eTEACHER

D1.3: ICT-based engagement for energy efficiency in buildings

WP* , *T 1.

Date of document

September 2018, (M12)

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eTEACHER

EE-07-2016-2017

Innovation Action

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768738.

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Technical References

Project Acronym	**eTEACHER**
Project Title	end-user Tools to Empower and raise Awareness of Behavioural Change towards EneRgy efficiency
Project Coordinator	Noemi Jimenez CEMOSA noemi.jimenez@cemosa.es
Project Duration	1 October 2017 – 30 September 2020

Deliverable No.	D1.3
Dissemination Level	PU
Work Package	WP 1 – Design for Behavioural Change for Energy End-Users
Task	T 1.3 – ICT-based engagement for energy efficiency in buildings
Lead beneficiary	3 (NCC)
Contributing beneficiary(ies)	1 (DMU), 4 (GRA)
Due date of deliverable	30 September 2018
Actual submission date	2 October 2018

Versions

Version	Person	Partner	Date
1.0	Sam Preston	NCC	14 Sept 2018

0 Executive Summary

ETEACHER is a Horizon 2020 project which aims to develop an ICT tool that will empower building users to achieve energy savings and improve comfort conditions. It will do so through research, monitoring and trials within 12 pilot buildings that span three countries; namely Romania, Spain and the UK. This document reports on Task 1.3, sitting under Work Package 1, which is Design for Behavioural Change for End-users.

Task 1.3's aim is to consolidate current knowledge on how ICT-based engagement activity can support energy efficient behaviour in buildings. It requires the facilitation of two workshops to develop knowledge across the project team and with selected building users. The workshops share and draw upon key ideas identified in WP1 and identify how to apply this learning in the development of WP2 and WP3.

To satisfy these criteria, two distinct workshop designs were developed. The first, *Workshop Ask,* consults building users on their ICT habits and preferences; data which subsequently forms the basis for *Workshop Bridge.*

The report is broken down into five overarching sections:

Section 1: Introduction of Task 1.3 and the eTEACHER case study buildings

Section 2: ICT design for energy behaviour change - a literature review

Section 3: Workshop designs – new methodologies for user engagement

Section 4: User preferences and design recommendations – presenting workshop findings

Section 5: Discussion and conclusions

Final ICT-based recommendations for design are set out below, prioritised using MoSCoW ('Must'; 'Should'; 'Could'; 'Wont'):

1. (S) make eTEACHER an app with all full functions available on a smartphone.
2. (M) ensure eTEACHER is, at least in part, available on tablets, PCs and plasma screens, so certain relevant features can be accessed on these devices.
3. (C) adapt design to alternative hardware relating to specific pilot building to ensure engagement with all key building users.
4. (W) any longer target smart watches as a primary device.
5. (M) explore ways app engages with people without smartphones (example: teachers give students points for good energy actions so targeting student behaviour even though they do not interact directly with the technology).
6. (S) ensure inclusion of most popular functions: alarm, dashboard, advisor, reward, feedback.
7. (M) incorporate gamification but avoid serious games.
8. (M) make app adaptable in terms of basic functions through one or both of:
    a. Manual customisation – user choice.

   b. Automatic filtering according to user or building type.

9. (S) make app settings (e.g. alarm, advice frequency) adjustable through one or both of:
   a. Manual customisation / user schedule input.
   b. Automatic settings according to user interaction.
10. (C) build in layers: headlines giving key info which can be expanded for extra detail if user has the interest and time.

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1 Introduction

Buildings are a major source of energy consumption across the world, and in the European Union, constitute approximately 40% of final energy consumption (European Commission, 2017). There is growing recognition that technological upgrades by themselves are not sufficient for maximising a building's potential for efficiency, as, ultimately, it is the people inside who govern energy use (Janda, 2011). Attention is turning towards the role of building occupants in the journey towards a more sustainable future. Accordingly, the European Union is investing in the development of ICT solutions to achieve behaviour change towards energy efficiency. Specifically, it is funding a number of intervention projects to provide an overview of best practices, and eTEACHER is one such initiative.

ETEACHER is a three year project aiming to develop an ICT tool that will empower building users to achieve energy savings and improve comfort conditions. It will do so through research, monitoring and trials within 12 pilot buildings which span three countries, namely Romania, Spain and the UK.

Work Package 1 (WP1), entitled Design for Behavioural Change for Energy End-users, lays an evidence-based foundation for tool development through "consolidating and sharing current knowledge on effective programme design for behaviour change; characterising relevant behavioural and contextual factors for each case study building, and supporting project partners to put this knowledge into practice". This document reports on one particular strand of WP1: Task 1.3, which is ICT-based engagement and behavioural change for energy efficiency in buildings.

1.1 Aim, scope and requirements

Referring to the grant agreement, this task "aims to consolidate current knowledge on how ICT-based engagement activity can support energy efficient behaviour in buildings. Such ICT-based activities include using gamification to engender social norms, enhancing energy visibility through mobile phone apps, or improving energy literacy through software linked to smart meters. Knowledge on the impacts of these activities will be consolidated by drawing upon findings from academic and practitioner literature on the approaches undertaken and results achieved. The scope will include residential and commercial buildings, and interventions aimed at both building users and building managers."

In terms of outputs, T1.3 has delivered knowledge transfer through "facilitation of two workshops to develop knowledge across the project team and with selected building users. These workshops aimed to share and draw upon key ideas identified in this WP, and to identify how to apply this learning in the development of work packages 2 and 3."

1.2 eTEACHER case study buildings

Table 1 details the 12 pilot buildings in which the eTEACHER tool will be developed and trialled. Together, the pilots bring a diverse set of contexts in terms of climate, architecture, age, building uses and occupant demographics.

Table 1 Summary of eTEACHER pilot buildings

eTEACHER pilot building	Location	Use	Building type
InCity (4 separate blocks: A, B, C & D)	Bucharest, Romania	Residential	Private
Villafranca	Spain	Health Care Centre	Public
Guareña	Spain	Health Care Centre	Public
IES Torrente Ballester	Spain	School (High School)	Public
CEI Arco Iris	Spain	School (Kindergarten)	Public
OAR	Spain	Office	Public/Private
Av. Godofredo Ortega y Muñoz Residential Apartment Block	Spain	Residential	Private
Council House	Nottingham, UK	Office	Public
Djanogly City Academy	Nottingham, UK	School (High School)	Public

1.3 Report structure

To develop an initial understanding of ICT-based behaviour change and point of reference for emerging results, the report continues next with a literature review addressing the subjects of hardware, software, real world barriers and user-centred methodologies. Subsequently, the methodology behind the workshop development and delivery is explained, leading on to a description of the results. The results section culminates in a set of 10 ICT-based recommendations for the eTEACHER tool design. These are expanded upon in the final discussion, which closes with a complementary set of conclusions.

In summary:

- Literature review - overview of the academic backdrop
- Methods – development and description of workshops with justifications
- Results – overview of data collected from workshops leading to 10 design recommendations
- Discussions and conclusions – exploration of results with reference to literature.

2 IT design for energy behaviour change: a literature review

A rich body of literature is devoted to energy behaviour change interventions, with many of the more recent studies find focusing on IT and smart technologies as part of behaviour change interventions. To begin with, this review summarises work addressing the interaction of building users with hardware devices as part of energy behaviour change campaigns, offering an impression of what has so far proved appealing and convenient to users in various environmental contexts.

For the most part, research of this nature centres on communicating energy feedback to users. Thus, as the review moves from evaluating the execution of behaviour change interventions, i.e. how the tool fits into the user's physical world, to the conceptual content it comprises, attention is firstly paid to simple feedback; its different types and visual manifestations.

Feedback alone, however, is subject to comprehensive criticism within the academic field. Its shortcomings are briefly discussed to illuminate the underlying motives for transcending its basic form. Sequentially, the review investigates a range of extensions and alternative approaches to IT tool development to gain insight into how users might be galvanised into exhibiting positive energy behaviours.

Even an exemplary intervention cannot be immune to certain situations and dynamics unfolding among the target building communities. For the sake of future resilience, the potential for often complex and unpredictable "real-world" barriers is considered (Bull *et al.,* 2015).

Increasingly, studies are recognising that the value in user engagement is not confined to the eventual assessment of their response to interventions; that, rather, their input during the entire design process may be prerequisite for success. On this account, the review turns to methodologies for user engagement as part of product development.

In closing, the prevailing message that "one size does not fit all" (Khosrowpour *et al.,* 2016) is accentuated against the backdrop of eTEACHER's multi-contextual setup, with the effect of substantiating the particular importance of ICT-based engagement with users from the early stages of this project.

2.1 Tool execution: hardware interface

2.1.1 Device type

2.1.1.1 Display screens

Much of the early research on energy behaviour change interventions concerns itself exclusively with the domestic setting (Bull et al., 2013) and, particularly, the implementation of In Home Displays (IHDs). IHDs are domestic devices presenting near-real-time consumption data (Krishnamurti et al., 2013). Murtagh et al.'s (2014) extensive review on IHDs notes that numerous studies report their success in reducing energy consumption in the home, with savings up to 14% (e.g.; Abrahamse et al., 2005; Darby, 2006; Ehrhardt-Martinez et al., 2006)

Equally, however, there are many revealing inconsistent results. In one such case, Hargreaves et al. (2010) attributes the differing degrees of user engagement with domestic displays to the varying constraints of

social relationships and practices in different households. Buchanan et al. (2015) goes further to challenge, what they call, the "entrenched view" that feedback via IHDs offer a sufficient solution to rising carbon emissions and energy demand, pointing out that short-term reductions are only 2% on average. In alignment, Hargeaves et al. (2013) finds from qualitative interviews that, ultimately, in spite of improving knowledge and confidence about energy consumption, IHDs do not always motivate residents to decrease their energy use. Displays, they claim, while not discarded, commonly "become 'backgrounded' over time within normal household routines and practices", so attention to feedback diminishes, in agreement with Van Dam et al., (2010) who find this to be true even over short time periods.

Many studies pay heed to the significance of the display screen's physical position and appearance itself. Wilson et al. (2010) and Riche et al. (2010) both assert that there is a larger chance of a device's acceptance and incorporation into daily routines if it complements the home aesthetically. Comparably, Fitzpatrick and Smith (2009) and Anderson and White (2009) believe users should be able to personally choose the location for installation.

Beyond the home environment, communal displays can communicate information to a wider audience. Judging by Staddon et al.'s (2016) review of energy behaviour change in the workplace environment, this avenue has not yet undergone a great deal of assessment. Bearing in mind the increasing prevalence of digital information displays in offices and other shared and public buildings, with the digital signage market expected to grow by 7.4% between 2017 and 2023 (Markets and Markets, 2017), this instrument for effecting behaviour change is worthy of inquiry. One of the few studies reporting on public displays screens is DECC's (2018) CarbonCulture project. While it is multi-faceted, display screens are said to be part of its "critical" technical architecture and have the attraction of already being common in the workplace. A central display screen was more fundamental to Timm and Deal's (2016) energy behaviour change programme, assimilating data from four US college campuses. Significant savings of were reported, 7-10% for electricity and 50% for gas, although there was insufficient evidence to attribute this to altered staff and student attitudes. Tellingly, the mounting of feedback in a public space was also an explicit design criterion of Murugesan et al., (2015).

2.1.1.2 Computers

Personal computers, be they desktops, laptops or tablets, are widespread across nearly all building types, making them an advantageous choice of vessel for behaviour change interventions in this respect. Vine et al. (2013) comments that the option of email offers a means of directly sending feedback to users and also linking to websites with extra or more detailed information. Correspondingly, multiple studies present evidence of success via this approach, both in home (e.g. Gleerup et al., 2010) and workplace environments (e.g Carrico and Reimer, 2011; Dixon, et al., 2015; Kamilaris et al., 2015). Computers also serve as suitable hosts for dashboards and lend themselves to interactivity if desired (e.g. Owen, 2010; Metzger et al., 2011; Yun et al., 2015), which Fischer (2008) identifies as a common denominator in successful household interventions.

2.1.1.3 Smartphones

Smartphone penetration in all three of eTEACHER's pilot countries exceeds 60%, with the UK now above 70% (Newzoo 2018), rendering it a key device to investigate in this project. In accordance, Weiss et al (2013) advocate the use of smartphones over IHDs, emphasising that the former is within reach of the user and generally has no cost given that most people already own one, a notion echoed by Tisov et al. (2015), yet "fits unobtrusively into the home environment". Full exploitation of smartphone technology allows building in existing social media platforms, camera and GPS functions (Bull et al., 2013) and more innovative features, too, such as scanning QR codes as demonstrated by Tolias et al., (2015).

Nevertheless, caution is well advised in light of difficulties encountered in several studies. By way of illustration, Bull et al. (2015) observed that smartphones were in fact "quite novel" to the majority of their participants which posed a barrier. Similarly, Wilson et al.'s (2015) review warns that complex devices can threaten the inclusivity of a behaviour change campaign by intimidating users with a "low level of education, technical ability or free time to understand or engage with".

An extension of the smartphone gaining appreciable traction (Lamkin, 2017) is the smartwatch. The obvious advantage of so-called wearable technologies is that they are always attached to the user, allowing for continual behavioural information to be recorded and reminders to be received more frequently (Helbostad et al., 2017). However, their level of ubiquity cannot be said to match that of the smartphone so their utilisation in a behaviour change engagement programme may be of considerable cost. Indeed, in any intervention, the smartphone's feasibility is likely to be strongly governed by the demographic of the target building users which influences both attitudes and access to different technologies. Those users who are inclined to mistrust new technology (Bull et al. 2013) may feel alienated by the idea of using a smartwatch.

2.2 Tool content: function and features

2.2.1 Conventional feedback

The exercise of examining existing findings about hardware reception exposes a predominance of the feedback approach in the field of energy behaviour change programmes. Feedback here simply means the relaying of energy consumption data to a user, which is far from being novel to the domestic user, and to some extent specific non-residential building users, who have always had access to bills and meter readings. What is more recent is the digitalisation of energy feedback using wireless transmitters on incoming cables, or more advanced 'smart' meters, to present more frequent and dynamic consumption data on the display devices discussed above (Bull et al., 2013), and its implementation beyond the realms of the domestic residence. According to Abrahamse (2005), feedback falls into the category of consequence interventions, as opposed to antecedent interventions, meaning it intends to bear influence after, rather than before, a behaviour, by creating a meaningful consequence. Through receipt of detailed consumption data, it is postulated that a user becomes equipped with the necessary information to gain knowledge and awareness and encouraged to lessen their consumption, otherwise known as the information-deficit-based approach (Hargreaves, 2017).

A large volume of research is dedicated to the simple conveyance of feedback as a means of driving energy consumption reductions. The online qualitative analysis of Buchanan et al., (2014) lends support to the

"theoretical assertions that feedback transforms energy from invisible to visible, prompts motivated users to learn about their energy habits and helps to address deficits about energy use". Feedback serves as a more tangible alternative than attempting to propagate feelings of social obligation (Darby, 2008). In practice, sizeable savings of 10%-30% have been achieved (Zhou and Yang, 2016; Inyim et al., 2018).

2.2.1.1 Feedback forms

Post-consumption feedback is said to be direct or indirect. Whereas the latter is processed, direct (real-time or near real-time) feedback is immediate and reportedly harnesses better results in terms of energy savings, at least in the short term, and lends itself more easily to individual customisation (Wood and Newborough, 2003; Vine et al. 2013).

Additionally, feedback may be normative, where individual or team consumption data is compared. It can also be historic so that, for example, the difference between today's consumption and this day last month or last year is calculated so the user can compare over time. Although these can be independent, they are often paired in interventions, as was the case in Harries et al. (2003)'s study which concluded that direct feedback is sufficient for success on the condition it is comparative and historic.

Disaggregation can add a further dimension to feedback. It can be broken down by appliance, activity, room or energy type, among other approaches, to build and strengthen conscious links between actions and consumption (Wilson et al., 2010; Stankovic et al., 2016). Interestingly, Lynham et al. (2016) concluded the "learning effect", where users gain insight into how different activities consume energy is of more significance to improving conservation than the "saliency effect", which embodies frequent reminders. Krishnamurti et al., (2013) found that users favoured appliance-specific feedback expressed in monetary terms, yet generalised, aggregated kWh format proved more educational. In a workplace environment, data can be isolated to individual desk spaces, allowing for personalised feedback, which, through heightening accountability, has proven in some cases to instigate more energy efficient behaviours (e.g. Coleman et al., 2013).

There is no consensus on the most conducive combination of feedback types as different works cite varying formulas for success. Mulville et al., (2014) and Dixon et al. (2015), for example, demonstrate the capabilities of a comparative feedback campaign in reducing energy consumption in workplace environments, yet Jain et al., (2012)'s results justify the recommendation of a historical format but not normative or disaggregated forms of feedback in a domestic context. Similarly, Mulville et al. (2016) found that their significant energy savings in offices did not at all rely on modified perceived social norms.

In spite of these conflicts, Vine et al. (2013) recognises patterns of features across the more efficacious trials, which include having a standard to relate to, being sent out as immediately as possible, and being customised to the individual users.

2.2.1.2 Feedback visualisation

A wealth of authors in the field emphasise the magnitude of feedback data presentation. Many go into great depth concerning the preferred types of charts and graphics of their participants in terms of what

proves both visually appealing and comprehensible (e.g. Egan, et al., 1996; Roberts and Baker, 2003; Roberts et al., 2004; Iyer et al., 2006). These findings often conflict with one another, which is possibly attributable to varying personal preferences of different audiences and perhaps serves to reiterate the importance of tailoring information to the specific user audience in question (see sections 2.4 and 2.5). Importantly, Van Dam et al. (2010) highlight that graphical and numerical displays are not universally intelligible. Hargreaves (2010) and Fitzpatrick and Smith (2009) both advocate an 'at-a-glance' display to avoid deterring users with complex information. The former finds effectiveness in a traffic light system reflecting the users' performance; a case strengthened by user responses in Wilson et al. (2013) and Anderson and White (2009). Simplification of data presentation is taken yet further by ambient light feedback where different colours signify varying levels of consumption (Maan et al., 2011), although this runs the risk of lacking meaningfulness through ambiguity. Gupta et al., (2017) looks into alternative ways of visualising feedback, namely through carbon mapping and thermal imaging, which proved popular and effective at engaging community members, although some users were put off by the hurdle of having to log-in and what they perceived as excess information.

2.2.1.3 Feedback limitations

Evidently, real-time feedback to induce energy efficient behaviour has been thoroughly explored over the last few decades. Naturally, this has brought to light its deficiencies, and numerous academics have developed theories in explanation. First and foremost is contestation over the underpinning 'information deficit' based approach. Bull et al. (2013) suggests this perspective is problematically paternalistic. They explain that it is grounded in 'ABC' models, seeking answers in an energy user's attitudes (A), behaviour (B) and context (C), which are criticised by academics such as Shove (2010) owing to their over-simplification or disregard of deep-routed values, practices and barriers.

Adding weight to these doubts are cases in the field where feedback alone proved inadequate for achieving substantial energy use reductions (e.g. AECOM, 2011; Buchanan et al., 2015). Wilson et al. (2013)'s reported that participants perceive an inability to change certain energy usage actions, no matter what the feedback information. Timm and Deal's (2016) attribution of their energy savings following feedback provision to improved facilities management, as opposed to any alternations in staff or students attitudes, is another pertinent example. What's more, Delmas et al.'s (2013) review casts doubt on the methodological reliability of the most impressive results published.

A second major strand of criticism is the seeming inability of simple feedback to sustain long term behaviour change, either because habits do not last once feedback is stopped or that users simply revert back to previous behaviours as the novelty wears off (Snow et al., 2013; Hargreaves et al., 2013; Buchanan et al., 2015).

2.2.2 Beyond feedback

In light of the various criticisms outlined above, experts have repeatedly called for strategies to transcend feedback in future work of this kind. Hargreaves (2017) articulates the value in going "beyond the retrospective focus of conventional energy feedback (…) to generate more prospective and speculative

approaches" and promotes "experimenting with forms of energy feed-forward". Others make the case for shifting the focus to more active user participation to harness the power of communities and workplace cultures (Owens and Driffill, 2008; Moezzi and Janda, 2014). Bull and Janda (2017) correspondingly suggest enlarging the aspect of social interaction in framing energy as a "communal subject for discussion, negotiation and partnership".

The next section visits supplementations or alternative strategies to conventional feedback in the quest to actuate effective and lasting energy conserving behaviours. While these have independent underpinning theories and consequences, they can be, and often are, combined in various ways to form a single campaign.

2.2.2.1 Goal-setting

In line with the aforementioned recommendations to move from retrospective to future-based thinking, and a clear-cut example of Abrahamse's (2005) antecendent intervention, goal-setting gives a predetermined aim for users to work towards (Osbaldiston and Schott, 2012). From their trial, based on the Feedback Intervention Theory which is based around goal-setting, McCalley et al. (2010) report this tactic has the potential to enhance motivation, improve concentration towards actions and increase perseverance. Rather than relying on feedback as a sole motivator, feedback is instead implemented as a tool for benchmarking performance in relation to a set standard defined by the goal, and has been shown in some cases to sizeably increase savings (McCalley et al., 2006; Wilson et al. 2015).

Particular care should be taken in setting goals, on the authority of Wood and Newborough (2007), who maintain that over-ambitious targets can demotivate participants while, of course, unambitious targets place restrictions on an intervention's accomplishments.

2.2.2.2 Social network

Increasingly studies have turned attention towards the use of social media within behaviour change intervention strategies. Social media use has become a global phenomenon and shows no sign of fading, with almost 3.2 billion active users worldwide, up 13% from 2017 (Chaffey, 2018). In fact, this statistic is based on the use of social networking sites alone but this, according to Kaplan and Haenlein (2010), is only one of six categories of social media use, the others being collaborative projects (e.g. Wikipedia), blogs, content communities (e.g. YouTube), virtual game worlds and virtual social worlds (e.g. Second Life). Encompassing all strands, Stewart et al. (2012) defines social media as a "collection of internet based applications that facilitate social interaction via the creation and exchange of user-generated content". With the call from authors to amplify social interaction within behaviour change interventions, it follows that social media could prove an invaluable mechanism for campaigns.

Researchers have experimented both with creating entirely new bespoke platforms for their users, but also with "piggybacking" on existing popular sites, which benefits from pre-existing habits of frequent engagement rather than attempting to solicit regular use of a new login and unfamiliar system (Mankoff et al., 2007). Among field trials using the latter is Crowley et al., (2014) who connected their BMS with Twitter so that following users could see targeted consumption updates and generating reductions of 26%.

Other trials have asked for more effort and input on the part of the users, drawing upon their knowledge and experiences to form robust communities uniting over energy matters. Members might upload blog posts, photos and videos and examples of best practice (Bull et al., 2013). A working example presented by Bull and Janda (2017) is GoodDeeds (Digitally Engaging and empowering Employees for energy Demand reduction) for local authority employees, which incorporated social media, physical user meetings and feedback. Due to fears over privacy, users expressed favour towards a new platform rather than using existing sites. The solution was accessible on PCs and smartphones, and allowed users to flag building issues and request a solution. In another trial, this time in the context of Canadian university campuses, social media was implemented to launch and energise a competition between 6500 students (Senbel et al., 2014). Increased motivation was observed which was primarily generated through actions and stories of friends as opposed to the scores of unknown peers, which prompted an optimistic conclusion with regards to offering multiple pathways for participations for the sake of achieving sustained behaviour change. Petkov et al. (2011)'s EnergyWiz and Inyim et al. (2018)'s Building Brain are further cases demonstrating the utilisation of social media in apps for effecting energy behaviour change.

Like most approaches, social media use is not without challenges. Bull et al. (2015) relays the obstacle of privacy and trust concerns which can compromise a user's willingness to share and contribute. Also raised is the fear of negative public posts when the network is hosted by a particular organisation, which could damage the reputation of the institution in question.

2.2.2.3 Serious games and gamification

Gamification of energy use to encourage behaviour change of individuals has become more prominent in recent literature published on ICT-based behaviour change interventions. Serious games are an "interactive computer-based (…) software for one or multiple players to be used on any platform (…) with the intention to be more than entertainment" (Ritterfeld et al., 2009). Distinguishably, gamification is the "use of game elements in non-game contexts to improve user experience and user engagement" (Deterding et al., 2011), and as succinctly put by Grossberg et al. (2015), "encourages people to do something by making it fun". Elaborating, they explain that, whether it is as basic as a points competition between buildings or neighbourhoods, or as sophisticated as an app with energy avatars, gamification consistently enlivens tasks through: 1) clear goals and rules, 2) a compelling storyline, 3) small, challenging but achievable tasks and 4) quick feedback; features which the real world all too often lacks. The authors take care to differentiate between gamification and rewards, noting the former's purpose is simple enjoyment and entertainment as opposed to tangible compensation.

Johnson et al. (2017) conclude from their systematic review of 25 studies that gamification, on the whole, is valuable to efforts to achieve energy conservation. To name but a few positive examples, de Vries and Knol's (2011) EnerCities was met with significantly improved attitudes towards saving energy, based on a seven point scale of positive awareness. Banerjee and Horn's (2014) Ghost Hunter app instilled higher awareness of consumption as children identified different devices which used energy and became more familiar with energy units, and during the playing period of Geeleen et al. (2012)'s Energy Battle game, household consumption by up to 45% with an average of 24%.

While in the last case the reductions were sustained by 6/10 households post-intervention, some studies report initial success but failure to perpetuate positive behaviours in the long term, such as the Power Explorer and Power Agent mobile apps reported on by Gustafsson et al., (2009). However, other examples were unable to engender any change at all, such as Kimura and Nakajuma's EcoIsland (2009).

Grossberg et al. (2015) advise that the most fruitful game designs are fastidiously tailored to the specific user audience and integrate social media to "compare, amplify and reward players' efforts". Comparably, Wood et al.'s (2014) proposed criteria for effective serious games draw attention to the importance of comparing performance socially, as well as improving energy literacy via applicability to physical energy use, and having clear, actionable goals.

In relation to the recommendations to include social elements, Senbel et al. (2014) learned that their success in reducing energy consumption stemmed not from the competitive point scoring against unknown peers, but in the communication of stories and experiences with personal friends.

2.3 Real world barriers

Regardless of the intervention's form, Bull et al. (2015) emphasise the susceptibility of results to influence from obstacles arising the real world context. In their particular study, against the background of a local authority organisation, these took shape in budget cuts and concomitant staff redundancies, a lack of clarity in where responsibility for energy management lies, and a reportedly risk-averse culture, manifested in the mistrust of new technologies. Elsewhere, energy feedback can be met with suspicion for want of confidence in the source, particularly if from business or industry (Frederiks et al., 2015) and sometimes government, as opposed to community-based or not-for profit organisations (Miller and Ford, 1985; Lutzenhiser, 1993; Rodden et al., 2013). Christina et al. (2014) hypothesises that personal attitudes are outweighed by the wider organisational structure when it comes to staff behaviour and that, often, multiple-goal conflicts within energy management impede progress of behaviour change programmes. What's more, in the workplace employees are not affected by consumption costs and often share equipment, which can embody a 'tragedy of the commons', where management is left to the energy manager who does not possess sufficient control (Bedwell et al., 2014; Goulden et al., 2015; Staddon et al., 2016).

Though it is true that household energy users have more control over consumption and a direct financial incentive to save, studies have proven that residential buildings are not free from complex contextual barriers, either. Hargreaves et al. (2010), for example, ascribes the marked variation in intervention response between different households to existing embedded social practices which prevent some households from carrying out certain actions. Even within households, users were found to be unequal as energy users, with a distinct gender divide, on the whole. Socio-demographic factors like family situation and relations, extent of local community cohesion and household size are listed among Scepanovic et al. (2017)'s influential contextual factors that can hinder the impacts of interventions.

2.4 User-centred methodology

On the whole, there is an apparent absence of human-centred methodology in the energy literature (Sovacool, 2014). Acknowledgement of the critical nature of user input during the design process of an energy behaviour change program is now becoming more common, with a growing consensus that, for optimal success, the target audience should actively contribute from the early stages of development and then recurrently throughout (e.g. Wallenborn et al., 2011; Larson et al., 2013; Christina et al., 2014) . In this way, the design is progressively refined to ensure the final output will accommodate the users' needs and wants, thereby maximising the chance of intensive and prolonged engagement (Yardley et al., 2016).

Various models and components of methodology that place users at their heart have been implemented in the design of more recent interventions. Sundramoorthy et al. (2010) employed User Driven Innovation (UDI), a user-centric product development process where users are part in the creation and refinement stages. This resulted in a user driven domestic energy monitoring system called DEHEMS which achieved 8% consumption reductions, with behaviour changes sustained at least for the duration of the four month study. User-Centred-Design, meanwhile, is adopted by Dalen et al., (2016) who references its six core principles:

1) the design is based upon an explicit understanding of users, tasks and environments,

2) users are involved throughout the process,

3) the design is driven and renewed by user-centered evaluation,

4) the process is iterative,

5) the design addresses the whole user experience and

6) the design team includes multidisciplinary skills and perspectives (ISO, 2010).

Wilson et al. (2013) also upholds the UCD approach, stressing its necessity in advance of selecting an intervention strategy, to gauge context and behavioural antecedents. They explain it generally comprises a cyclical and iterative structure. As part of their own UCD process they employed two techniques; the first, semi-structured interviews. Secondly, they facilitated semi-structured guided tours where a researcher captures the interactions between participants and their domestic artefacts in order to build an initial picture of the user and specific context. Feedback on the intervention prototype was then collected, ultimately to uncover the users' requirements from the system, for which they regarded focus groups to be the most appropriate forum. Indeed, it is concluded that the focus group interview is "ideal" for this purpose in early stages of intervention design, while user trials are recommended for refinement of the final design.

2.5 eTEACHER and concept of "one size does not fit all"

The clear recommendation for active user engagement during development stages points towards a crucial heterogeneity in the needs of different groups of building users, which precludes reliable success when blanket solutions are rolled out (e.g. Van Dam et al., 2010). Addressing all building users uniformly in spite of this fact is regarded as an oversight by Khosrowpour et al. (2016) who argues for targeted and tailored

interventions that treat each group of users according to their characteristics. This sentiment is fortified by the conclusions of many other studies which place emphasis on the importance of in depth user studies (e.g. Tang, 2010) and the crafting of personalised and context-aware interventions (Mcmakin et al., 2002; Bull et al. 2015; Lossin et al., 2016; Inyim et al., 2018).

While research into ICT based energy engagement within specific building types is abundant, there are very few works which span multiple building and user types. In this respect, eTEACHER looks to be a pioneer in its attempt to develop an app to empower a broad range of building users, across not only residential buildings, but also public office buildings, healthcare centres and schools. In the knowledge that one size does not fit all, the project must address the need to create an intervention, which adapts to a diverse array of energy users, while at the same time forming a whole, coherent, branded product. The potential for innovation here is twofold; firstly, in the development of an original, user-centred methodology to identify trends across building types relating to demographics and user roles; and secondly using subsequent insights to develop an ICT tool which will function in a wide range of contexts to instil behaviour change towards energy efficiency.

3 Workshop designs – new methodologies for user engagement

3.1 Overview of workshops

Task 1.3, as stated in the Grant Agreement, "aims to consolidate current knowledge on how ICT-based engagement activity can support energy efficient behaviour in buildings" and entails "facilitation of two workshops to develop knowledge across the project team and with selected building users. These workshops will share and draw upon key ideas identified in this WP, and identify how to apply this learning in the development of work packages 2 and 3." The specification does not extend beyond these criteria, leaving the style and configuration of the workshops to the governance of project partners. After considering various approaches to the task, NCC devised a preliminary framework to meet the stipulated conditions while maximising engagement opportunities within the limited timeframe.

Figure 1 illustrates the task framework. As specified, two distinct workshop designs were developed, *Workshop A* and *Workshop B*, respectively depicted by the diagram's outer and inner rings. Fundamentally, *Workshop A* consults building users to gather data that subsequently forms the basis for *Workshop B*, which is attended by project partners who accordingly begin to establish recommendations for design. In correspondence with these functions, and for the sake of memorability, the two workshops were from thereon dubbed *Workshop Ask* and *Workshop Bridge*.

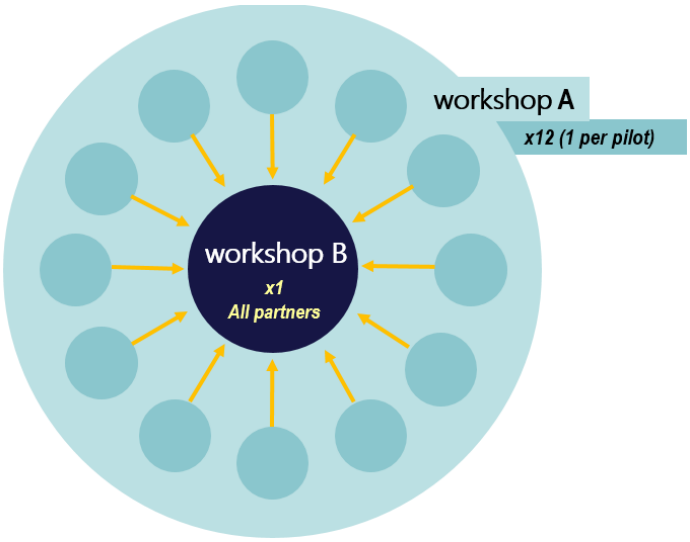


Figure 1: Task 1.3 framework

Workshop Ask asked users about their ICT practices and opinions on different kinds of eTEACHER visions. The intention was to deliver it in all 12 pilot buildings using a uniform template to generate consistently formatted results, amenable to fruitful analysis. The knowledge transfer prescribed in the grant agreement takes two forms: firstly, knowledge of ICT preferences from building users to pilot coordinators and secondly, from the project to building users as eTEACHER is introduced and the foundations of a trusting relationship are laid. The main outputs of these workshops are completed datasheets to be analysed and presented in *Workshop Bridge.*

Workshop Bridge bridges the user engagement aspect of social research with the eTEACHER product's technical design. In a single session between all project partners, it circulates Workshop A outcomes, brought together the individual findings from all 12 pilots to build a full picture and, uniting diverse expertise, extends analysis to start making intelligent conclusions for informing work packages 2 and 3.

Table 2 summarises the two workshops including the types of knowledge transfer and outputs.

	Workshop Ask	Workshop Bridge
Duration	2 hours	3 hours
Purpose	Obtain information to design effective ICT tool	Bridge knowledge to partners; consolidate findings
Facilitator	AGE, ICPE, NCC	NCC
Participants	Selected building users	All eTEACHER partners
Knowledge transfer	Inform users about project; receive user perspectives on ICT	Communication of user perspectives to consortium
Output	Data spreadsheets for analysis (to be presented in Workshop Bridge)	Design recommendations; D1.3 report

Table 2: T1.3 workshop summaries

3.2 Workshop Ask

3.2.1 Development

This section describes the processes and discussions involved in the development of *Workshop Ask.* A range of experts were consulted during the development stage to refine the workshop plans, with the intention of maximising the opportunity to communicate with building users.

3.2.1.1 General assembly

NCC proposed the workshop framework skeleton, as described above, to the eTEACHER consortium during the second general assembly meeting in Nottingham (March 2018). As part of this presentation, NCC took the opportunity to put four key questions to partners that had come up during the early development stages. Settling these uncertainties via consortium consensus was necessary prior to *Workshop Ask* planning to maximise the value of the critical engagement opportunities, ensuring the expectations of all sides were to be met. The four key questions were as follows:

1) *Should WSA be open-ended or steered?*

On the one hand, the workshops could present a broad range of ICT solutions and ask users for their own ideas. This open-ended format has the advantage of granting creative scope to users, allowing them to generate new ideas that could inspire intervention design. However, such ideas may lack technical or economic feasibility, and so it may be wiser to narrow down and focus on the limited range of options able to be developed.

2) *Should WSA be universal across all eTEACHER buildings or tailored to specific building contexts?*

User workshops could be delivered using a central template or, alternatively, could be tailored according to building and user types. The former approach is likely to accommodate consistency and easier comparison and avoid predetermining results. However, it may be that building and user types are so starkly different that it is more valuable to ask different kinds of questions from the beginning. For example, the universal route may warrant asking all users about games so that the possibility of any one type responding favourably is not excluded, even if previous research suggests otherwise. A tailored tactic might conversely ask only students about games and presume apathy on the part of adult users, which could allow more time for exploring specific technologies likely to capture their interest.

3) *What extent of information should be presented to users?*

Giving building users a full briefing on the project might inspire the most trust and enthusiasm but could possible run the risk of skewing results by raising awareness of energy behaviour before commissioning of the eTEACHER tool.

4) *What format(s) of data would be preferred from Workshop Ask by project partners?*

Gaining an understanding of the most useful form of data collection and presentation for partners in later work packages, be it statistics, summarised answers, detailed testimonials or a mixture, was important in order to ensure maximum worth for product design.

Partners were asked to form groups to discuss each point and then feed back their answers to the wider group to be recorded.

Secondly, NCC invited partners to contribute more generally to the workshop content. Given that *Workshop Ask* was to constitute the only face-to-face interaction with many everyday building users prior to product design, the sessions had to extract the specific behavioural knowledge required by technical partners to facilitate a successful outcome.

The various partner input, some of which was received in the following weeks due to time constraints and to allow time for contemplation and discussions within organisations, was compiled into a table consolidated and employed to refine the *Workshop Ask* plan. An engagement specialist within Nottingham City Council (NCC) was consulted with this updated brief, which underpinned subsequent mind-mapping towards a basic workshop skeleton.

This served as groundwork for a detailed preliminary plan which, over the course of multiple meetings with DMU attendance, went through a series of development stages. Among these was a timed trial run-through with NCC employees with various backgrounds, including communications and marketing, engagement and consultation, education, IT and energy management.

In addition, partners, particularly those with technical IT expertise, were asked if they might be able to offer assistance in running software trials as part of *Workshop Ask* or a later event to sustain user interest and interaction with the project.

3.2.2 Final *Workshop Ask* structure

In light of its importance as the sole face-to-face engagement opportunity prior to tool creation, *Workshop Ask* was designed to collect a large volume of information within a limited time-frame, yet minimise onerousness for users by means of varied, visual and interactive tasks. Although basic focus groups have the advantage of logistical simplicity and can generate insightful testimonies, weaving these conversations around practical activities enables the identification of quantitative trends for making helpful generalisations to guide design recommendations. Furthermore, the added colour, tactility and mental stimulation aimed to make the experience more memorable and form a positive association with the project in the mind of the user, boding well for future cooperation.

Each session was designed for 8-12 participants, representing user profiles deemed necessary and representative by DMU, as specified in the Grant Agreement document. Figure 2 illustrates the recommended workshop setup, with participants divided into three groups, each with a facilitator, one of whom will lead the presentation to guide the session. Participants were asked to complete a consent form and given a group number and colour which was used to track their individual responses during the workshop activities.

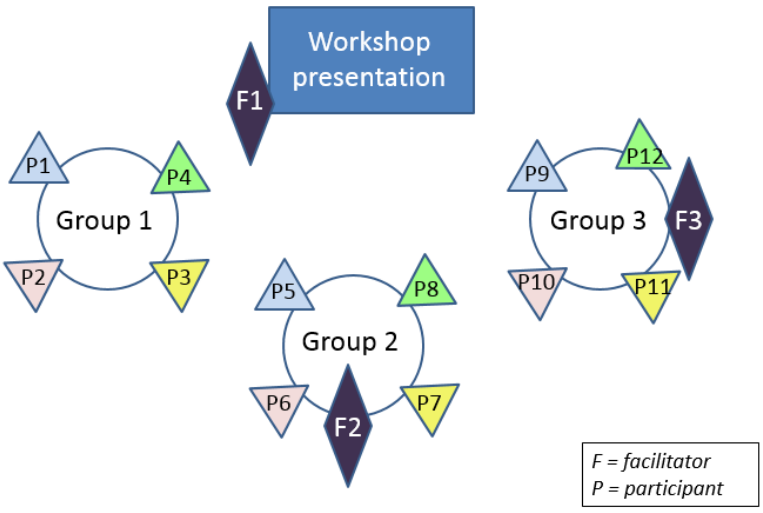


Figure 2: *Workshop Ask* set up schematic

Workshop Ask began with a welcome and thank you, followed by a session breakdown and a run-through of housekeeping information. The lead facilitator asked participants to introduce themselves and carried out an icebreaker activity, where appropriate.

3.2.2.1 Project presentation

Before asking information from building users, the project was explained to give an understanding of the context and their involvement within it. In order to avoid overwhelming or deterring participants the presentation focused only on key facts. The project presentation aimed to introduce eTEACHER, its goals and wider purpose, before talking through the workshop agenda and allowing building users to put any questions to the lead facilitator before the workshop activities began.

3.2.2.2 Activities

Workshop Ask consisted of six different activities in total, both group focused tasks and individual tasks. Table 3 gives an overview of activities in chronological order.

	Task description	Data
Activity 1	In groups users identify as many hardware devices as they can from an image sheet.	Quantitative: recognition rate Qualitative: discussion summary bullets and key quotes
Activity 2	Each user sticks on hardware devices to a group pyramid template to indicate their frequency of use.	Quantitative: hardware popularity Qualitative: discussion summary bullets and key quotes
Activity 3	Each user sticks on software devices to a group circle template to show their relative importance.	Quantitative: software popularity Qualitative: discussion summary bullets and key quotes
Activity 4	Users listen to an 'ideas' pitch (different eTEACHER potentials) and individually circle their preferences relating to each.	Quantitative: IT preferences
Activity 5	Each user rates the eTEACHER ideas using a group template.	Quantitative: idea popularity Qualitative: discussion summary bullets and key quotes
Activity 6	In groups users produce a poster, evaluating their favourite idea and creating a unique vision of eTEACHER for their building.	Qualitative: motivations, barriers, improvements and new visions of the eTEACHER experience; discussion summary bullets and key quotes

Table 3: Workshop Ask activities summary

Throughout the activities, participants received and used sticker sheets in their personal assigned colour so that answers could be traced back to their user role and demographics, allowing trends in the data to be identified during analysis. Facilitators were asked to record key bullet points and quotations during each activity to summarise the attitudes of participants and capture extra significant pieces of information, instrumental in reaching explanations of results at later stages.

Preceding each activity, a slide was presented, detailing the purpose of data collection to avoid confusion or suspicion.

For clarity and preparation for their input, participants were initially presented with simple definitions of hardware and software. In *Activity 1*'s introduction, it was made clear that the focus lies firstly on hardware. The exercise was effectively a five-minute warm up, asking participants to look at a sheet of hardware device images and, together as a group, note down the names of those recognised. This visual

and straightforward challenge gently prompted users to start to become conscious of their relationship with ICT and, meanwhile, served to acquaint the group with one another. The quantitative results give a broad impression of users' tech awareness, and how this varies according to demographics and role type. Qualitative analysis of key quotations and summarised attitudes recorded highlights the particular enthusiasm or aversions to certain hardware, insights for eTEACHER tool design recommendations.

Continuing with the subject of hardware, *Activity 2* asked users to report on their frequency of use for different IT devices using a large (A1-size) template and a sticker sheet of devices in their allotted colour. Figure 3 illustrates this process. The template is a pyramid with a vertical scale so that hardware use increases moving upwards, with a topmost label of "every working hour" and a bottom label of "less than once a year". Sticking on eight different types of hardware stickers, users provided a high level of detail in only 10 minutes, while enjoying a colourful and dynamic task, as opposed to filling in paperwork. As with the previous activity, qualitative recording of the concurrent group conversation illuminates useful information about users for design and, potentially, reasons behind numerical trends.

Figure 3: Schematic to show the configuration of Activity 3

Leading into *Activity 3,* the lead facilitator declared a shift in focus from hardware to software. In the same vein as the preceding activity, participants placed stickers from their personal sticker sheet onto a "software circle" (Figure 4) to indicate the extent to which they rely upon basic kinds of IT functions e.g. email, social media, payment, games. The more central to their daily life they regard the software, the closer to middle of the circle they stick it. Benefits of the quantitative and qualitative data collection mirrored those of *Activity 2.*

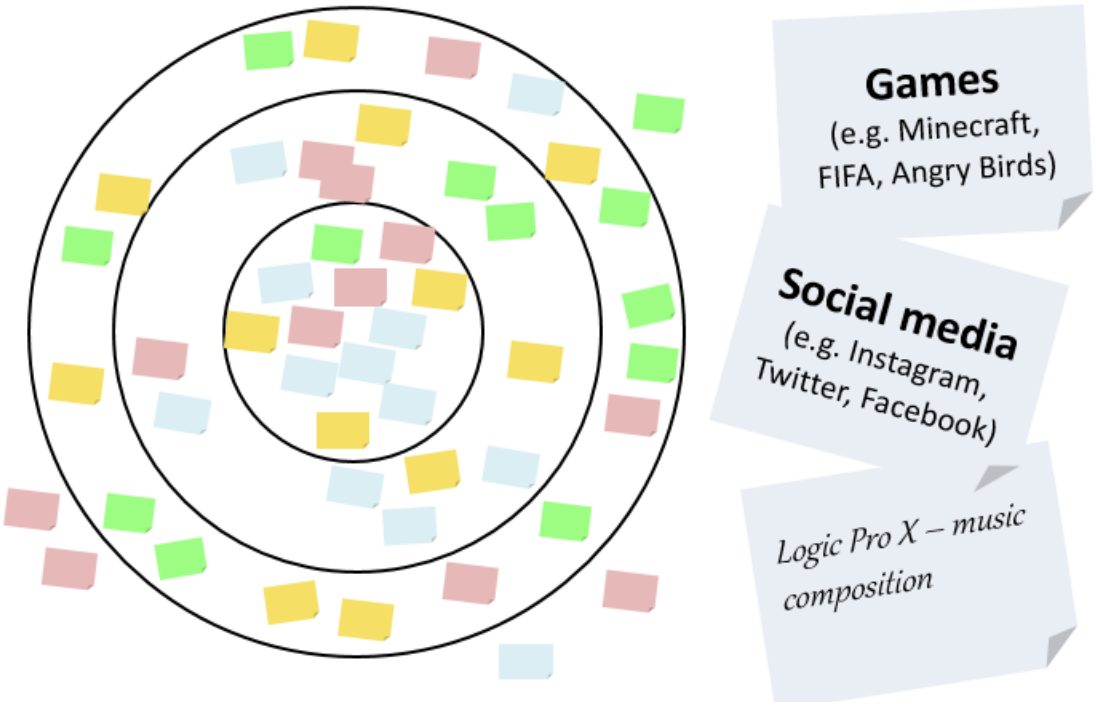


Figure 4: Schematic to show the configuration of Activity 3

Activity 4 began with an "ideas pitch" which formed the basis for all of the remaining activities (4, 5 and 6). Each idea was a potential vision or feature for the eTEACHER tool, previously discussed by the consortium (e.g. dashboard, social network, games). Building users were given handouts with multiple-choice questions relating to the eight ideas, which they answered as the lead facilitator presented each idea in a manner that encouraged participants to imagine they have downloaded each option. Much of the handout's contents was intended to raise more specific questions put forward by partners, which may have been difficult to fit in elsewhere in the workshop. Therefore, in spite of the short duration and engaging audio-visual style, the resulting quantitative data captured high volumes of detailed information about ICT preferences.

Having introduced the potential eTEACHER options, *Activity 5* asked users to evaluate these eight alternative forms by way of a third group template (Figure 5). Very simply, users were given a sheet in their colour with eight stickers labelled 1-8, each corresponding to the ideas previously presented, and instructed to place them each in one of three boxes, labelled "would definitely use", "might try" and "wouldn't use". Evidently, this quantitative data enabled a straightforward assessment of the relative popularity of the ideas, both in themselves and in relation to one another. In parallel, the qualitative records enhance the understanding of responses to the competing visions, be they forms of enthusiasm, resistance or apathy.

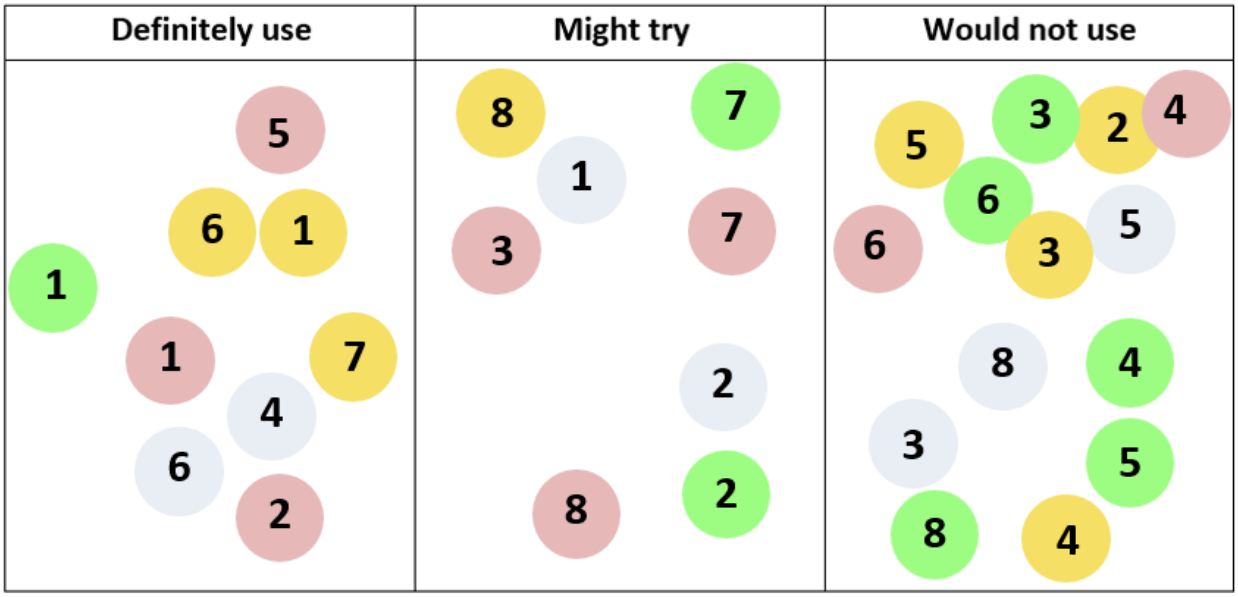


Figure 5: Schematic to show the configuration of Activity 5

Finally, centring on the same eight ideas, *Activity 6* challenged users to create a group poster using a fourth group template (Figure 6), starting by selecting their favourite idea or combination of ideas of the eight presented as a group. In adjacent boxes they proceeded to write motivations and barriers, i.e. what they would consider as incentives and deterrents towards app download, respectively. Next, users developed the basic ideas by suggesting how they would improve the ideas, with emphasis on tailoring to the specific environmental context of their building. Finally, they were asked to write the group's vision, conveying how their ideal tool would look and work, with a box available for supplementary drawings. The latter tactic added more diversity to the workshop exercises, catering to a broader range of learning and working styles. *Activity 6* bestowed some creative input to the building users, acknowledging an appreciation of their ideas and opening up the possibility of sourcing design inspiration from those for whom the tool is intended, and who of course know the pilot buildings best. All data was qualitative in this case, coming in two streams. The various poster contents constituted the first, which imparts a richer understanding of what users envisage working in their own daily environments and routines. Secondly, the recording of group discussions, as in former activities, offered additional detail to elucidate user responses.

Following the six activities, participants were given a 10-minute break before completing the questionnaire, during which time refreshments can were served (which may have been used as an incentive for attendance in the first place).

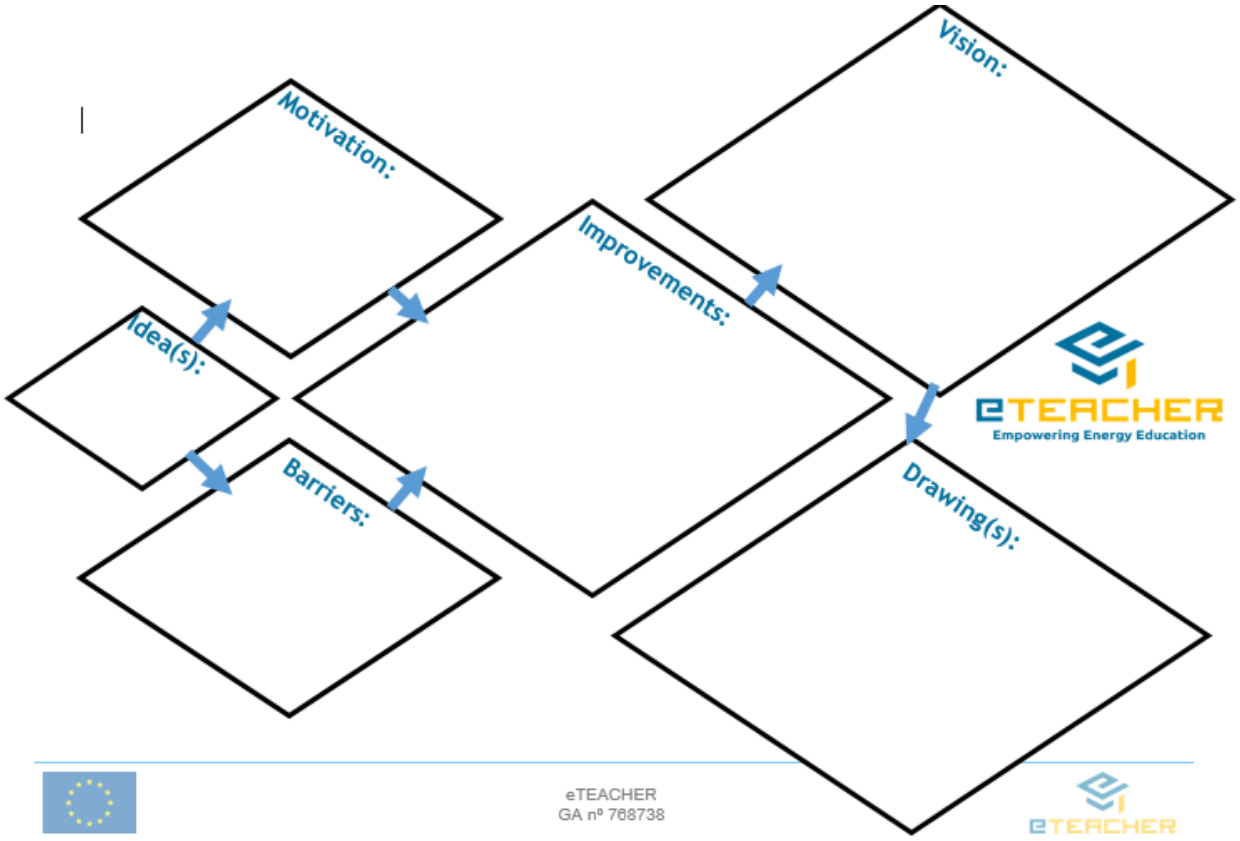


Figure 6: Activity 6 group poster template

3.2.2.3 Questionnaire

As recorded in the development log, the building questionnaire was strategically sequenced at the end of the session so that users, by the time they began, had become immersed in the relevant subject-matter and had considered their personal relations with ICT and therefore in a position to submit measured responses.

3.2.3 Training Workshop Ask

NCC delivered training sessions to AGE and ICPE, the other pilot coordinator partners, via WebEx, so they in turn were prepared to deliver *Workshop Ask* in their respective pilot buildings.

Accompanying the training slides were 'facilitator packs', comprising two set of files, the first being tools to support the partners in running the sessions and collecting the data, and the second being the workshop materials themselves including handouts, sticker sheets and templates. Table 4 lists the pack contents in full. The option of having physical copies of these sent over was offered, either copies for every facilitator or just one full pack which could then be replicated.

Table 4: Workshop Ask facilitator pack contents

Material	Point of distribution	Copies per group	Notes
Facilitator guide	Facilitator keeps	1	To aide data collection
Consent form	Pre-workshop	4 (1 per user)	Distribute weeks before workshop
Participant information sheet	Pre-workshop	4 (1 per user)	Distribute weeks before workshop
Questionnaire	Last 30 minutes	4 (1 per user)	Users complete individually
Blank sticker sheets in 4 different colours	Pre-workshop; activity 3	4 (1 per user)	Name stickers; plus blank stickers for other activities if printed not enough
Sticker Sheet 1	Activity 2	4 (1 per user)	4 different colours to match name sticker of each user
Sticker Sheet 2	Activity 3	4 (1 per user)	4 different colours ^
Sticker Sheet 3	Activity 5	4 (1 per user)	4 different colours ^
Handout 1	Activity 1	1	Group completes together
Handout 2	Activity 4	4 (1 per user)	Users complete individually
Template 1	Activity 2	1	A1 sheet: group work
Template 2	Activity 3	1	A1 sheet: group work
Template 3	Activity 5	1	A2 sheet: group work
Template 4	Activity 6	1	A3 sheet

After introductions and an outline of the set of tools above, coordinators were reminded of the workshop objectives in relation to the wider project and presented with a schematic to show the room setup (Figure 2). The training then took the coordinators through the *Workshop Ask* presentation, which forms the session's backbone. Beneath each workshop presentation slide a script was provided, which the facilitator could translate word-for-word or use merely for guidance to understand what must be relayed at each stage. Integrated among these slides were pink instruction slides which provided guidance on delivery using a mixture of plain text, yellow summary boxes specifying required data in reference to the input spreadsheets provided, diagrams and screenshots of handouts and spreadsheets.

To consolidate the various data collection instructions, following on from the workshop presentation slides, the coordinator's attention was drawn to the output overview table prepared by NCC, which detailed what data was to be obtained from each activity and how it should be inputted ready for analysis. Notes about

extra observations that could be reported on in *Workshop Bridge* were also mentioned at this point. As the coordinators were expected to give a brief talk about their workshops as part of Workshop Bridge, including atmosphere, reception and challenges, in advance of NCC's overview of collated results, emphasis was placed on recording this information.

Data was divided into core and secondary branches and deadlines for submission were stated; the former being more immediate, given its centrality to the *Workshop Bridge* objectives. A broader timeline with inclusion of dates was shown and, finally, further support was offered with suggested options including step-by-step instructions, a mock run-through and follow up meetings for further questions.

A key document within the 'facilitator pack' is the 'facilitator guide', to be used by facilitators through *Workshop Ask* so they understand what to do and hand out at each side. It was presented in a checklist format so tasks could be ticked off for optimal ease and clarity. Facilitators were advised to read through this document before their first session to familiarise themselves with the tasks and to make any necessary preparations. The guide explains that each facilitator is responsible for collecting data from their group which will have a maximum of four participants. It presents a detailed table of materials in the pack, including the point of distribution, copies per group and helpful notes. A table for writing the name, role and sticker colour of each participant is laid out, encouraging the neat documentation of this essential information. For each activity, step-by-step instructions were provided with check boxes to aid the completion of quantitative data collection, followed by a table for qualitative summaries of group conversations. In support of the latter process, three relevant 'prompt questions' were provided, which could be used by the facilitator to stimulate conversation if the group is quiet and also gain in-depth insight if the discussion runs off topic. Lastly, the guide sets out a table (Table 5) listing what data needs to have been collected from the session and what the next step is, imparting an understanding of the data's purpose and destination.

Table 5: Workshop Ask material selection (extract from facilitator guide document)

Data	Next step
This document + extra paper with qualitative notes written	English translation → excel sheets
4 questionnaire answer sheets (1 x 4 users)	Write English translation under text answers → scan answer sheets
5 handouts (1 x HO1; 4 x HO2)	Use to complete excel sheets
4 template photographs (1 x T1; 1 x T2; 1 x T3)	Send and use to complete excel sheets
1 poster (T4)	English translation → excel sheets

3.3 Workshop Bridge

3.3.1 Preparation and development

In light of *Workshop Bridge's* function, to translate the social research concerning ICT engagement for the benefit of the technical design stages, its formulation found its base in the data output from *Workshop Ask.*

An important piece of groundwork on the part of pilot coordinators was producing a brief presentation on their *Workshop Ask* sessions to fit in near the beginning of *Workshop Bridge,* for the purpose of contextualising the data prior to the exploration of the collated results. Coordinators used a PowerPoint template created by NCC, consisting of four slides: the title page, background, atmosphere and, finally, challenges.

NCC was responsible for synthesising the Workshop Ask data to identify enlightening trends and offer some preliminary interpretations for design recommendations. These preparatory exercises were facilitated by the consistent spreadsheet format submitted across all pilots, owing to the uniform excel book template issued by NCC prior to the engagement sessions.

However, the ambition behind *Workshop Bridge* was not confined to the communication of collated data findings, but transcended to making collective conclusions to inform the next project stages. In the wake of a discussion garnering such a diverse pool of expertise, it was hoped that the ensuing recommendations were both technically feasible and truly reflective of user preferences.

Rendering some structure to this discussion, with the support of DMU, NCC identified five key challenges, which needed to be addressed by the consortium. As a visual means of communicating these and conceptualising the process, NCC and DMU developed a bridge building activity. The goal of the session was to connect the left and right blocks, the former representing WP1 and the latter WP2 and WP3. Each key challenge was symbolised by a pillar or 'building block' between the sides. Contributing answers to a key question within subgroups formed a link across to the succeeding block so the consortium could move on to the next challenge, culminating in the formation of a complete bridge between WP1 and WP2 & WP3. In this way, a degree of tangibility was introduced to the progress of discussion, while its place within the broader context of the project is continually accentuated.

3.3.2 Final workshop

Workshop Bridge was held as part of the third general assembly meeting hosted by ICPE in Bucharest in July 2018. It was broken into two sessions, either side of a comfort break. As introduced to the consortium, Session 1 was primarily for establishing 'bridge building blocks', as alluded to above, which were then put to use in Session 2, entitled 'bridge construction'.

3.3.2.1 Session 1 – bridge building blocks

Session 1 began with an overview of the agenda and a reminder of Task 1.3 for context; its requirements, its place and significance in the wider project and NCC's approach to implementation (Figure 1). It was followed by giving an overview of the *Workshop Ask* template and explained how the outcomes fit into *Workshop Bridge.* Part of this was showing the bridge diagram serving as Session 2's skeleton, so that partners understood what the session was working towards.

The session moved on to the *Workshop Ask* summaries lead by the three pilot coordinators, in turn. Data alone can only give a limited account of user engagement and, bearing in mind that it was these partners who ran and experienced the sessions, their reports at this stage were of considerable value. Section 3.3.1 mentions there were four slides presented by each coordinator, under the direction of NCC's template. Expanding on this, the title slide introduced the buildings with some photographs from the sessions and the background slide displayed a table detailing the number of workshops, group size, user roles present, demographics and any other relevant information. Thirdly, partners described the atmosphere, in terms of their perception of user feelings and attitudes towards the workshops, their level of interest and any comparisons between different kinds of users' reception, if disparities were obvious. Fourth and finally was a slide commenting on challenges faced, be they grounded in stakeholder resistance or logistics. Discussing and comparing the various pitfalls and any resolutions is likely to alert and prepare partners for difficulty and thereby strengthen future engagement efforts across the board.

Having built an appreciation of the user engagement sessions run across the 12 pilots, *Workshop Bridge* reached an opportune stage to present an overview of collated results. This was done in a chronological fashion, summarising the data that pertained to each of the six of activities in turn. For clarity, each of the six components began with a recapitulation of the activity in question, with reference to expository diagrams and screenshots.

Depending on the nature of the data and how it may be of maximum value , the format of presentation ranged between single figures, tables, bar charts, stacked bar charts, column charts and pie charts. Such variation also visually enhanced the session slides to encourage sustained interest.

There was a focus on quantitative data through the first five activities, but Activity 6, the poster exercise, yielded only qualitative results. Accordingly, its presentation took the form of four digest boxes, one for each section of the poster (motivations, barriers, improvements and vision), with concise bullets reflecting the ideas and opinions expressed across the various sessions, referencing the specific pilot building source. The intention here was to offer a succinct yet insightful impression of user response in each of the four key areas, highlighting how they align or conflict between different buildings.

Although it formed part of *Workshop Ask's* data collection, the questionnaire results were not explored in *Workshop Bridge,* for two main reasons. Firstly, this element belonged to DMU and extended beyond ICT engagement, to the more general relationship between the building and its users. Secondly, due to its comprehensiveness and the workshop's time limit, it would have been difficult to visit results in any meaningful way.

3.3.2.2 Session 2 – bridge construction

Session 2 opened with the initial, incomplete bridge diagram (Figure 7). It was reiterated that, from the data reviewed in the first session spanning all 12 pilots, five key points have been identified, which must be addressed. Key Challenge 1 (KC1), it was explained, was fairly clear cut and. Therefore, the first recommendation had been predetermined, subject to consortium confirmation, in order to lend an example. Correspondingly, *pillar 1* is labelled with its key challenge, signifying the starting point of the session. The first link, that between the left-hand 'land', representing WP1, and *pillar 1,* is shaded in to signify completion. This link symbolises *Workshop Ask* sessions and was labelled as such.

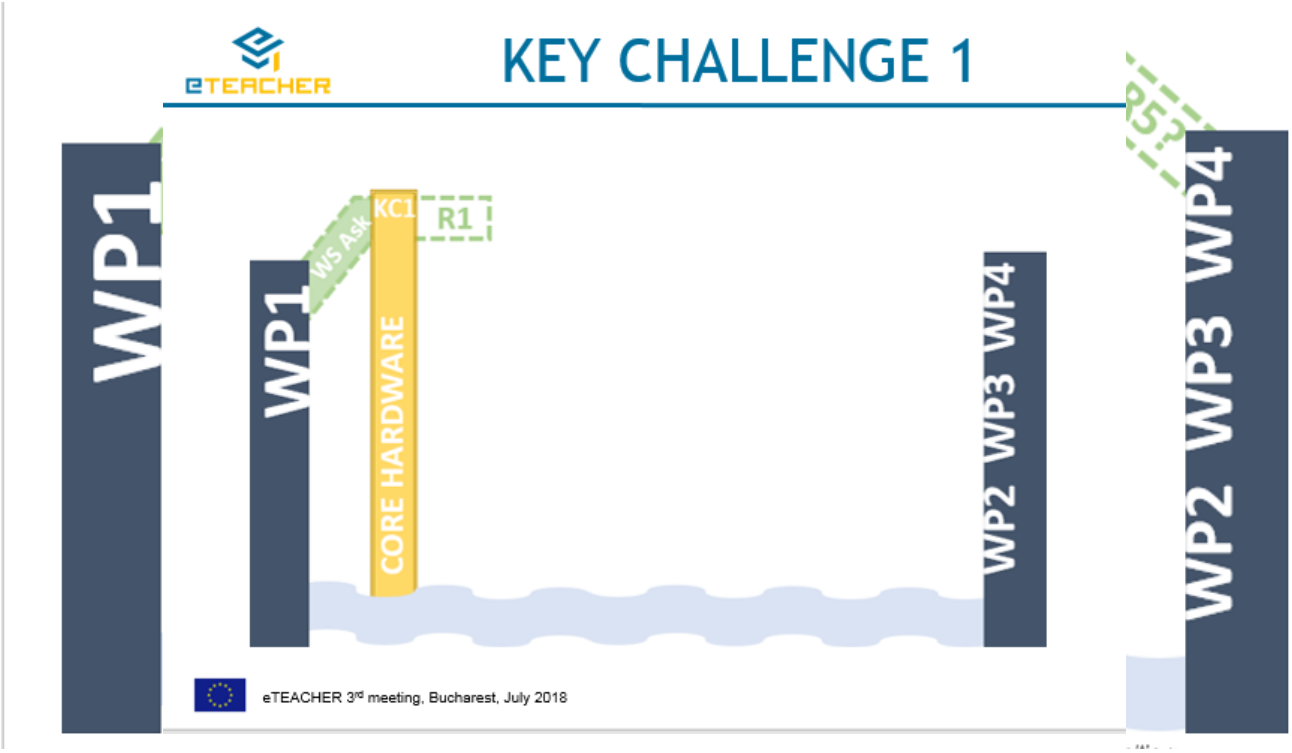


Figure 7: *Workshop Bridge* - initial bridge to introduce KC1

To add further clarity, the intended outcomes of the sessions were set out in a table. In it, each key challenge was listed, and question marks were written next to the last four to indicate that recommendations are yet to be made. Partners were informed that the workshop's aim was to complete this table with five agreed key recommendations for eTEACHER design and to advance successful long-term user engagements, therefore bridging WP1 and WPs 2, 3 and 4. Each key challenge was briefly mentioned, noting that the first two were hardware-related while the final three centred on software.

Before initiating the discussions, three subgroup lists with equal numbers of members, predetermined to ensure a mix of backgrounds in each, were shown and partners were asked to convene accordingly. Breaking down into smaller groups encouraged more universal participation, conferring time for more voices and increased confidence, in the case of some members.

In line with the reasoning above, *Key Challenge 1* was introduced with relevant analysis of both quantitative and qualitative origin was displayed. These collective findings constituted the justification behind *Recommendation 1,* which was subsequently put to the consortium for their approval.

It was hoped that the audience would now be familiar with how the discussion would function in order to reach recommendations.

When agreement was reached, the updated bridge diagram was shown whereby the 2nd link, representing Recommendation 1, was shaded in and the second pillar, representing *Key Challenge 2* was revealed (Figure 8). As the deliberation continued, this pattern was repeated so that a link and new pillar appeared once the previous key challenge has been addressed. These updated bridge diagrams were interspersed through the Session 2 slides as a visual marker of progress.

A parallel image was also assembled on a whiteboard using coloured paper, post-it notes and magnets.

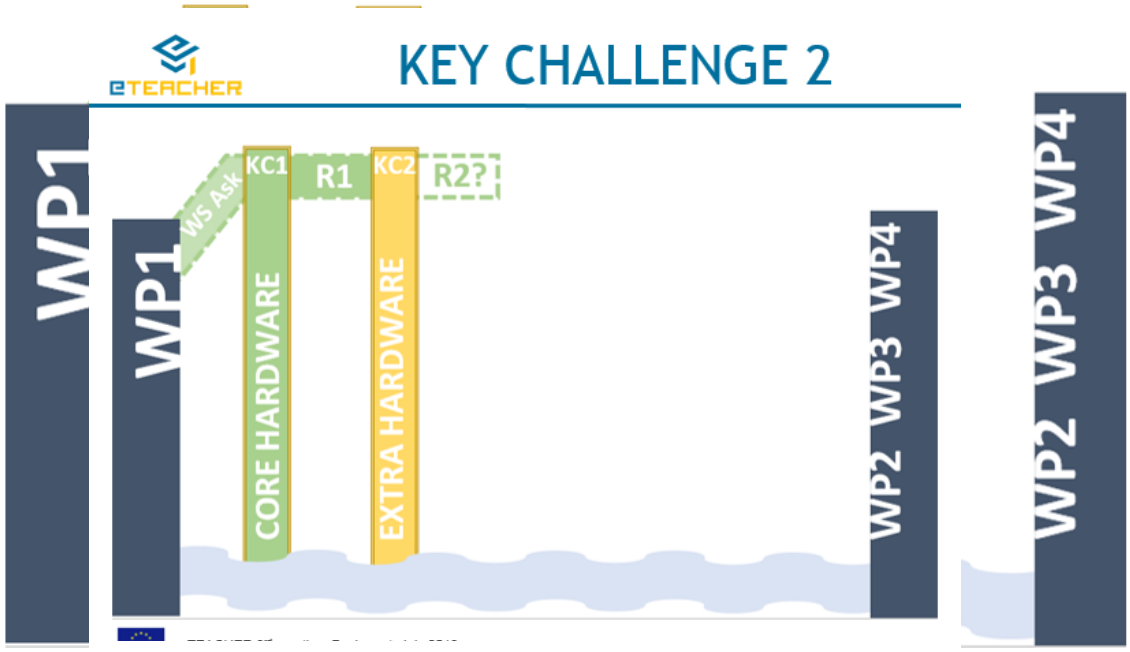


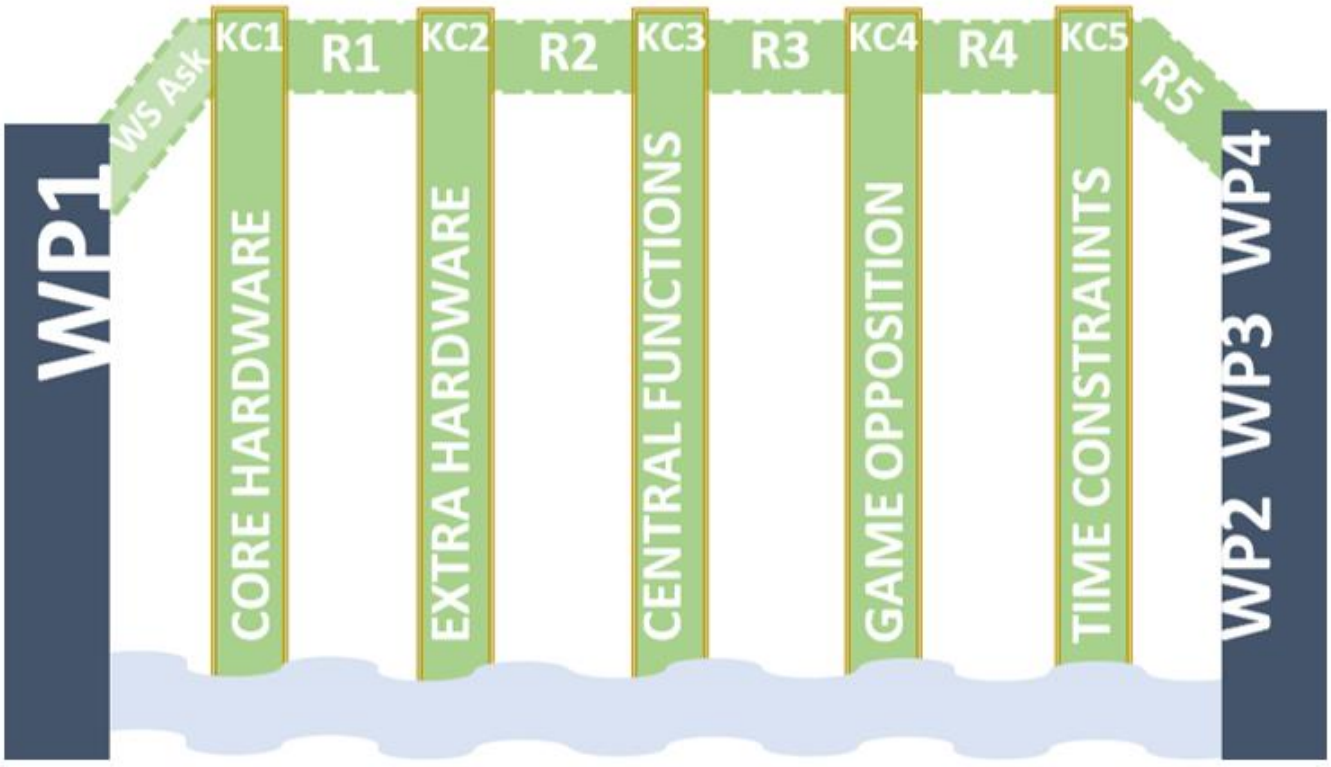
Figure 8: Figure 7: *Workshop Bridge* slide - updated diagram to introduce KC2

For each of the remaining key challenges, the discussion proceeded as follows:

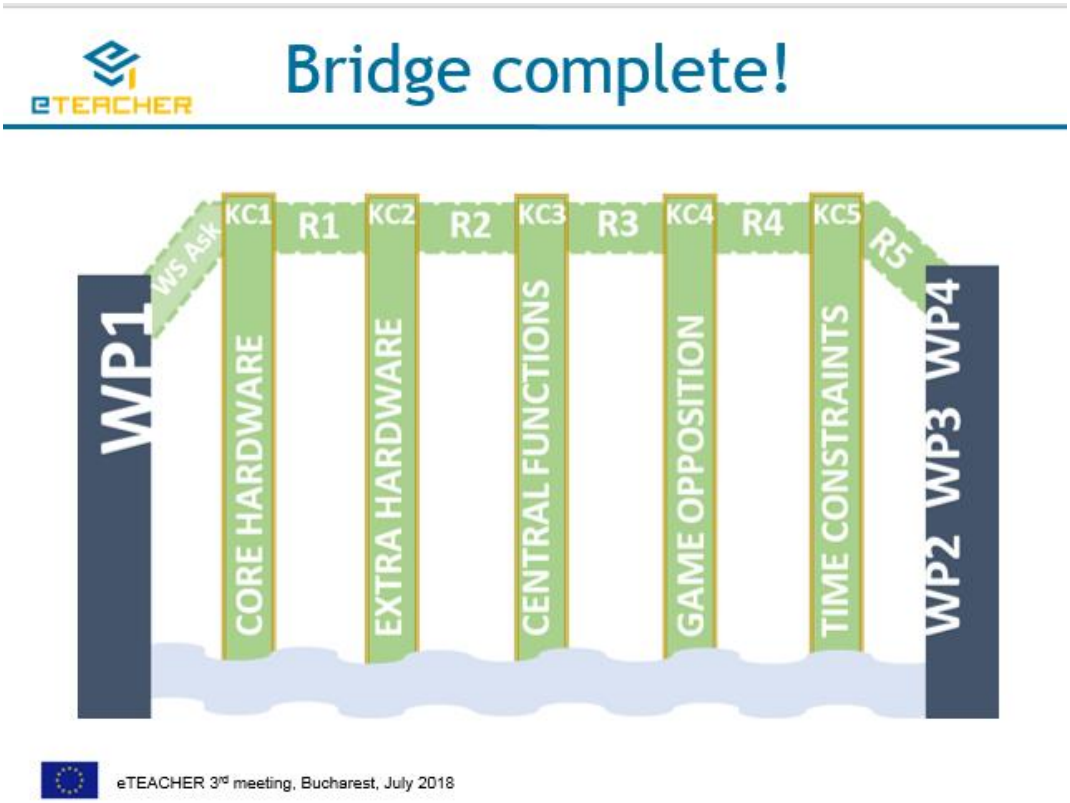
- Alongside an updated bridge diagram, the question was stated and explained.
- Assembled evidence of relevance to the topic, both quantitative and qualitative, from various *Workshop Ask* activities, was examined.
- A multiple choice was offered to partners as a starting point, invariably including an 'other' option to invite alternative interpretations or approaches.
- Subgroup discussions took place for 5-10 minutes, culminating in post-it notes with their answer(s) (lettered according to the multiple choice options) with a brief explanation beneath.
- Feed back to entire group if time.

After all five challenges had been discussed, a completed bridge diagram was shown to indicate completion (Figure 9). Partners were informed that their input was to be consolidated into a list of informed recommendations, which would be disseminated, allowing additional feedback before finalisation.

Figure 9: *Workshop Bridge slide* - completed bridge diagram to close session



Lastly, before closing, partners' attention was drawn to 'bridge maintenance'. Extending the analogy, it was



explained that, while the bridge was now built, there is plenty of opportunity to strengthen it and that it must be maintained. By this, it was meant that literature contends that building users must be continually consulted throughout the whole process for a successful and high uptake. What's more, returning to the users not only hones in on gaps in the knowledge which technical partners feel is important to know, but also keeps users engaged and sustains interest. Linking to the former point, partners were asked if they feel any important information is missing from users.

Importantly, the post-it notes answers from the physical whiteboard image were filed away ready to be analysed and summarised to settle on recommendations.

3.3.3 Final recommendations (methodology)

Using the post-it note input, partner feedback was assembled and summarised into a table and subsequently distributed to partners, inviting feedback.

As a means of reconciling any conflicts between partners, the MoSCoW method, as used in D1.2, was adopted in writing up the final recommendations. These recommendations are laid out in the upcoming results section.

4 Users preferences and design recommendations – workshop results

4.1 Overview

T1.3 results have six main strands (S1-6):

1) Partner feedback to proposed T1.3 framework and resulting development
2) *Workshop Ask:* user reception (as observed and recorded by pilot coordinators)
3) *Workshop Ask:* user activities
4) *Workshop Ask:* key challenges
5) *Workshop Bridge:* partner interpretations and feedback
6) Final recommendations

Questionnaire results are not discussed in this report given that they do not fall under T1.3. Refer to D1.2 report for this analysis (Morton, Reeves and Bull, 2018).

4.2 Overview Framework development (S1)

4.2.1 Partner feedback

During the second general assembly meeting in Nottingham (March 2018) project partners gave feedback to shape the development of NCC's proposed framework for approaching T1.3.

The partners' answers to the four key questions asked by NCC are summarised in Table 6.

Table 6: Summary of consortium's feedback on T1.3 in general assembly meeting

Key question	Answer(s) / notes
Q1: Open-ended or steered?	1) Steered 2) Both, specific answers for certain questions 3) Steered loosely, with open ended questions 4) Open ended
Q2: Universal or tailored?	1) Mixture, universal, then into tailored for buildings / users 2) Mixture, universal, then into tailored for buildings / users 3) Universal because eTEACHER is universal 4) Tailored
Q3: Extent of information presented to users?	1) Transparent 2) Transparent 3) Transparent, but not too much information 4) Adapted to different users
Q4: Data format(s) from workshop A?	1) Summary by building types 2) Qualitative and quantitative 3) Qualitative and quantitative 4) Statistics, and testimonies

Besides each question, four answers are listed. These correspond to the four subgroups which the wider consortium divided into to work through the task. Opinion was divided over Q1 (open-ended or steered) as group 1 answer 'steered', group 4 answer 'open-ended', while groups 2 and 3 suggest a mixture would be best. Similarly, a range of views were expressed in response to Q2 (universal or tailored) with group 3 answering 'universal', group 4 'tailored', and the remaining groups opting for a mixture. More of a consensus was reached after discussing Q3 (extent of information presented to users) as the first three groups expressed the importance of complete transparency is important, while group 4 recommend adapting information appropriate to the user type, for maximum appeal. Finally, Q4 was also met with more homogenous opinion; groups 3-4 ask for a mixture of formats, both qualitative and quantitative, while group 1 specifically called for a summary according to building type.

Partners were asked to give general feedback on the concepts of Workshop Ask and Workshop Bridge, particularly what they believe ought to be included, this feedback can be found in the table included in Appendix 1. Input ranged from broad ideas and suggestions on style and content, to specific questions to be put to building users, both related to applicable ICT-use and otherwise. Examples of less directly relevant questions included what media systems users have in their cars, what kind of jobs they think should always be handled by people over computers and how their bills are sent to them. Table 7 sets out the response of technical partners to requests for assistance in running software trials, either at the end of *Workshop Ask* to add a more hands-on element, or at a later event to sustain user interest in eTEACHER.

Table 7: Response of technical partners to idea of software trial

Partner	Comments: software support
ACX	Might be able to provide website with sample GUI. (although eT GUI developed in WP3 with only minor ACX input).
ASC	Won't be able to prepare any software prototype for the gamification component but we have those mockups, to give a first idea
GRA	We can provide our software so users can try out to make it more interactive. Could be that we have a list per pilot who the users are per pilot so we know better which tool is more suitable for them?

4.2.2 Influence on task plans

Taking into consideration the obvious discrepancies with regards to the first two questions in Table 6, compromises must be found on this matter in the development of *Workshop Ask.* For Q1, this takes the form of creating largely steered data collection so that specific questions deemed important by the literature and consortium, including many extractions from the feedback given from partners (Appendix 1), are addressed. However, the call for open-endedness was honoured by encouraging users to expand upon their answers, by means of blank stickers to write on alternative answers, 'other' options, and prompt questions feeding into the qualitative data collection. Furthermore, Activity 6, while steered to the extent that the poster has guidance boxes, is a direct invitation to users to generate their own ideas and create a unique vision.

Regarding Q2, while group answers varied, the majority called for some form of universal template, so a core *Workshop Ask* design was decided on. This enabled consistent data collection for comparable results, with the possibility for adaption to user groups in certain aspects such as icebreaker activities and timings. Q3 is more straightforward; building users are presented with the full basic facts of the project, although, as suggested by group 3, are not overwhelmed by excess information. Finally, Q4 responses indicate a demand for mixed data presentation, which aligns with the combination of quantitative and qualitative data comprising the solutions agreed upon to address previous questions.

Moreover, as much material from Appendix 1 is built into *Workshop Ask* as possible, prioritising those questions which directly concern ICT, given the particular scope of T1.3, and which have clear relevance to product design. Those questions with high specificity are difficult to fit into the group activities, but some are be included within Activity 4 which asks individuals about their preferences, and others can be expressed via the prompt questions listed on the 'facilitator guide' documents. Others still, particularly those unrelated to ICT, are built into DMU's questionnaire so the information is still obtained but is not analysed and fed into the conclusions of T1.3. Although there was the initial idea to include software trials in the workshop, ultimately, it was realised that to include software testing while also collecting the desired depth of information from users was unfeasible. Therefore, it is decided that that a software trial can be run as a follow-up activity, mentioned at the end of *Workshop Ask* to perpetuate participant interest and investment in the project.

4.3 Workshop Ask results

Results from *Workshop Ask* are divided into three sections. Aptly, the first is the set of qualitative observations made first-hand by the coordinators running the sessions, detailing the background, atmosphere and challenges of engagement, and thus acting as an insightful introduction to later results.

Forming the bulk of analysis, the second section is dedicated to data from the workshop activities, which are largely quantitative but with important qualitative supplementation. Following on directly, the final section comprises five key challenges identified from this analysis of activity results.

4.3.1 Session reception and feedback (S2) Overview

4.3.1.1 Background

Table 8 amalgamates the background tables produced by pilot coordinators to encapsulate the *Workshop Ask* sessions run in their buildings. While NCC and AGE ran workshops in the attended group sizes, ICPE hosted two workshops in a single day for all four of their pilot buildings, totalling 39 participants. AGE had to run one pilot session as a conference, giving the presentation and distributing some questionnaires but not collecting any other data, and had to postpone the workshop until after summer. In all workshops, a diverse assembly of user types was evident, as had been hoped. There was however only one student was present at the AGE Spanish secondary school pilot session. Indeed, AGE claim their age range is mostly 40-69, while ICPE's is 18-60 and NCC's 11-60. Sessions were all held in respective native languages. Both AGE

and NCC report that school students are forbidden from using smartphones, a vital finding for the eTEACHER project.

Table 8: Summary of *Workshop Ask* sessions by country

Detail	AGE pilots (Spain)	ICPE pilots (Romania)	NCC pilots (UK)
Number of workshops	4 workshops 1 conference	1	3 (x 1 Council House, x 2 Djanogly City Academy)
Group size	8-12 per workshop (total 36+12)	39	10-12 per workshop (total 32)
User roles present	Building Manager; facility Manager; staff; cleaning crew; Students (only for State Secondary School "Torrente Ballester", Miajadas)	Facility Manager; technical team; owners/tenants; visitors	Council House: admin staff, cleaning staff, Councillor Djanogly: teachers, other staff (admin, cleaning, kitchen), pupils
Demographics	Age range: Most of them -> 40-69 Language spoken: Spanish (only a few of the attendees speak English)	Age range: Most of them -> 18-60 Language spoken: Romanian	Age range: 11-60+ Language spoken: English
Other information	Some hardware and software have a limited use in some buildings. E.g. Smartphone is forbidden for students at school. Social media APPs and similar are forbidden in Administrative and HCCs for staff	All participants were very involved and enthusiastic to participate in activities, especially the group templates. All completed questionnaire but some complained.	No technology bans at Council House but tight time constraints Students may not use smartphones during school hours.

4.3.1.2 Atmosphere

AGE noted that the sessions were highly appreciated by training centre users but others were disinclined to commit their time. However, they report interest and excitement towards the project aims from all attendees and an acknowledgement of the importance of saving energy, in addition to money. In terms of session comparisons, they observe some common feelings and ideas between user roles across buildings, but contend that corresponding attitudes are more significant between building types.

Among ICPE's Romanian residents there was a high level of involvement and enthusiasm towards all of the workshop activities, particularly using the group templates. Although some expressed reluctance when

faced with the questionnaire, owing to its length, all participants completed it. ICPE report a high level of interest from building users and that users asked many questions concerning the project objectives. No obvious differences among users according to role or building type were discerned.

NCC relay a general absence of knowledge and experience of the project or anything of its kind among users at the beginning of the sessions, and concomitantly a high number of questions. On the whole, users engaged positively, offering their full attention, willingly giving opinions and generating innovative ideas. The Council House staff expressed more enthusiasm after investment in the building was mentioned. An openness to trying out new solutions was evident, although staff across both pilots emphasised concern over time constraints. Djanogly pupils showed conscientious attitudes and seemed excited by the prospect of new installations and being a part of the creative process. While staff from both buildings shared similar priorities and concerns, students perhaps demonstrated a greater interest in energy as opposed to money and comfort factors.

4.3.1.3 Challenges

Table 9 sets out the engagement challenges reported by the three pilot coordinators.

Table 9: *Workshop Ask* engagement challenges by country

Pilot	Data collection challenges/lessons	
	Stakeholder resistance	Logistical
AGE	Adapting training to each kind of building; online training suggested as some building users not comfortable with face-to-face meetings (mainly residential and healthcare centres)	Pilots geographically far apart so planning and running workshops involve a lot of travelling.
	BM and FM have high expectations of eTEACHER software with a preconceived idea of its functions.	
ICPE	Difficult to get required numbers to volunteer time	Large amount of data processing – time-consuming
	Recommend starting project promotions earlier, with more emphasis on the importance of their feedback and its significance on their daily lives	
NCC	Perceived futility of staff involvement (energy problems seen as result of building fabric not energy behaviour)	Student exams
		Conflicting staff schedules
		Only specific day in school (Friday); other events organised

4.3.2 Activities (S3)

Pilot coordinators' raw data from the *Workshop Ask* activities was submitted to NCC using the template excel book NCC had provided as part of the training package. Trends across all building types were

identified to give an overall impression of user attitudes, in the knowledge that the eTEACHER tool must cater for all kinds of building users. However, the nature of data collection, where answers were tracked using distinct coloured stickers, means results can also be broken down to show user role patterns, in addition to variance according to building type.

4.3.2.1 Activity 1: hardware recognition Overview

Across all groups in every pilot, the average recognition rate was 88%, showing there is a high level of awareness of modern technologies among users. Table 10 gives a breakdown according to building type. Schools have the highest average recognition at 93.1% while residences have the lowest at 79.5%.

Table 10: Hardware recognition results

Offices	**86.5%**
Schools	**93.1%**
Healthcare centres	**86%**
Residences	**79.5%**

4.3.2.2 Activity 2: hardware use Overview

Hardware used "every waking hour" by all users engaged in all pilot workshops is shown in Figure 10. Evidently, smartphones are used by far the most frequently, with over half of users interacting with them every waking hour. Correspondingly, an OAR employee commented, *"I don't think I know anyone without a smartphone".* One Council House employee admitted feeling cut off without a phone and another deemed it their most important possession, describing as their *"life-line"* and the *"gateway to [their] whole life"*. What's more, the smartphone was noted as the only hardware allowed for private use in the Spanish healthcare centres and the only technology Council House cleaners have access to during the working day.

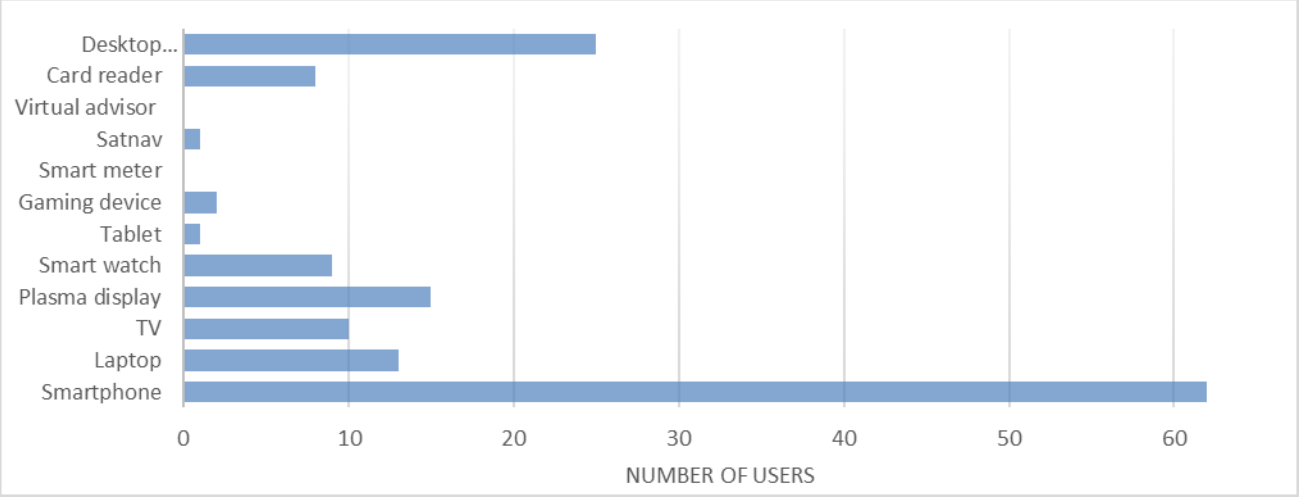


Figure 10: Hardware devices used "every waking hour" - collation of all pilot results

However, as mentioned in *section 4.3.1.1,* smartphones are not permitted for use by students during the day in the Spanish and UK schools, with the exception of break times in the former. A breakdown of

smartphone usage by user role type can be seen in Figure 11. Somewhat predictably, students are by far the largest group who use smartphones a few times a week or less. The graph also highlights that nearly 30% of cleaning and kitchen staff and 10% of FM or energy managers across the various pilots have access a few times a month or less.

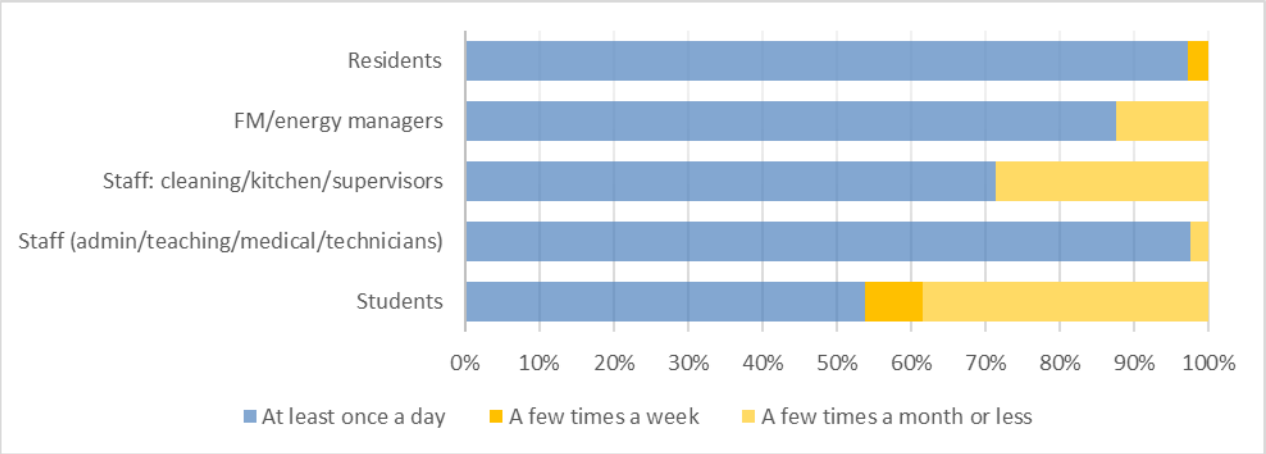


Figure 11: Smartphone usage by building user role

Figure 12 shows that when devices used “every day” are also taken into consideration, PCs are more widely used. Many users also interact with TVs, plasmas and card readers at least once a day, exceeding 60, 35 and 25 users, respectively. In Djanogly’s student workshop, one group agreed that the most used technology in schools are plasma displays in the corridors as these are used to give important news and information and can be easily seen between classes and during breaks.

Meanwhile, the smart watch, gaming device, smart meter, satnav and virtual advisor see relatively little use across the pilots, with only 12 users interacting with a smartwatch once a day or more and 5 or less using the remaining devices at this frequency.

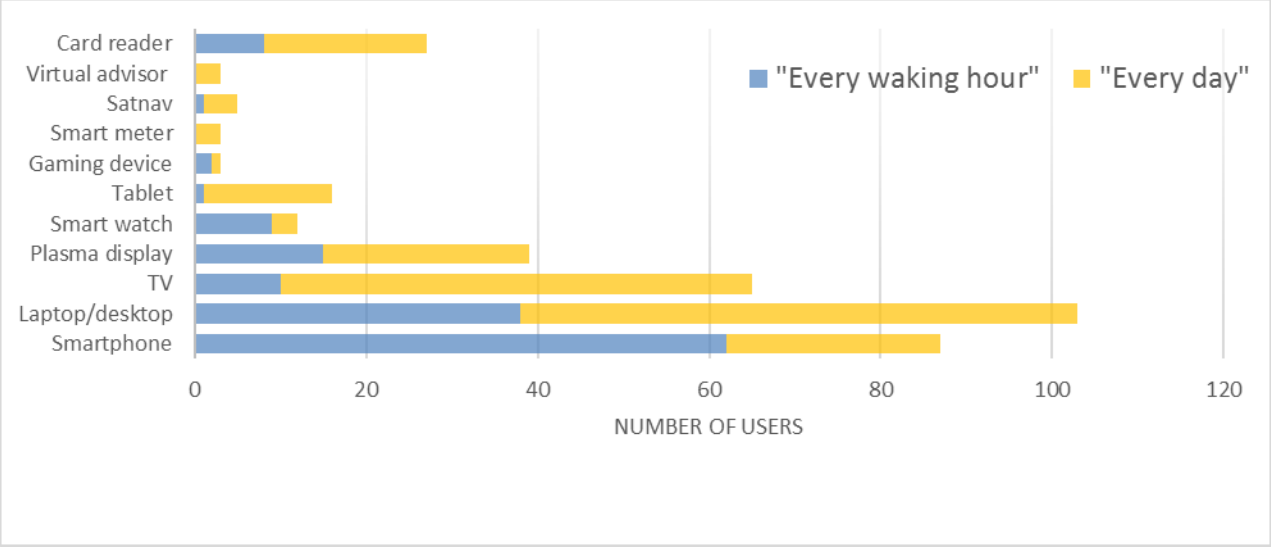


Figure 12: Hardware devices used "every day" and "every waking hour

4.3.2.3 Activity 3: software use

A comparison of the number of software users' ranked as used most often is presented in Figure 13. Email and office documents (e.g. Word, Excel, Keynote) are used frequently by most users (both 45 or more). Payment, social media and news and weather also rank relatively highly, all being selected by 29 users. The perceived omnipresence of social media was raised in multiple sessions; Arco Iris (Spanish nursery) staff commented that the smartphone is used more for social networks and messaging than for making calls and in a similar discussion, a Djanogly (UK school) staff member shared, *"even my Grandma's on Facebook!"*

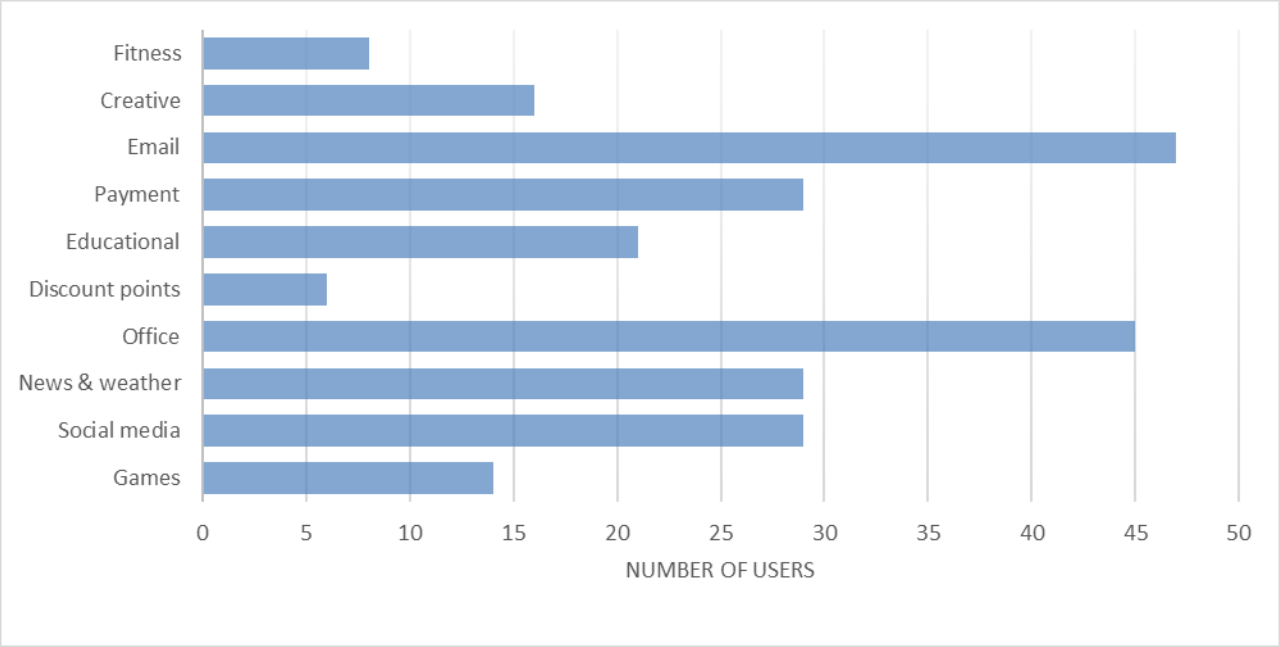


Figure 13: Software used "often" by building users

Educational software, used "often" by 21 users, was a topic of particular interest among Djanogly staff and pupils. It was explained by a teacher that the school was the top user of the 'GCSE pod' in the UK, having listened to more than 25,000 revision clips, none of which took place in class. The school also employs a software called Forum where students contribute to news which appears on communal display screens. Students emphasised the importance of educational software for homework; one, for example, insisted they would be *"lost without BBC Bitesize".*

At the other end of the scale are discount points, games and fitness, selected by 14 users or less. Across the pilots, many users expressed their aversion to games. Evidently this included domestic residents, with one user from the Romanian InCity block branding games a *"waste of time"*. In parallel, a Council House employee explained they *"never go near the games [because they] take up too much time".* In Djanogly school in the UK both students and staff cared to mention previous attempts to introduce games in an educational context to not much avail, including a Nintendo Wii in PE lessons and a classroom Playstation.

4.3.2.4 Activity 4: tool preferences Overview

In agreement with *Activity 2* results, Figures 14 and 15 indicate the smartphone is the most popular device on which to respectively receive an energy alarm and energy advice. The popularity of email is also reiterated on Figure 14, as is that of the PC and laptop on Figure 15. Energy advice on plasma screens also appeals to a considerable number of users. On both counts, smart watches are an unpopular option, as is the home TV for advice.

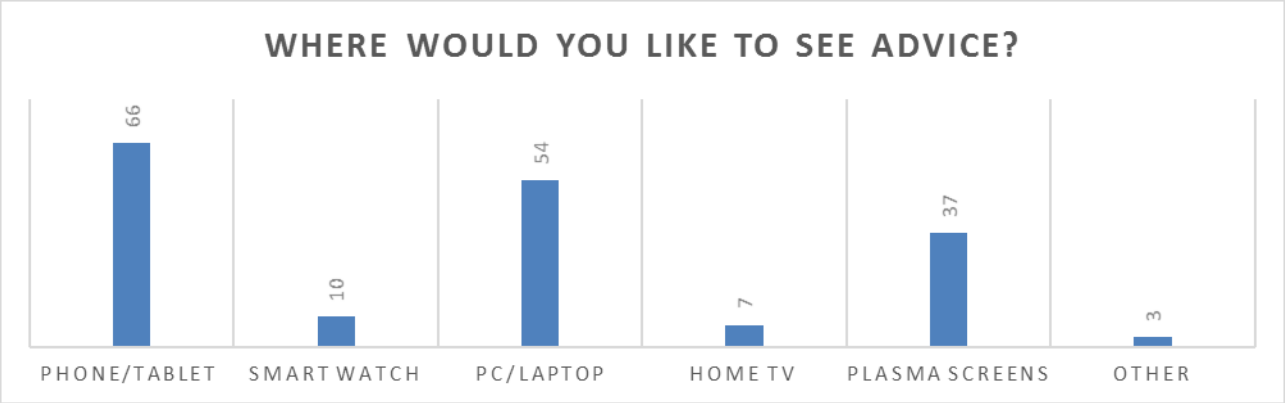


Figure 16: User preferences - advisor

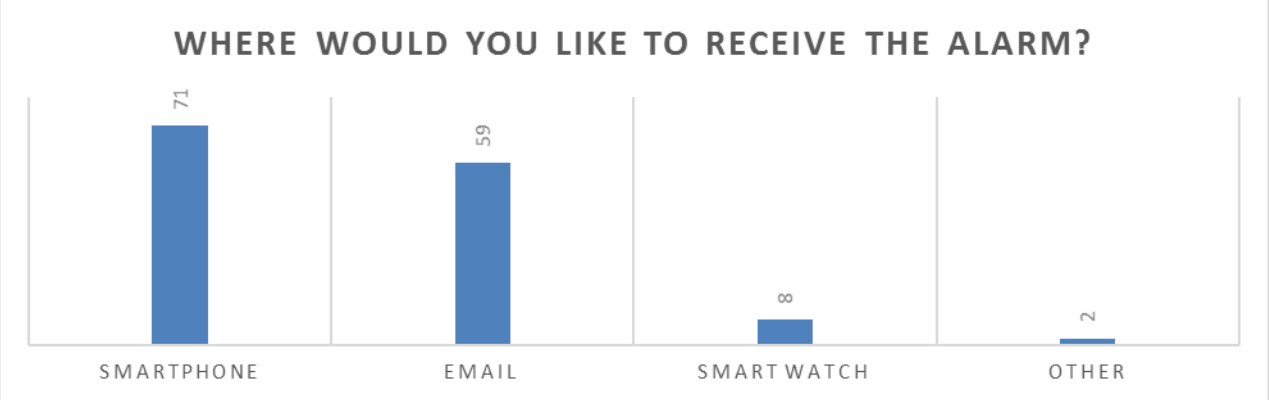


Figure 14: User preferences - alarm

With regards to a dashboard feature, a mixture of graphs and number displays is by far the most welcomed as highlighted by Figure 16, while for displays of savings, energy and monetary units are both indicated preferable over carbon emissions (Figure 17). In answering which other information about the buildings users would like to see besides energy, temperature is highly requested with humidity and external weather also proving popular (Figure 18).

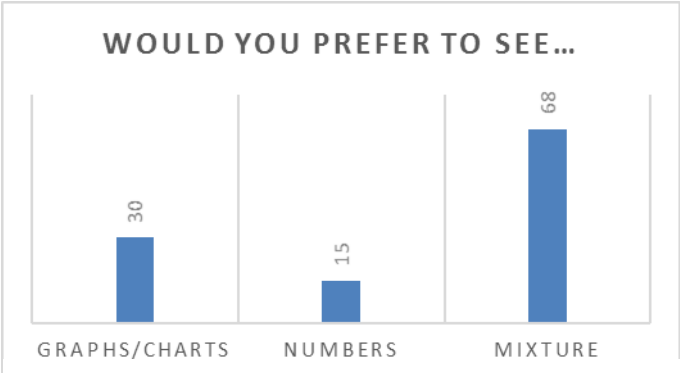


Figure 17: User preferences - dashboard

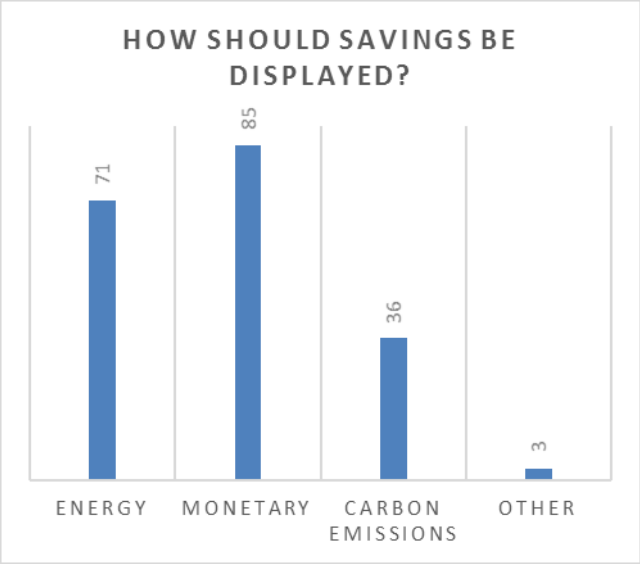


Figure 18: User preferences - units

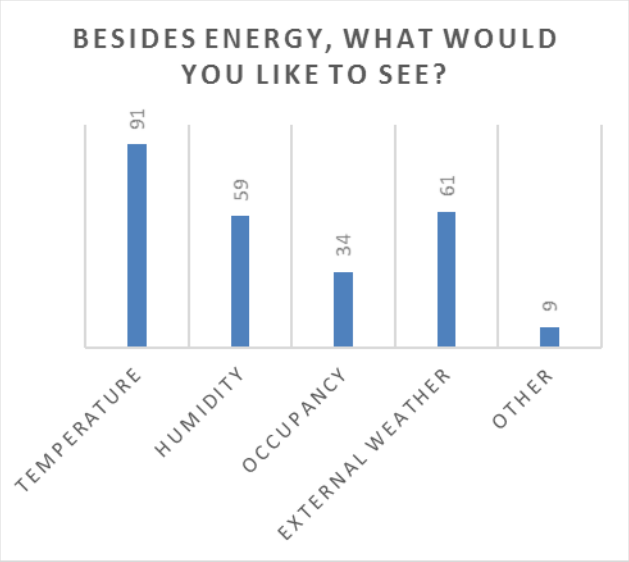


Figure 19: User preferences - building information

On the topic of competition, the vast majority of participants express a preference to compete as a team rather than as an individual (Figure 19). Approximately two thirds are of the opinion that prizes are necessary for motivation (Figure 20), and over two thirds are happy to share energy data beyond their building for use in external competition (Figure 21).

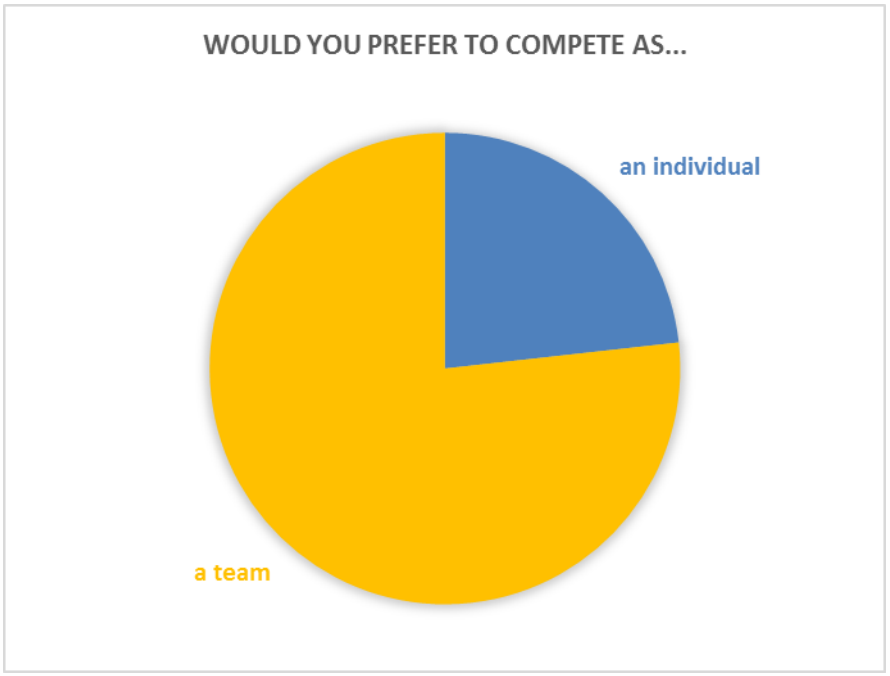


Figure 20: User preferences - competition

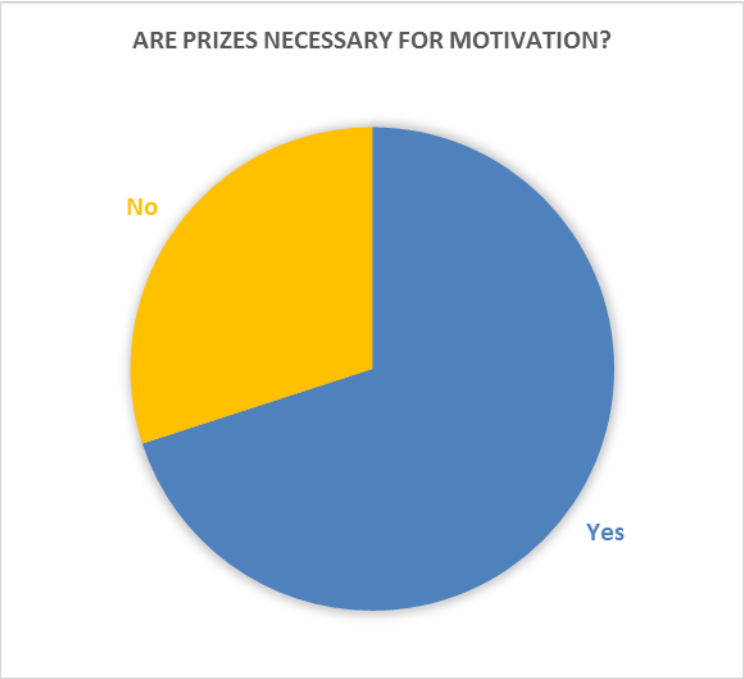


Figure 21: User preferences - rewards

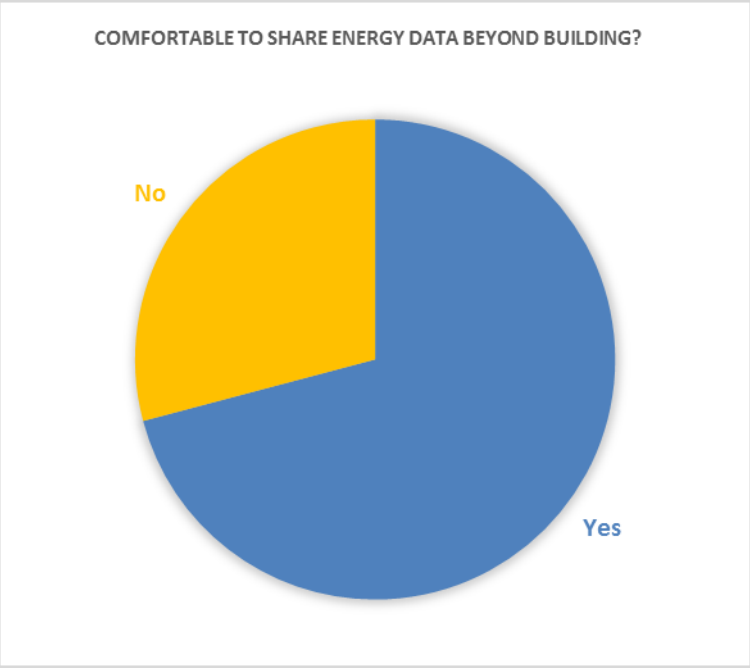


Figure 22: User preferences - data sharing

When asked about games, users suggested strategy games are most appealing (Figure 22). It is perhaps relevant to note that, during the workshop, numerous participants in the UK pilots voiced their abstinence from answering this question, owing to their general aversion to games.

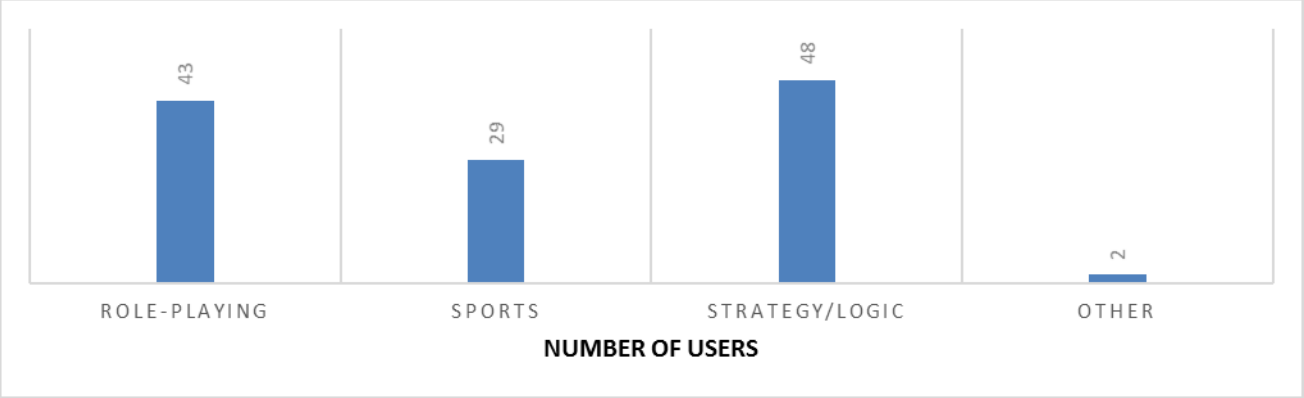


Figure 23: User preferences – game type

Figure 23 shows the most popular type of incentive is shopping vouchers, while Figure 24 indicates brief text updates and performance comparisons are the most favoured features for a social media app. Finally, there is a fairly even split in terms of how users might like to give feedback, although public and personal devices are slightly more popular than communal (Figure 25).

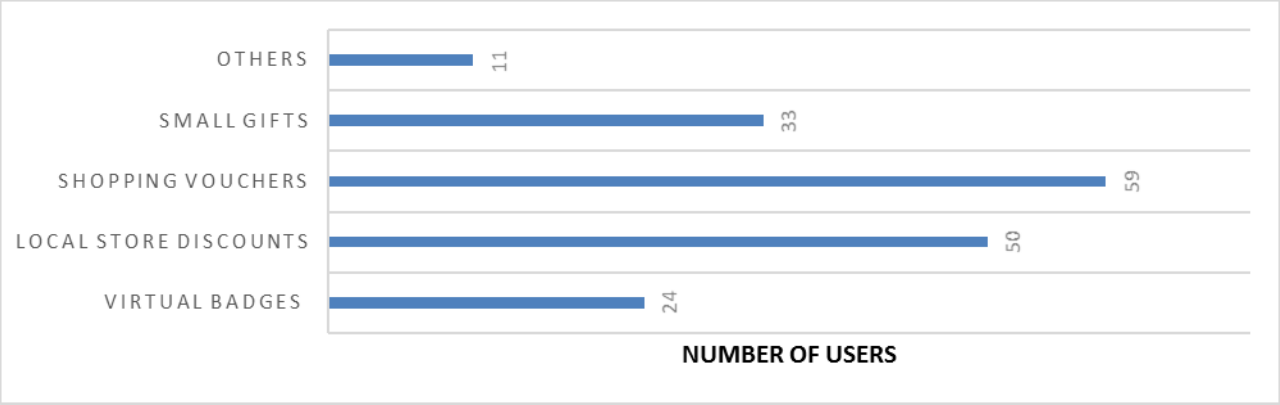


Figure 24: User preferences - reward type

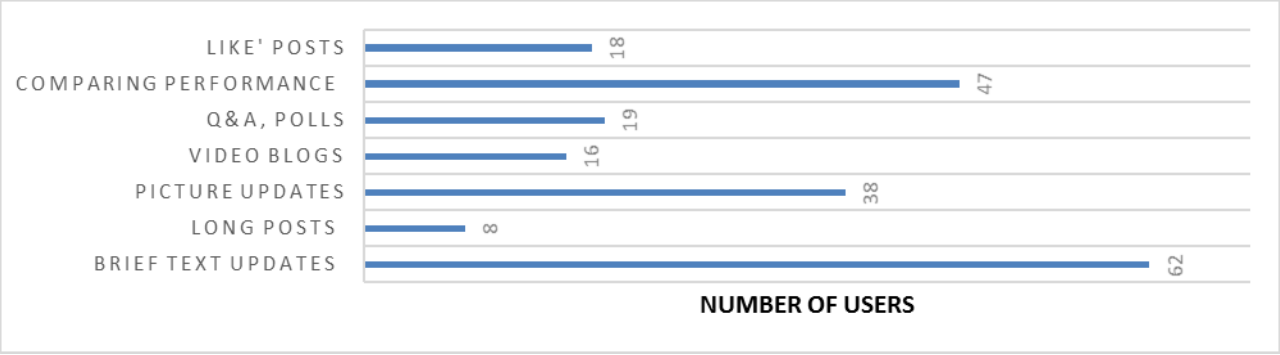


Figure 25: User preferences - social media

4.3.2.5 Activity 5: idea grading

Of the eight main ideas, preferences within which are explored above, the one which most users indicate they would definitely use is the 'energy alarm', which would alert them when their building's energy consumption approaches a certain threshold (Figure 26), followed by a dashboard.

Figure 26 present a more detailed breakdown of users' responses to these ideas. Nobody says they would not use the alarm while over 4.5 say they would definitely use it.

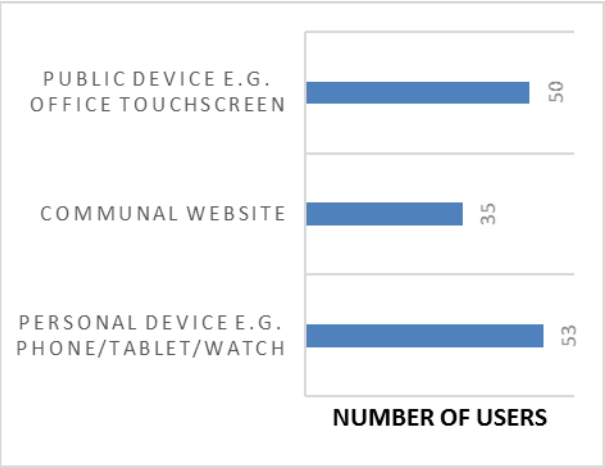


Figure 26: User preferences - giving feedback

Nearly 2/3 would definitely use the dashboard and only 9% wouldn't use the advisor. Accordingly, a Council House employee expressed their enthusiasm towards the idea with reference to the hot weather that day: *"I would definitely use the advisor – I turned up in a Jumper this morning!"*. Users also appear open to trying the competition, rewards and the reporting feedback formats. Users from the Spanish school, Torrente, suggested the best way to get all people and at the same time gather a lot of useful building data could be through them giving feedback. Djanogly are already trialling an IT rewards system called Kickboard, whereby teachers award grad coins based on behaviour using smartphones, which can be spent by students on trips at the end of term.

Clearly, the most resistance was towards games and social networks, which 42% and 38% respectively said they would not try at all. One Romanian InCity resident asked, "games are enjoyable, but are they useful?" and, in one group of Djanogly pupils, ¾ said they avoid game devices completely. Throughout the *Workshop Ask* sessions, a theme of time constraint became apparent, and the subject of games repeatedly prompted this line of discussion. Council staff, for example, argued, "to weave [games] into daily work would be hard", and that "time would put people off games".

The topic of time pressure also overlapped with conversations about social media. A group within the Djanogly staff workshop found humour in the idea of social media and games within work, with one member elaborating, "we wouldn't have time because it's not a priority in the working day". Moreover, OAR (Spanish office) staff mentioned an outright social media ban during their office hours.

4.3.2.6 Activity 6: poster evaluation

Figure 27 displays the number of times each idea was picked to develop in the poster exercise. These results are in accordance with *Activity 5* findings in that the alarm and dashboard are most the most popular and social networks and games are the least, although feedback was also less favoured here. It is important to note that in the Spanish and Romanian workshops, groups generally chose one idea to analyse, whereas UK groups tended to select and combine multiple ideas, so results may be skewed in this sense. Nevertheless, the graph gives a helpful impression of which ideas appealed to users on the whole.

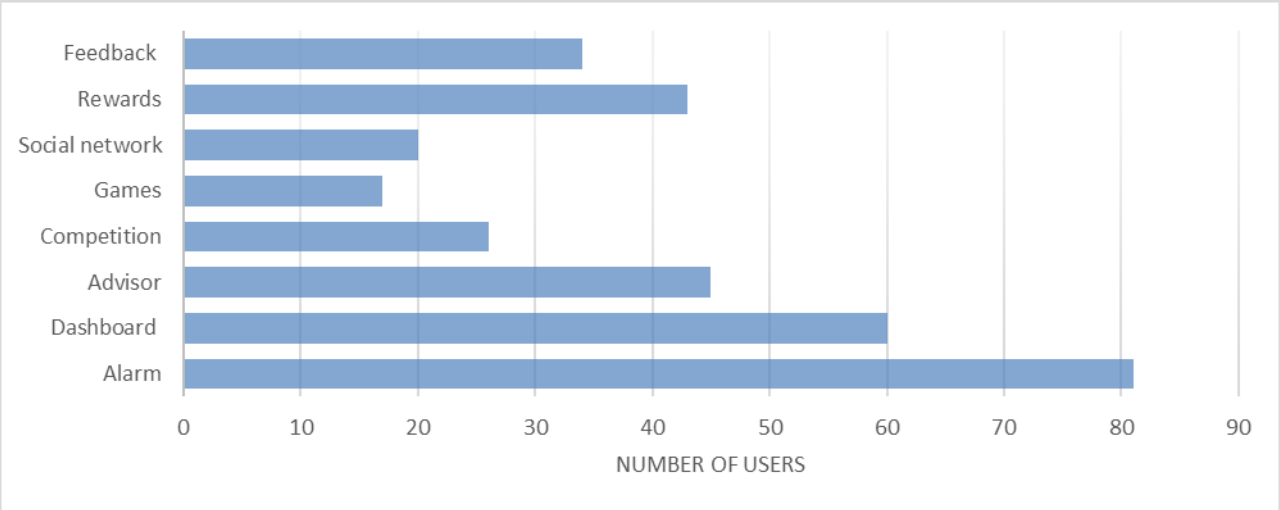


Figure 27: eTEACHER features users would "definitely use"

Offering more depth, Figure 28 presents written highlights from the various posters produced in the *Workshop Ask* sessions. Among the motivations for downloading put forward by users, both the UK office and school claim milestones are important in order to make progress visible. Some notable barriers include the concern from Romanian residents that they would not possess the necessary smart tools, while the Spanish office and healthcare centre respectively suggest that too much technical information and app intrusiveness would discourage uptake. Improvements put forward include Council House staff's suggestion to have built in layers so that headlines can be clicked to reveal more depth of information if desired, and a personalised, customisable dashboard proposed by the UK school and Spanish office. Finally, in the vision box, a few noteworthy examples are the Romanian residents' concept of physical buttons in buildings for

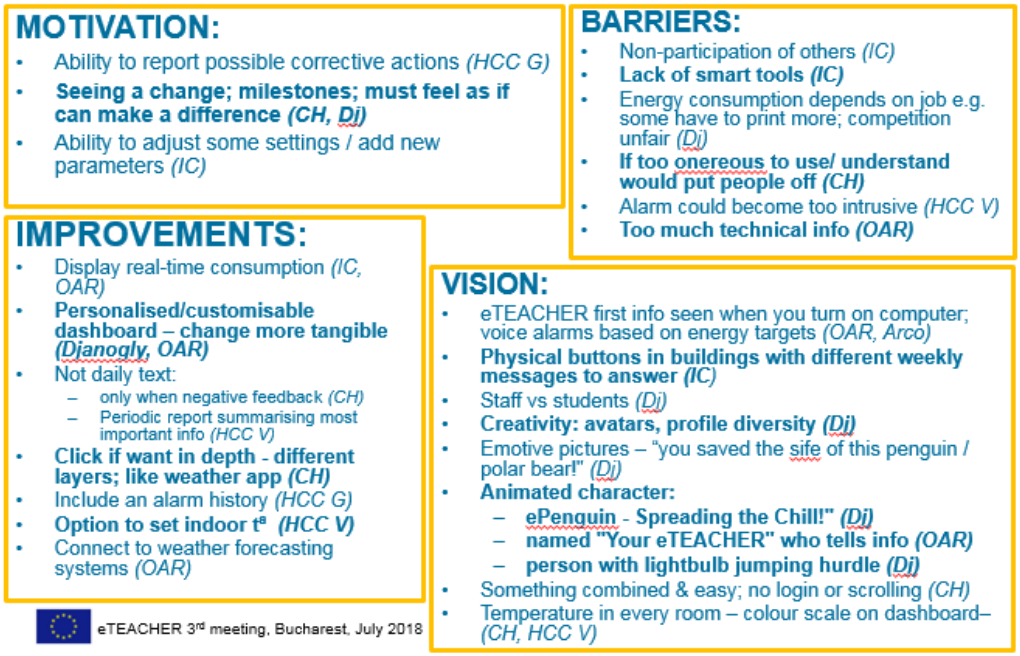


Figure 28: Highlights from evaluation posters

answering weekly messages and the UK school and Spanish office's creations of animated characters giving energy advice.

A common theme rising amidst all building types was the desire for simplicity and convenience, and avoidance of a cumbersome IT tool. The eTEACHER vision put forward by Romanian residential building users was described as *"short and to the point without too much information [or too many] questions asked*", while that of the Spanish healthcare centre users was a periodic weekly report conveying only the most important information. In their accompanying discussion, the latter placed emphasis on their disinclination towards 'information overload', in light of their day-to-day duties, which must take precedence over energy matters.

Flexibility is also widely favoured, as evidenced by the aforementioned calls for customisability from Djanogly and OAR, InCity's wish for "the ability to adjust some settings or add new parameters" and comment that "flexibility is the key to improvement". In particular, students at Djanogly propose "adjustable notification times" and Council House staff a weather app-inspired design with different layers, which can be expanded depending on the user's time allowance. The latter also suggest an option to give simple feedback *"so when you feel in the mood you can fill it in".*

4.3.3 Key challenges (S4)

Based on WSA Ask results described above, the five key challenges, forming the pillars of *Workshop Bridge*, are as follows:

1) What is the core hardware appetite?

2) What additional hardware should eTEACHER be adapted to, given that many users are without smartphone access?

3) What should eTEACHER's main functions be?

4) How to respond to the reported lack of enthusiasm towards games.

5) How to overcome user time constrains.

4.4 Workshop Bridge results (S5)

4.4.1 Key challenges response

Solutions to the key challenges based on the multiple choice offered to partners, settled on during the subgroup discussions which followed NCC's presentation of *Workshop Ask* data, are presented in Appendix 2. Feedback is split into 'points agreed' and 'inconsistencies' to highlight areas of immediate consensus and where compromise is required, respectively. The final column suggests solutions to reconcile varying partner opinions.

4.4.2 Preliminary recommendations

Based on the solutions reached in Appendix 2, a set of 10 preliminary IT-focused recommendations for the design of the eTEACHER tool were written:

1. eTEACHER should be an app with all full functions available on a smartphone.
2. eTEACHER should, at least in part, be available on tablets, PCs and plasma screens. This might mean certain relevant features can be accessed on these devices.
3. Consider alternative hardware relating to specific pilot building to ensure engagement with all key building users.
4. Smart watches should no longer be considered as a target device.
5. Explore ways app engages with people without smartphones (example: teachers give students points for good energy actions so targeting student behaviour even though they do not interact directly with the technology).
6. Ensure inclusion of most popular functions: alarm, dashboard, advisor, reward, feedback.
7. Incorporate gamification but avoid serious games.
8. Make app adaptable in terms of basic functions through one or both of:
    a. Manual customisation – user choice,
    b. Automatic filtering according to user or building type.
9. Make app settings (e.g. alarm, advice frequency) adjustable through one or both of:
    a. Manual customisation / user schedule input,
    b. Automatic settings according to user interaction.
10. Consider layers: headlines giving key info which can be expanded for extra detail if user has interest / time.

4.4.3 Partner feedback

The set of 10 preliminary recommendations as written above, supplemented by the table shown in Appendix 2 to give an understanding of the underpinning and demonstrate the collective contribution, was sent to all partners via email for their comments before finalising the guidelines for design. All of the feedback received from partners in summarised and presented in Appendix 3. The numbers listed adjacent to the partner in question relate to the recommendation numbers (1-10). It is assumed that those partners who did not submit feedback were in agreement with all recommendations in their preliminary form.

4.5 Final recommendations (S6)

Taking into account the consortium's various perspectives (Appendix 3), NCC's final T1.3 recommendations for design based on ICT user engagement are set out below using the MoSCoW method (signifying 'Must', 'Should', 'Could', 'Won't)

.

1. (S) make eTEACHER an app with all full functions available on a smartphone.
2. (M) ensure eTEACHER is, at least in part, available on tablets, PCs and plasma screens, so certain relevant features can be accessed on these devices.
3. (C) adapt design to alternative hardware relating to specific pilot building to ensure engagement with all key building users.
4. (W) any longer target smart watches as a primary device.
5. (M) explore ways app engages with people without smartphones (example: teachers give students points for good energy actions so targeting student behaviour even though they do not interact directly with the technology).
6. (S) ensure inclusion of most popular functions: alarm, dashboard, advisor, reward, feedback.
7. (M) incorporate gamification but avoid serious games.
8. (M) make app adaptable in terms of basic functions through one or both of:
    a. Manual customisation – user choice,
    b. Automatic filtering according to user or building type.
9. (S) make app settings (e.g. alarm, advice frequency) adjustable through one or both of:
    a. Manual customisation / user schedule input,
    b. Automatic settings according to user interaction.
10. (C) build in layers: headlines giving key info which can be expanded for extra detail if user has the interest and time.

5 Discussion and conclusions

Having sequentially presented the results of T1.3's *Workshop Ask* and *Workshop Bridge,* this chapter endeavours to offer an insightful analysis of the main outcomes against the setting of previous research findings. It begins with the discussion of the individual five key challenges (KCs). Here, both the questions themselves and the project's proposed solutions are considered with reference to the experiences and advice reported in parallel studies. Identifying points of alignment and conflict begins to establish its place amidst the existing body of literature. Additional discoveries about user preferences, falling outside of the scope of the KCs, yet still deemed of merit to the design, are then contemplated in the same fashion.

Consolidating the various insights from across all of the workshops and KCs, the 10 final recommendations are briefly expanded upon. This makes way for a closing set of conclusions serving to enrich and complement the design recommendations by way of elucidating, justifying and advising caution where appropriate.

5.1 Key challenges

Following the ICT-based user engagement realised through *Workshop Ask,* Task 1.3's second half was to facilitate the interpretation of captured information in order to bridge WP1 with WP2 and WP3, and it did so via the identification of five key challenges (KCs), around which the consortium's discussion was structured. The next section attends to each in turn, firstly explaining the significance of the issue and then exploring the course of action as settled by project partners in light of building user preferences. In doing so, it begins to form an impression of how the project fits in with and builds upon existing energy behaviour change research.

5.1.1 Key challenge 1: core hardware appetite

The first and perhaps most obvious key challenge was selecting the app's primary interface(s); the tool's materialisation in the user's physical surroundings, which, of course, sculpts the entire eTEACHER experience.

It is true that the perspectives of previous studies are valuable in laying the foundation for making such a decision, but, crucially, this report has detailed the movement towards user-informed design in the literature. Therefore, the pilot users' perspectives on hardware must be at the forefront in this deliberation.

For maximum energy savings, users would presumably interact with eTEACHER very frequently. It stands to reason, then, that they would have to have easy and continual to access to it, which must be reflected in the choice of hardware. Technologies said to be used "every waking hour", therefore, are perhaps the best starting point. In this case, smartphones are undoubtedly the logical choice of hardware as their popularity at this high frequency of use dwarfs all other devices discussed. Lending weight to this conjecture are the proclamations of attachment from users explored in section 4.3.2.2, for example heralding the smartphone as their "life line", and "gateway to [their] life", and the fact that it is the sole technology used by some

non-admin staff during the working day. Further reinforcement comes from observations in the literature commending portability, unobtrusiveness and pre-existing integration (e.g. Weiss *et al.* 2013; Sanguinetti *et al.* 2018), all of which the smartphone embodies. Tellingly, the first "people-centred" recommendation for the design of MOBISTYLE, a comparable project aiming to encourage behaviour change through personalised feedback via IT, is "emphasising smartphones" (Tisov, 2018). In congruence with eTEACHER's approach, their set of recommendations are the product of focus groups, supplemented by interviews and participant observations which shed lights on the expectations, habits and motivations of users. Mirroring *Workshop Ask* results, they find a clear preference for smartphone users among building users and mention that smartphones are one of the most widespread ICT tools, as part of their justification.

In line with the grant agreement's commitment to PC access and creation of an "advisor TV", and the relative favourability of these hardware devices on the part of users, extending to their inclusion in the design recommendations seems sensible. Previous research conclusions stand in testimony to this approach, as exemplified by Murugesan *et al.*'s (2015) design specification to make visualisation should be "portable" so it adjusts to multiple platforms including PCs, mobiles and tablets and public display screens.

Taking all of this into consideration, it was suggested to the consortium, who had been shown the relevant evidence to set a precedent for working through the next KCs, that eTEACHER would take the primary form of a smartphone application of some sort but with access broadened to tablets, PCs and plasma screens.

As alluded to in the results, however, the smartphone is widely but not universally accessible among eTEACHER pilot users, so regarding it as a panacea is inadvisable, which leads on directly to the second key challenge.

5.1.2 Key challenge 2: additional hardware

Smartphones are an obvious choice to suit the majority of eTEACHER building users, but the results also raise a challenge which cannot be ignored, and that is that a major user role type, namely students, are not authorised to use this device within their pilot building. The results also indicate that a notable proportion of facilities management staff across the various sites do not use a smartphone regularly, which is an inevitable impediment, given that this represents the core area of energy management. Alone, then, the smartphone is an insufficient channel for reaching all target users.

A second strand to KC2 questions is the place of the smartwatch in this project in light of the new knowledge, generated from *Workshop Ask,* that only a small percentage of users own such a device. The Grant Agreement specifies smartwatch utilisation, but the widespread provision would be undoubtedly costly and complicated and, so, a dilemma emerges.

Taking both matters into account, the question put to the consortium was: what supplementary hardware devices should eTEACHER be adapted to in order to infiltrate the daily lives off all users.

Addressing the former strand, this is by no means the first encounter with building users inexperienced or without access to modern devices (Bull *et al.,* 2015; Wilson *et al.,* 2015), although there seems to be little published on overcoming such a problem in school and workplace environments. While most of the users who do not carry smartphones in their buildings are exposed to TV screens, some of whom regularly use PCs, the potential for pervasiveness in a user's routine is perhaps reduced in the absence of a personal

device. Innovative alternatives were thus sought in this part of *Workshop Bridge*'s discussion. Inspired by Djanogly school users' points cards, which students use to open doors and pay for food, NCC proffered the idea of an eTEACHER card which could collect points based on good behaviours, with the advantage of being bespoke to the project and thus not in jeopardy of posing a distraction as a smartphone might. This idea gained some traction with two of three partner groups in the workshop. The third came up with an alternative solution of providing tablets in certain rooms, although doubts were raised about the eligibility of funds for such a venture.

Mirroring another of Djanogly's existing systems, a rewards software called Kickboard, was the idea of teachers having exclusive access to the app itself but monitoring and awarding points based on student behaviour. One group agreed this might be easier than trying to engage directly with students who lack the core device, although another contended that students are a fundamental user role who should not be excluded to any extent.

The smartwatch issue proved less contentious as, after being reminded that the Grant Agreement allows for some flexibility, especially if of obvious benefit to the project outcomes, partners quickly agreed to eliminate it from the list of target devices. From the qualitative data collection some alienation from new technologies were detected, particularly by older participants who perceived new devices as "gimmicky", while many did not recognise the smartwatch in its general function. In eliminating this technology, this potential problem is incidentally avoided.

5.1.3 Key Challenge 3: app functions

In the wake of the consortium's verdict on hardware interfaces, the next step was to turn to software and consider what eTEACHER should actually *do.*

Judging by the quantitative output of *Workshop Ask,* the energy alarm and dashboard ideas were the most well received. In some respects, this harmonises with studies promoting the effectiveness of conventional feedback (e.g. Abrahamse, 2005; Darby, 2008). In particular, Owen (2010) promotes a dashboard's ability to render statistical information comprehensible, attractive and interactive and notes that reviewing it hour-by-hour enables researchers to understand which kinds of communication stimulate behaviour change best. They found a spike in usage after lunch, indicating users actively sought feedback on their efforts; Metzger *et al.* (2011) also recorded high numbers of dashboard hits, mostly in response to push notifications. Meanwhile, an energy alarm could bear resemblance to the successful traffic light systems explained by Hargreaves (2010) in its underlying basis of a predetermined threshold, albeit more multi-sensory rather than simply a display colour.

Generally, the advisor was also welcomed, which sits well with a postulation made by both Darby (2006) and Fischer (2008) that supplementary *"how to conserve"* information enhances feedback to increase the potential for savings. Users seemed amenable to trying competitions and reward formats, which are commonly combined in practice. Gustafson and Longland (2008), for one, observed both a reduction in energy use and also a deeper cultural change which involved a "floor challenge", pitting floors against one another to compete for a team prize.

Where attitudes of resistance start to transpire are around the topics of games and social media. On account of its centrality to eTEACHER according to the Grant Agreement, gamification is examined in depth within the next section (KC4). The discernible disinclination towards social media is commensurate with Bull *et al.*'s (2015) observations of participant attitudes, although perhaps for different reasons. Fulfilling its methodological purpose, the qualitative data affords some insight here, as building user comments suggest, rather than an unfamiliarity or mistrust of social media ("even my Grandma's on Facebook!"), the problem lies in a perceived shortage of time in their daily roles. The theme of time constraints forms the basis of KC5 which offers further consideration.

Among the consortium, KC3 was met with a mixed response. One group simply decided that the app design should consider only the most popular ideas for all users; namely the alarm, dashboard, advisor, rewards and feedback submission. Conversely, a second group of partners argued the app should be tailored according to different building type or building roles, and the final group suggested the user should have the choice of content in offering an app with multiple layers. Subsequently, NCC put forward a compromise in the prioritisation of popular ideas but with built-in filters to allow for customisation.

5.1.4 Key challenge 4: aversion to games

Gamification is a term arising frequently in the Grant Agreement and a fair amount of discussion had taken place, prior to *Workshop Ask,* about how an eTEACHER game might be envisaged. Indeed, serious games have proven very fruitful to various other behaviour change initiatives (e.g. de Vries and Knol, 2011; Banerjee and Horn, 2014), yet, in this case, a stark proportion of building users made clear that they would not partake in energy games.

Problematically, compliance with project specification therefore clashes, to some extent, with the intention of maintaining a user-driven focus. Johnson (2017) comments on the common difficulty and subjectivity of distinguishing serious games from gamified apps. However, some of the more technically minded partners in *Workshop Bridge* were quick to emphasise that gamification can merely mean the employment of some gamified elements such as competitive points, which users seemed open to. It is by no means bound to resemble a fully-fledged computer game, they uphold. With this in mind, it was agreed with ease that the design process should bypass serious games but continue to entertain game components, *i.e.* "light" gamification, to borrow the term of Shi and Cristea (2014).

Choosing not to exclude gamification leaves open the potential to capitalise on providing an "inherently engaging" and educational experience to users (Dale, 2014). In synchrony with the "one size does not fit all" philosophy, Grossberg *et al.* (2015) maintains that, to make a success of gamification and ultimately exploit "the multiple satisfactions that are there in the first place", the "players'" needs must be understood prior to development.

5.1.5 Key challenge 5: addressing user time constraints

The final KC debated by partners in *Workshop Bridge* stems from the unmistakable sentiment expressed generally across the pilots that perceived time shortages would constrain their potential to engage with eTEACHER. User response to eTEACHER tool ideas, in summary, conveys a willingness to participate in

interactions which are perceived as easy and quick for the building users and a reluctance to commit more demanding activities, which could be said to conflict with calls for higher levels and broader means of user engagement (e.g. Owens and Driffill, 2008; Moezzi and Janda, 2014).

It appears that this attitude of users is not uncustomary in behaviour change studies. Fitzpatrick and Smith (2009) note a preference for at-a-glance information, while Hargreaves (2010) reports that users can be put off by the need to actively engage. Apprehension about "information overload" and even the inconvenience of logging in were expressed by the participants of Gupta *et al.* (2017), echoed precisely by the comments of some eTEACHER users. In the workplace environment, multiple studies highlight a perceived incapacity to pursue energy matters owing to higher priorities (e.g. Bull *et al.,* 2015; Boomsma *et al.,* 2016), a view which did emanate from some of the *Workshop Ask* sessions. The issue should not be taken lightly given that it may obstruct efficacy further down the line, as found by Van Dam *et al.* (2012) who noted that, after interest has waned, complete abandonment of efforts might be triggered by minor technical issues.

Users' time-poverty and/or impatience is reflected in the solutions proposed by studies such as Wilson *et al.* (2010) who recommends brief information bullets to maintain interest, and MOBISTYLE (Tisov, 2018) whose fourth recommendation is "Calm Technology principles". By this they mean that interventions should "disappear and weave themselves into the fabric of everyday life until they are indistinguishable from it", so, presumably the user's awareness of it and, by extension, the time it takes up, is minimal.

To some degree of similarity, eTEACHER partners generated a number of suggestions to circumvent the issue of pilot user time constraints which surfaced in *Workshop Ask.* Different manners of customisation to give the individual more choice were discussed; both manual, for example the ability to adjust notification frequency or input schedules, and automatic so the app responds to the level of user interaction. Building in layers was another theme, where the app would have main headlines that could be expanded for more detail depending on the user's time and interest levels. In fact, this reflects the features of Jacucci *et al.*'s (2009) EnergyLife mobile app where numerous levels of detail were made accessible to the user. While details varied between groups in *Workshop Bridge*, the prevailing trend was to build in flexibility so that busy users would feel less pressure to devote their time, and therefore more inclined to engage regularly.

The notion of mandatory roll-out was broached but the overwhelming majority agreed this would defeat the goal of users independently discovering the benefit of eTEACHER to their daily lives, and, what's more, might trigger defensiveness and resistance.

5.2 Other user preferences

Before recapitulating the final recommendations, there are a few insights besides the KCs which are worthy of a mention. Firstly is the users' preference for a mixture of graphs and number displays as part of a dashboard. This falls in line with Murugesan et al.'s (2015) contention that feedback visualisation should be varied and multi-faceted to capture the interest of users.

Many behaviour change studies have investigated feedback unit preferences in depth. *Workshop Ask* results suggest there is not much between monetary and energy units, although carbon emissions units apparently appeal far less, agreeing with the findings of McMakin *et al.* (2002) and the questionnaire

results reported in D1.2 (Morton *et al.* 2018). However, Wilson *et al.* (2015) observes that no one metric is to every user's satisfaction and argues it should depend on the target individual; indeed, numerous works report contradictory user preferences. Dalen *et al.* (2016), for one, refrained from listing them in design requirements as a result. This project follows suit, deeming such fine details better left to the refining trial stages.

On the whole, building users in this case indicated an interest in temperature, humidity and external weather data in addition to energy, which, if actualised, could serve to attract more attention to the app.

On a final note, the majority of building users favoured competing as a team over by themselves which complements Grossberg's (2015) recommendation of team play, owing to its instilment of a "wider purpose, one that may potentially widen out to include the welfare of their community and, ultimately, the planet".

5.3 Other user preferences

1. **(S) make eTEACHER an app with all full functions available on a smartphone.** *Smartphones are used at a high frequency by the majority of participating building users so are deemed the best vessel for energy information exchange.*
2. **(M) ensure eTEACHER is, at least in part, available on tablets, PCs and plasma screens, so certain relevant features can be accessed on these devices.** *PCs and plasmas are advantageously pre-integrated, both physically in the buildings and also psychologically within most users' daily habits. Their implementation ensures users without smartphones are not neglected.*
3. **(C) adapt design to alternative hardware relating to specific pilot building to ensure engagement with all key building users.** *To target as many users as possible in a meaningful way, designers could look for an innovative extension to other types of hardware devices.*
4. **(W) any longer target smart watches as a primary device.** *Smartwatches are not familiar or accessible to the majority of users; their exclusion mitigates the risks of user alienation and high costs.*
5. **(M) explore ways app engages with people without smartphones (example: teachers give students points for good energy actions so targeting student behaviour even though they do not interact directly with the technology).** *Whether or not innovative hardware solutions can be established, all users including those without smartphones must be reached to effect energy behaviour.*
6. **(S) ensure inclusion of most popular functions: alarm, dashboard, advisor, reward, feedback.** *Complying with a user-centred approach, the app should include the features called for by the building users during the ICT-based engagement sessions.*
7. **(M) incorporate gamification but avoid serious games.** *A balance must be struck between fulfilling project commitments and respecting the wishes of users, who generally express a clear aversion to playing games in their respective buildings.*
8. **(M) make app adaptable in terms of basic functions through one or both of:**

   a. **Manual customisation – user choice.**

   b. **Automatic filtering according to user or building type.** *To allow for personalisation in light of the message that "one size does not fit all", the app must in some way be personalised to the user.*

9. **(S) make app settings (e.g. alarm, advice frequency) adjustable through one or both of:**

   a. **Manual customisation / user schedule input.**

   b. **Automatic settings according to user interaction.** *Addressing the users' evident concerns over time pressure, users should have the option of adjusting setting according to their time allowance.*

10. **(C) build in layers: headlines giving key info which can be expanded for extra detail if user has the interest and time.** *In a further effort to respect user time constraints, users could be presented only with the important messages and have the option of finding out more if they so wish.*

5.4 Summary and conclusions

T1.3 has embodied the initial face-to-face communication with pilot building users, specifically to ask and understand their current relationship with ICT and their preferences going forward. It has collated this information and facilitated an interpretive discussion among project partners. Finally, it has fed the outcomes into a set of 10 specific, ICT-related recommendations and, in doing so, formed a bridge between the social research and the technical design in this project.

Taking heed of the literary consensus, which advocates a user-centred approach, an original methodology has been developed in order to extract a high volume of information from users, of both a quantitative and qualitative nature, but not at the expense of their interest and enjoyment.

On the basis that, when it comes to energy behaviour change, "one size does not fit all", the final recommendations are very much the product of the engagement workshop results. More than this, though, they are also grounded in the thorough deliberation of project partners to ensure technical feasibility and practicability. They therefore encapsulate the knowledge and experiences of both groups of stakeholders.

Three key themes can be seen across the recommendations; firstly, the need to fit conveniently into every user's physical environment, so that, spatially speaking, eTEACHER is easily reachable. Turning to its temporal integration, eTEACHER should secondly aim to weave into the user's every day routine and not demand a high investment of time and effort, necessarily. Finally, eTEACHER's content should adhere to software preferences ascertained in engagement workshops in order to perpetually entice users, and in doing so effect long term behaviour change towards energy efficiency.

It is very important to be aware that maintaining a user-centred approach, which is said to be critical for programme success, necessitates future revisits to building users as part of a continual engagement plan. While T1.3 has established a strong starting point, the value of further user input in the creation and refinement of app design cannot be emphasised enough. The next and final report under WP1, D1.4

(Reeves *et al.* 2018), sets out recommendations for continual engagement as part of the enabling change framework.

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7 Appendices

7.1 Appendix 1

	Workshop Ask	**Workshop B**ridge
ACX	<u>Qs on current ICT usage -</u> • Which kind of devices are available to/common with the users? • What is the users favourite app on their smartphone and why? • What kind of media systems do users have in their cars, are they happy with it, why did they chose it? • Which internet services do users use? • Are smartphones used for payment services or similar? <u>Questions on attitudes to new technologies -</u> • Is there a feature they feel like their smartphone is lacking? • Are they looking forward to buying a new device/smartphone? • Do they watch keynotes or visit exhibition regarding new devices/technologies? • What kind of jobs/services should always be handled by persons?	Would it be possible to get a gender/age information on the participants or even a direct correlation to the answers of the question? We have supported a workshop for people of ages 65+ on smartphone uses and noticed they are not necessarily challenged by the technology itself (though this is to be taken into account) but more by the way its presented, e.g. small fonts, low contrasts or confusing Terms & Conditions.
ASC	• Ask to think of hints and rewards e.g. discount at a local store, reducing the additional costs for the rent, some virtual badges and achievements, loot boxes. • Ask if ranking system would make sense, if people wanted to compete against each other or are more interested at ranking up. • Suggest RPG, where you get experience and level up as you save energy – how could that look? • Research other gamification mechanisms of other products, perhaps working with DMU on this to see what most effective. • Question: What could be a reason to install an app, like the eTEACHER mobile app? • Structure: a presentation first, to give suggestions and to start everything. And then let the participants brain storming. • Idea: subtopic sessions in each workshop- get some feedback. Perhaps make a small presentation about a topic, provide some initial ideas, let everyone write their ideas on post-its and put it on some white board and discuss about that. Not all examples have to be serious, to get the people a little bit more comfortable (funny	

examples could help).

CEM	**Instructions** Enhance following questions to make them more specific (easy to be answered) and adapt them to audience: teachers, health care centre staff, etc. In general ask questions in two ways: • What do you prefer? • What do you already use? **Brainstorming of questions:** 1. Pilot type? Role (staff, student, etc)? range of age <35, <60, < 85? 2. How do you usually check your consumption on electricity, phone, etc.? Pdf bill sent by traditional mail, mobile phone app, Pdf bill sent by email, other? 3. What are your highest interests?: Energy related costs (euros), energy consumption (kWh), emissions/carbon footprint, comfort, others… 4. What do you usually check/visualize: energy related costs, energy consumption, emissions/carbon footprint, comfort, other, nothing 5. Are you interested in visualizing energy consumption/emissions/comfort/costs? How? Graph or number? Instantaneous or accumulated per month? 6. What display do you prefer mobile phones, TVs, PCs, other? 7. How do you prefer to receive info: email, social network, alarms, mobile phones apps/newspapers, screen informative displays, PCs websites, other? 8. Are you interested in receiving an alarms when energy cost/consumption/comfort/emissions are over a certain limit? What other kind of alarm would you like to receive? How would you like to receive the alarm: mobile phone, email? 9. Do you like bonus systems? What kind of bonus/incentives do you usually use (e.g. supermarket card/discount, payment by results in companies, etc.? what kind of bonus/incentives would you like to have? 10. What kind of digital games do you like more? a), b), c)? 11. What social network would you like to use more for energy related issues? a), b), c)? -	No additional comments but wish to emphasis importance of certain element of meeting: Draw conclusions → understand how insights can be transferred to advise eTEACHER tool design. - this is key!

DMU	Workshop gives participants the chance to get a good sense of what using the proposed interventions would mean in terms of their user experience – that is, what would it be like to be presented with a What-if analysis, or building data, or a chance to report issues to an energy manager (including whether this would happen via an app, web page on a phone or otherwise). Then they could give meaningful feedback on whether or how they'd be interested in using it, or suggest changes to the process of support to change behaviour. Follow-up: [makes] most sense if the users gave feedback via your workshops, so that our get-together in Dresden (now probably late May) could build upon this feedback and decide which elements to move forward with or how to do so. • Ask/enquire about how long people think they would interact with the tool – could have a big impact on how successful eTEACHER is and therefore should perhaps be an element of feedback which is incorporated into the intervention designs. • Enquire about best method to get people on board – e.g. would you pay enough attention to a poster, would it need to be something sent directly to you? • Ask about what would make them download the app or use the website – what needs to be there for them to engage? • Give an extensive list of "optional information" which the tool could report on e.g. temperatures, humidity, energy, external weather… and see what users identify as being information of interest to them.	
	-	
EAS	• Questions Steered loosely, with open ended questions (steer a little bit to put more focus on ICT applications with regard to energy-efficiency consciousness, energy system control, interactions of users with building appliances, ICT and energy metering / billing. One of main questions should be what users exactly expect from an ICT solution like eTeacher (creative activity). What information and support should eTeacher app/tool provide. Why would they buy it? Ask users what they expect from ICT solution like eTeacher: • What information it shall provide: text advice, warnings, numbers/scores, graphics, a mix of them? • Support: does it feel better in a mobile app, on a PC/laptop, on the home TV, in big screens in office buildings? • Among the app output information which kind of information would make them change their habits: cost exceeds, energy exceeds, threats of losing gamification points, being better or worse user than neighbours or	Summaries of outcomes from workshop A should be sent to partners prior to workshop B

	colleagues, etc? • Data privacy: do users agree to make public data about their habits and energy use through the app? Do they prefer to keep data private between different flats, offices in a same building? Target and differentiate different user types. Three main types of users: building owner, FM manager, inhabitant/office employee
GRA	We would like user feedback about the solutions. i.e. how would users prefer information about the buildings be communicated (i.e through a website, app, screens on the hall). What information they consider relevant to be communicated? -A flyer is good -A short introductory video could have more impact and get more attention but use more resources.

7.2 Appendix 2

1.	**Core hardware appetite**	Design app primarily for smartphones which can also be accessed on tablets, PCs and plasma screens.	May not be possible to make all features on smartphone available on PCs.	Whole app for smartphones with some but not all features available on tablets, PCs and plasma screens.
2.	**Additional hardware adaptation**	Eliminate smartwatch (option B)	**Group 1:** (E) idea to provide tablets in rooms to be inclusive of users without smartphones <u>but</u> project cannot fund (?). **Group 2:** (C) considering ways card readers could work. Not D! **Group 3:** (D)	Do not design for smartwatch; consider alternatives such as card readers (cheap, easy, non-distracting) – research; Build app around non-students but use other hardware to engage students in some way.
3.	**Central functions**	Varied	**Group 1:** Focus on C - app with multiple layers	Include (and possibly prioritise) most popular ideas, but either build in

			Reference to B and A as to what fits each building. **Group 2:** Focus on B – break down ideas into building type/user roles, and tailor app to suit different preferences C **Group 3:** A – focus only on most popular ideas: alarm, dashboard, advisor, reward, feedback. App could filter out whether at home or work.	filters or make manually customisable so different features for different user roles / locations / personal preferences. Trials / further user engagement to get more specific picture of what users want/respond well to?
4.	**Game opposition**	Serious games not necessary but gamification needs to be a part of eTEACHER.	-	Incorporate gamification but avoid serious games.
5.	**User time constraints**	(Option A) Build in flexibility by allowing users to adjust settings; frequency of notifications, expectations etc. G1: make fun – want to use during smoking break/on toilet; app must open quickly and show info wanted G2: customise for self; maybe input schedule and receive info within that window. G3: react to user – if see not interacting filer out lower priority alarms.	Group 1: (B) layers (headlines but users can expand for more detail/features if time) Not D – if have to force people to use then have failed Group 2: Not D – if make mandatory need someone to enforce; encourages defensiveness & resistance. Group 3: (B) layers (headlines but users can expand for more detail/features if time); has worked well in other projects like weather app. (D for trial) – debate in groups; suggestion of two month test phase of mandatory roll-out.	Build in flexibility by allowing users to adjust settings; consider manual user customisation and automatic response according to user interaction. Consider layers – headlines shown which can be expanded for extra detail if user has interest/time. Roll-out voluntary not mandatory.

7.3 Appendix 3

ACX	**1.** Agree, depending on its features it either needs to be a fully-fledged app that is to be downloaded from the App Store or it could just be web-app' a webpage that fills the full screen of the device. **2.** This would be able with web-apps or a normal webpage. It would limit the access of the app towards the devices hardware (e.g. gyro-Sensor) to what a normal browser can though. Obviously Ascora has the say as the technical aspects. **3.** We need to find a common sense of what that alternative hardware could be, respectively what we focus on. E.g. screens, card readers. **4.** Agree; depending on smartwatch function it could still relay the push-messages/notifications of the smartphone, effectively integrating the smartwatch. **5.** That is a topic for WP1; knowing these ways, the app can be designed appropriately. **6.** Agree; **7.** Agree; Ascora and Granlund probably have relevant experience. Competition important so user can see saving statistics compared to others and receive a ranking. A reward system would be good although unsure at this time what the rewards could be. **8.** Agree; need to find out more about demo sites, once additional equipment installed so the potential need for different profiles for different building types can be identified. **9.** Point (a) is more feasible. Point (b) is perhaps exemplified by fitness apps that send frequent notifications which would decrease when the user failed to react to it, eventually ending with a "I give up notifying you" message; such as approach might negate our goal of user engagement. Some notifications should be mandatory such as turning off the light when leaving. **10.** Agree.
CEM	Agree with all: the recommendations are very sensible and adequate for our purposes.
EAS	**1.** Not realistic to target all functions on smartphone app. Things like dashboards and plots easier to display on Ps and wider screens; might be that smartphone app provides the core functions with lightweight visualisations (feedback advice, simpe graphics and gauges and additional more detailed views would be provided on PCs, tablets and TV screens. **2.** See comment above **3.** – 4. Potential for simple features like warning messages about building issues (performance issues, energy wasting, appliances still used while building unoccupied). 5. Give free credit or free ice creams on the meal card. 6. – 7. Still raise peoples' awareness that they play with their money; the goal is that they reduce their bills, which is motivating. 8. b) Differentiate users, e.g. facility managers, owners.
GRA	Looks good. As the development progresses we will have a clearer view of the functions and hopefully all of them should be available on a smartphone.
SEZ	**5.** Example of schools: make it as easy as possible as teachers will not have a lot of time for the app either. Giving points to individual students is a good way to support behaviour if students constantly move from room to room, otherwise I'd recommend one tablet per room. I also wonder (thinking the tool further and looking at replication possibilities) how many schools give points to students in general and if this is a common means of interaction. What

	if most schools do not give bonus points? Agree with all other points.