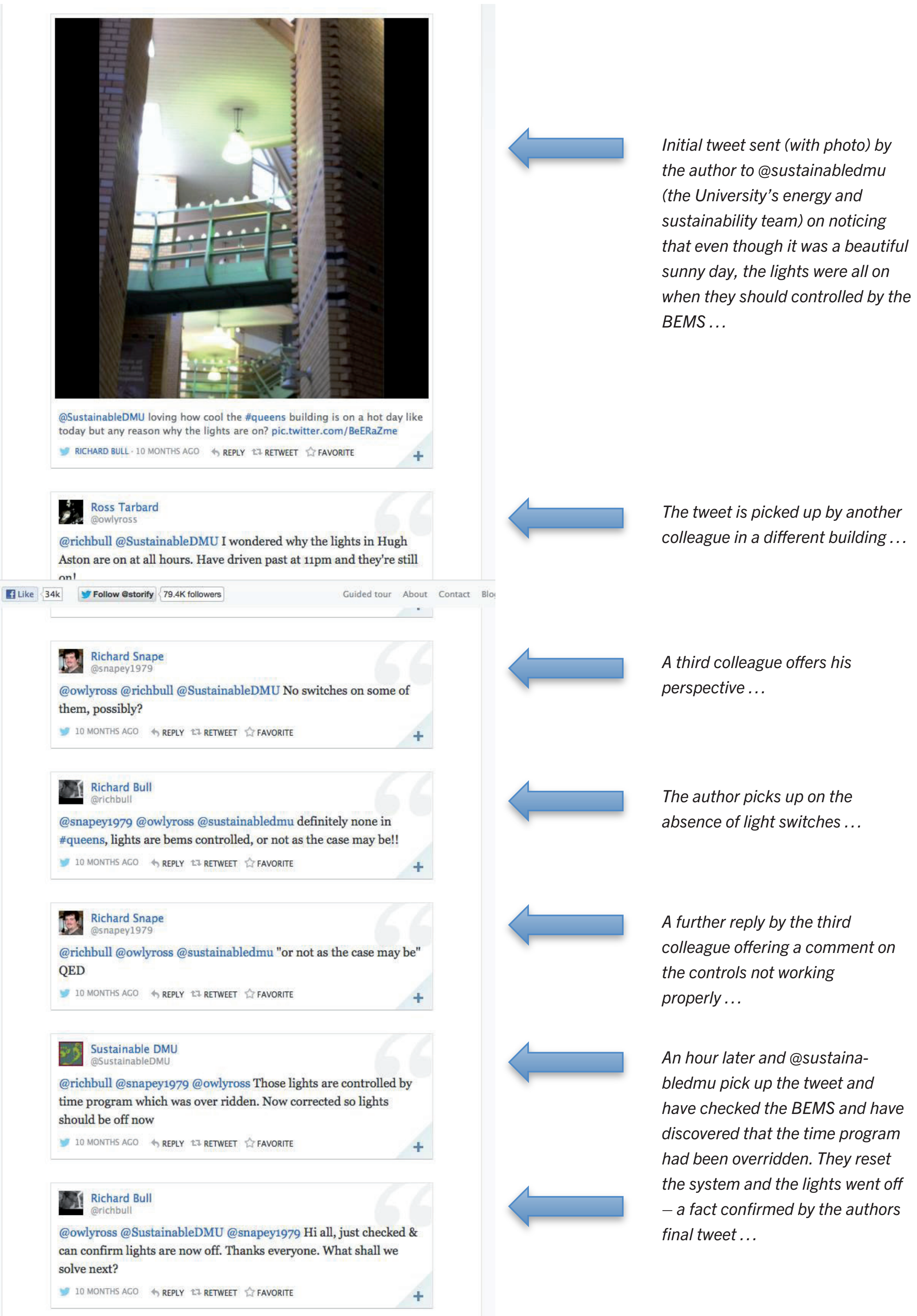

Figure 5. An example from DMU of how social media could be used to facilitate interactions between building users.

Control in Your Building. World Workplace 99, October 3–5, Los Angeles, CA.

Baumgartner, J. and J. Morris (2010). "Myfacetube Politics." *Social Science Computer Review* 28: 24–44.

Bickerstaff, K. and G. Walker (2005). "Shared Visions, Unholy Alliances: Power, Governance and Deliberative Processes in Local Transport Planning." *Urban Studies* 42(12): 2123–2144.

Briones, R., B. Kuch, et al. (2011). "Keeping up with the digital age: How the American Red Cross uses social media to build relationships." *Public Relations Review* 37: 37–43.

Brown, N., R. J. Bull, et al. (2012). "Novel Instrumentation for monitoring after-hours electricity consumption of electrical equipment, and some potential savingts from a switch-off campaign." *Energy and Buildings* 47: 74–83.

Bull, R., J. Petts, et al. (2008). "Social Learning from Public Engagement: Dreaming the impossible?" *Journal of Environmental Management and Planning* 51(5): 703–718.

Bull, R. J., N. Brown, et al. (2011). Findings from the DUALL project: lessons in engaging building users in energy reduction in a UK University. ECEEE 2011 Summer Study.

Bull, R. J., N. Chang, et al. (2012). "The use of building energy certificates to reduce energy consumption in European public buildings." *Energy and Buildings* 50: 103–110.

Bull, R. J., D. Everitt, et al. (2012). The Gorilla in the Library: Lessons in using ICT to engage building users in energy reduction. Conference Proceedings from the second Digital Economy 'All Hands' conference in Aberdeen, October 2012.

Bull, R. J., J. Petts, et al. (2010). "The Importance of Context for Effective Public Engagement." *Journal of Environmental Planning and Management* 53(8): 991–1009.

Burgess, J. and M. Nye (2008). "Re-materialising energy use through transparent monitoring systems." *Energy Policy* 36: 4454–4459.

Clements-Croome, D. (1997). "What do we mean by intelligent buildings?" *Automation in Construction* 6: 395–400.

Darby, S. (2010). "Smart Metering: What potential for household engagement?" *Building Research and Information* 38(5): 442–457.

Dascalaki, E., K. Droutsa, et al. (2010). "Data collection and analysis of the building stock and its energy performance – An example of Hellenic Buildings." *Energy and Buildings* 42(8): 1231–1237.

Drewer, S. and D. Gann (1994). "Smart Buildings." *Facilities* 12(13): 19–24.

Dryzek, J. (1990). *Discursive Democracy*. Cambridge, Cambridge Univeristy Press.

Dryzek, J. (2000). *Deliberative Democracy and Beyond*. Oxford, Oxford University Press.

Ferro, E. and F. Molinari (2010). "Framing Web 2.0 in the Process of Public Sector Innovation: Going Down the Participation Ladder." *European Journal of ePractice* 9.

Fioriono, D. J. (1990). "Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms." *Science and Technology & Human Values* 15(2): 226–243.

Fischer, E. and A. Rebecca Reuber (2011). "Social interaction via new social media: (How) can interactions on Twitter affect effectual thinking and behaviour?" *Journal of Business Venturing* 26: 1–18.

Fischoff, B. (1995). "Risk Perception and Communication Unplugged: Twenty years of process." *Risk Analsyis* 15(2): 137–145.

Forester, J. (1999). *The deliberative practictioner:encouraging participatory planning processs*. Cambridge MA, MIT Press.

Foster, D., S. Lawson, et al. (2010). Watts in it for me? Design implications for implementing effective energy interventions in organisations. CHI 2012.

Ghonim, W. (2012). *Revolution 2.0*. New York, HMH.

Google/MMA (2011). Global Pespectives: The Smartphone User & the Mobile Marketer.

Habermas, J. (1979). *Communication and the Evolution of Society, translated by Thomas McCarthy*. Boston, Beacon Press.

Habermas, J. (1984). *The Theory of Communicative Action. Volume 1: Reason and the Rationalization of Society.* . Oxford, Blackwell.

Hargreaves, T., M. Nye, et al. (2010). "Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors." *Energy Policy* 38: 6111–6119.

Hargreaves, T., M. Nye, et al. (2013). "Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term." *Energy Policy* 52.

Healy, P. (1992). "Planning through debate: the communicative turn in planning theory." *Town Planning Review* 63: 143–162.

Irwin, A. (1995). *Citizen Science*. London, Routledge.

Jaeger, C., O. Renn, et al. (2001). *Risk, Uncertainty and Rational Action*. London, Earthscan.

Janda, K. (2011). "Building's don't use energy: people do." *Architectural Science Review* 54: 15–22.

Kaplan, A. and M. Haenlein (2010). "Users of the world, unite! The challenges of and opportunities of social media." *Business Horizons* 53(1): 59–68.

Kroner, W. (1997). "An intelligent and responsive architecture." *Automation in Construction* 6: 381–393.

Leach, M., I. Scoones, et al. (2010). *Dynamic Sustainabilities: Technology, Environment and Social Justice*. London, Earthscan.

Lehrer, D. and J. Vasudev (2010). Visualizing Information to Improve Building Performance: A study of expert users. ACEEE Summer Study on Energy Efficiency in Buildings.

Lehrer, D. and J. Vasudev (2011). Evaluating a Social Media Application for Sustainability in the Workplace. CHI2011 May 7–12, 2011 Vancouver, BC, Canada.

O'Neill, S. and M. Boykoff (2011). The Role of New Media in Engaging the Public with Climate Change. *Engaging the Public with Climate Change*. L. Whitmarsh, S. O'Neill and I. Lorenzoni. London, Earthscan.

Obar, J., P. Zube, et al. (2012). "Advocacy 2.0: An Analysis of How Advocacy Groups in the United States Perceive and Use Social Media as Tools for Faciliating Civic Engagement and Collective Action." *Journal of Information Policy* 2: 1–25.

Parsons, D. and J. Chatterton (2011). Carbon Footprint Case Study: Intelligent Buildings, Cranfield University.

Petts, J. (2006). "Managing Public Engagement to Optimize Learning: Reflections from Urban River Restoration." *Human Ecology Review* 13(2): 172–181.

Renn, O. (1992). "Risk Communication: Towards a Rational Discourse with the Public." *Journal of Hazardous Materials* 29: 465–519.

Rheingold, H. (2002). *Smart Mobs: The Next Social Revolution*. Cambridge, Perseus.

Shirky, C. (2008). *Here Comes Everybody*. London, Penguin.

Shove, E. (2010). "Beyond the ABC: climate change and theories of social change." *Environment and Planning A* 42 (1273–1285).

SMART2020 (2008). Enabling the low carbon economy in the information age. http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf.

Stern, P. (2000). "Towards a Coherent Theory of Environmentally Significant Behaviour." *Journal of Social Issues* 56(3): 407–424.

Stewart, A., B. Ambrose-Oji, et al. (2012). Social Media and Forestry: A Scoping Report. Forestry Commission.

Webler, T. (1995). "Right" Discourse in Citizen Participation: An Evaluative Yardstick. *Fairness & Competence in Citizen Participation: Evaluating Models for Environmental Discourse*. O. Renn, T. Webler and P. Wiedemann. London, Kluwer Academic Publishers**:** 35–86.

Webler, T., H. Kastenholz, et al. (1995). "Public Participation in Impact Assessment: A Social Learning Perspective." *Environmental Impact Assessment Review* 15: 443–463.

Weiss, M., C. Loock, et al. (2010). Evaluating Mobile Phones as Energy Consumption Devices. Proceedings of Mobiquitous 2010 (7th International ICST Conference on Mobile and Ubiquitous Systems.

Wong, J., H. Li, et al. (2005). "Intelligent building research: a review." *Automation in Construction* 14: 143–159.

Wynne, B. (1996). May the sheep safely graze. *Risk, Environment and Modernity*. S. Lash, B. Szerszynski and B. Wynne. London, Sage.

Zhang, W., T. Johnson, et al. (2009). "The revolution will be networked." *Social Science Computer Review* 28: 75–92.

Endnotes

1. See Tim Jackson's expansive review of the behaviour change literature from 2004 as a good starting point alongside Elizabeth Shove's 2010 article critiquing the 'ABC' behaviour change school of thought.
2. http://ec.europa.eu/research/industrial_technologies/ppp-in-research_en.html
3. http://www.ectp.org/cws/params/ectp/download_files/36D2431v1_E2B_Roadmap_21-11_rev3.pdf
4. http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&QZ_WEBSRCH=EeB&QM_EP_PGA_A=FP7-NMP&USR_SORT=EN_QVD+CHAR+DESC&DOC=1&QUERY=013b61ad5e1b:04cd:22ed 446b accessed 17.15 Dec 3rd 2012.
5. 'JISC'(the acronym once stood for 'Joint Information Systems Committee', it is now their name) inspires UK colleges and universities in the innovative use of digital technologies.