eTEACHER

D1.: Analysis of end-use behaviour in relation to case study 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
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Project Duration	1 October 2017 – 30 September 2020

Deliverable No.	D1.2
Dissemination Level	PU
Work Package	WP 1 – Design for Behavioural Change for Energy End-Users
Task	T 1.2 – Analysis and characterization of end-user behavioural issues
Lead beneficiary	2 (DMU)
Contributing beneficiary(ies)	3 (NCC), 1 (CEM)
Due date of deliverable	30 September 2018
Actual submission date	28 September 2018

Versions

Version	Person	Partner	Date
1.0	Ashley Morton	DMU	20 Aug 2018
1.1	Andrew Reeves	DMU	22 Aug 2018
1.2	Richard Bull	DMU	29 Aug 2018
1.3	Ashley Morton	DMU	3 Sept 2018
1.4	Juan Jacobo Peralta	CEM	17 Sept 2018
1.5	Sam Preston	NCC	21 Sept 2018
2.0	Ashley Morton	DMU	25 Sept 2018

0 Executive Summary

The eTEACHER project aims to empower energy end-users to achieve energy savings and improve comfort and health conditions within buildings through enabling behavioural change. As part of the project, social studies shall be used to characterise energy end-users' behaviour, relating them to frameworks for building types and user types, and identify effective ICT-based behavioural change techniques that are appealing, user friendly and encourage users to save energy by optimising their comfort. These social studies form the basis of Work Package 1 (WP1), Design for Behavioural Change for Energy End-Users.

This report presents outputs from Task 1.2 within Work Package 1, aimed at identifying the key behavioural factors influencing energy use for each eTEACHER case study buildings. To achieve this, the data collection comprised key building design features and energy system control interfaces and information on the building users themselves. Building user data collection sought to identify users' energy-related needs and whether these are being met; control processes and interfaces and how these are understood and used in practice; and users' motivations for change and ideas for improvements within each building.

The report comprises of six main sections.

- Section 1: Introduction - introduces Task 1.2 and the eTEACHER pilot buildings
- Section 2: Data Collection Methods
- Section 3: End-user behaviour – presenting results on end-user behaviours from the data collected
- Section 4: Users' energy-related needs and using the 'COM-B' model to identify potential impact and requirements of eTEACHER interventions
- Section 5: Technical feasibility for the eTEACHER tool and behaviour change
- Section 6: Recommendations - summarising all findings and presenting design recommendations for the eTEACHER tool

The key findings and recommendations from WP1 are summarised in the following table. Recommendations are prioritised using MoSCoW (signifying 'Must have'; 'Should have'; 'Could have' 'Won't have'), a prioritisation framework developed by Clegg & Barker (1994):

Issue	Description	MoSCoW Recommendation(s)
Mixture of building types and user types	The added complexity of having a range of building types and users within the eTEACHER sample requires that the design take this into consideration. Energy managers will respond differently to specific info/data compared to regular everyday building users.	• (M) be one app, as discussed and decided by project partners. • (S) have layers within the app so that different users can access data as appropriate for their activities and agency within the building. • (M) have profile creation possible so that users can identify what kind of user they are in the building, allowing for tailored recommendations to be sent accordingly. • (M) be able to identify which building the users are from, and which rooms they use. • (C) allow users to select what sort of information/data they would like to receive.

Range of user ages	The range of ages of the target eTEACHER building users is very diverse and therefore the level of understanding and comprehension will vary within the sample.	• (M) use language and terminology that is accessible to all building users – therefore cannot be overly complex. • (S) use clear and concise text. • (C) provide options for text size, which may help some users.
App to be used across multiple countries	To add to the complexity of eTEACHER, it is being demonstrated in buildings ranging across three European countries.	• (M) Include options for English, Romanian and Spanish languages to be selected by users. • (C) Have multiple languages to select from for those users who are not fluent in English, Romanian or Spanish.
Capability of users	Not all building users have access to smartphones within the eTEACHER buildings and some are even prohibited from the use of smartphones. Therefore, alternative platform options need to be considered if we want to target all users. eTEACHER building users' understanding of energy is strongest when using cost and/or kWh. In general, using visual methods to communicate energy data is an effective approach to engage most users.	• (M) be accessible across multiple platforms – smartphone, tablet, laptop and desktop computer. • (W) supply ICT equipment to users to access the eTEACHER app on. • (M) Factor different understandings of energy into the design. Show savings and consumption data in cost and kWh consumption, using intuitive visual methods, to ensure comprehension for all users. • (S) put less focus on carbon footprint when referencing environmental impact as this was poorly received by building users.
Opportunities for users	Within eTEACHER pilot buildings, not all users have the opportunity to change behaviours due to restrictions within the buildings. This predominantly involved users being restricted in altering the thermal environment.	• (M) consider the opportunity available in each building. • (S) give advice around window use and/or blind/shade use and use of clothing to improve the thermal environment as this advice can be targeted to all users. • (S) target advice specific to HVAC system use to energy managers/facility staff/those users with the agency to alter behaviours. • (C) enable users to enter building-specific target behaviours into the app, to take into account local issues and opportunities.
Motivations of users	Some building users within the eTEACHER pilot buildings have a keen interest in energy use within the building and in using eTEACHER. Their feedback regarding what information they would like and what influences them needs to be taken into consideration. These users, and many others, may be more likely to continue to use eTEACHER if Gamification principles are employed to sustain engagement and motivation to use eTEACHER.	• (M) emphasise the benefits of the eTEACHER tool to users in terms of cost savings, environmental impact and potential benefits to personal comfort when using eTEACHER. • (S) include information on room temperatures, total energy consumption, energy saving advice and comfort enhancing advice. • (S) use a range of Gamification principles, such as rewards for daily use, social comparison, challenges and 'unlocking' extra features as progress is made. • (C) have a separate tile on the app menu which has a daily energy saving tip – this could be generic across all building types and users but changes daily to keep interest. • (C) also add comparison data for users,

		including before/after and comparison with other users/buildings.
User behaviour – lighting	Lighting use behaviour was identified as being one of the key behaviours to target across all buildings. 87% of all building users reported that lights are regularly left on in the buildings. Lighting Behaviours include: – Turning off lights when leaving a room or at end of day (all users) – Checking lighting levels and needs during day – reducing use of unneeded lights (energy/facility managers or staff) – Replacing bulbs with more energy-efficient ones (residents and building managers) – Installing improved lighting and controls (building managers) – Making use of natural light more (all users)	(M) sub-meter lighting energy at a whole building level at the very least. (S) aim to sub-meter lighting to room/apartment level. (C) give lighting use advice which factors in the natural sunlight available (with links to Lux measurements if possible). (C) have a daily reminder for switching off lights or set as a weekly challenge to gain a "reward". This latter approach keeps reminders salient, as daily reminders might be ignored after a couple of weeks.
User behaviour – appliances	Appliance use behaviours were reported as being key problems across most eTEACHER buildings, particularly in relation to the use of computers. 70% of building users reported computers being left on when not in use; 63% reported them being left on standby overnight. Appliance use behaviours include: – Ensuring appliances are not left on standby overnight – Changing default settings or manually using sleep/hibernate modes and 'screen off' when computer is not in use – Turning off computer if away from desk for any length of time – Turning off own computer at end of the day – Changing power mode to be more efficient – Choosing more efficient hardware and default settings (building managers) – Turning off chargers once fully charged – Turning off TVs/screens at end of the day – Turning off projectors when not in use – Turning off medical equipment if possible (staff)	(M) sub-meter appliance use, at the very least on whole building level but ideally at appliance level. (S) aim to monitor computer usage, given that it is identified as being a key energy use behaviour across all buildings. (S) give advice to all about remembering to switch off computers/appliances at end of the day. (C) include appliance energy saving tips in the daily tip section of the app. This could be combined with information on the energy savings from changes in behaviour (e.g. from switching to hibernate/sleep instead of leaving a workstation left on).
User behaviour – comfort	Heating use and comfort preferences were also reported as being an important behaviour to target across all buildings. 65% of users reported that the heating is often on when not needed in the eTEACHER pilot buildings. 63% also reported that additional heat sources are used by some to improve their own personal comfort. Heating use and comfort behaviours include: – Reducing thermostat temperature for heating – Managing temperature via clothing or activity rather than heating/cooling whole space – Increasing air-conditioning temperature set for cooling (energy manager/facility staff) – Ensuring that air-conditioning and heating not on at the same time (residents or energy manager) – Ensuring that if heating is on, windows and doors are kept closed (if possible) to keep the heat from escaping (all users) – Choosing more efficient systems or better use of	(M) sub-meter HVAC consumption on whole building level. (S) target advice on effective settings for HVAC to building managers/energy facility staff. (S) target advice to improve personal comfort to all building users.

	system settings (energy/building manager) – Reducing use of personal fans/heaters within the building	
User behaviour - engagement	Engagement with the eTEACHER interventions is a vital part of the design of the ICT tool. Without widespread user engagement with the tool, eTEACHER's success will be limited. Engagement behaviours include – Self-reporting energy-related behaviours in response to in-app activities and challenges – Reporting comfort levels to app in response to prompts (all users) – Viewing energy consumption of whole building (all users) – Viewing energy consumption of own room/apartment – Using eTEACHER tool to report any building issues (e.g. overheating, too cold, equipment failures etc.) with Facility Management (all users) – Using eTEACHER tool for Facility Management to report back to users the status of any issues in building (all users) – Viewing energy data for specific appliance use – Discussing energy-related issues, such as sharing tips and suggestions with other building users	• (M) record users' engagement with eTEACHER tool in order to analyse how they use the tool, how prolonged their use is and what features they respond best to. • (S) allow users to report and discuss issues within the building, but also receive feedback from Facility Management regarding the progress of the issues. If resolved as reported, users are more 'forgiving' of unsatisfactory conditions if they are made aware of progress. • (S) encourage prolonged engagement by showing personalised energy information (building level at least, room level ideal). • (C) use charts/rewards/pledges/ladder to show personal improvement made (environmental impact & cost) through personal actions taken in the building. • (S) take user preferences into consideration regarding styles of app (future research would be needed with building users to gain their feedback on this).

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1 Introduction

The eTEACHER[1] project aims to develop an Information and Communication Technology (ICT) tool-box which empowers energy end-users to achieve energy savings and improve comfort and health conditions within buildings through enabling behavioural change. This will be achieved through providing tailored interventions that result in significant energy savings and better productivity, health and comfort levels.

As part of the project, social studies will be used to characterise energy end-user's behaviour, relating them to frameworks for building types and user types, and identify effective ICT-based behavioural change techniques that are appealing, user friendly and encourage users to save energy by optimising their comfort. These social studies form the basis of Work Package 1 (WP1), Design for Behavioural Change for Energy End-Users. WP1 focuses on: understanding energy end-users (building occupants, visitors, facility manager(s), staff, students etc.); uncovering key factors influencing energy behaviours; identifying relevant techniques to motivate behaviour change and, in particular methods for engagement between building users and the final eTEACHER ICT tool-box.

Energy use behaviour is resultant of wide-ranging individual and contextual factors. As introduced in D1.1 (Morton, Reeves & Bull, 2018), contextual factors such as the installed energy systems and building controls are a key influence on energy use in buildings. However, a significant influence also comes from the individual and social factors, such as norms of behaviour, the ability and agency for using energy systems in the building, and users' understanding of how energy systems work. This often means that energy use in buildings can vary dramatically from one building to the next; even those of similar construction. Three factors were introduced in D1.1 as being the main influences on energy use in a building – the building fabric and its physical performance, the energy system within the building and the occupants of the building. It was identified that eTEACHER aims to target the overlap between human factors and the building fabric and building services, to reduce energy consumption. However, this overlap of human factors with building factors will vary depending on the building typology and its use, which will vary significantly between domestic and non-domestic buildings. Within domestic buildings there is often a direct connection with the users' energy use and the cost the user pays for energy, however within non-domestic buildings there is often no direct connection to the personal wealth of individual employees/users of non-domestic buildings (EEA, 2013). Often motivation for energy efficiency engagement within non-domestic buildings is reliant upon corporate and social responsibility objectives and societal norms, with company policy and regulations having a significant impact. Policy and regulations within non-domestic buildings could potentially limit eTEACHER ICT interventions if there are strict policies regarding the use of IT equipment or restricted access to websites.

As highlighted in D1.1, there is a wealth of literature on behaviour change programs and often these emphasise the need to design behaviour change interventions around specific behaviours undertaken by specific actors in a given context. Therefore, it is vital for eTEACHER to consider each stakeholder and

[1] eTEACHER stands for: end-users Tools to Empower and raise Awareness of Behavioural CHange towards EneRgy efficiency

associated behaviour specifically in the context of the building in which they use/manage. This report presents outputs from the second task in WP1, Task 1.2, "Analysis and characterisation of end-user behavioural issues", building upon the knowledge identified during Task 1.1 and reported in D1.1, specifically within the context of the eTEACHER pilot buildings and the building users.

1.1 Aim

The aim of Task 1.2 was to identify the key behavioural factors influencing energy use for each eTEACHER case study building. Therefore, to gain this understanding it was vital to collect information on each building summarising key building design features and energy system control interfaces as well as information on the building users themselves. This building user information needed to focus upon: users' energy-related needs and whether these are being met; control processes and interfaces and how these are understood and used in practice by building users and building users' motivations for change and ideas for improvements within each building.

1.2 eTEACHER case study buildings

The eTEACHER project focuses on twelve different pilot buildings, varying in location, building typology and building users, creating a diverse sample including both private and public buildings. The pilot buildings are located in three different European countries, which are Spain, United Kingdom and Romania. A summary of the pilot buildings location, typology and use are included in Table 1.

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 End-user Behaviour change in eTEACHER

Wolfe et al (2014) points out that to achieve deep and sustained energy behaviour change in users, behaviour change programmes need to be systematic and well-designed and go beyond "simple" competitions or lobby energy displays. Engagement of users with behaviour change programs is vital. Various behaviour change methods have been reported in the literature, all aiming to encourage behaviour change and improve energy conservation. These methods include; feedback, providing information/education, rewards or incentives, commitment and goal settings, gamification, social marketing and communities, changing defaults and nudges, energy audits and many others. Behaviour change interventions are often designed differently given the context of the research aim. For example, behaviour change interventions in the domestic sector has typically focused on feedback to users via in-home displays or monitors (Anderson and White, 2009; Parker, Hoak and Cummings, 2010; Ueno, Tsuji and Nakano, 2006; Wood and Newborough, 2003 and 2007; Hargreaves, Nye and Burgess, 2010; Darby, 2006). Since there is often a direct connection between energy use and cost for users within domestic sector, it is perceived that users will change behaviours once they are given information which increases their awareness or knowledge of their energy use and the implications (often cost savings) of changing their current usage. Within the non-domestic sector, behaviour change interventions have typically focused on feedback or gamification. Feedback within the non-domestic sector has been given in various forms including personalised energy feedback (Coleman et al., 2013; Murtagh et al., 2013) and comparative feedback (Siero et al., 1996). Various gamification interventions have also been implemented in non-domestic buildings with varying levels of success (Grossberg et al., 2015) ranging from serious games, to interactive displays, rewards and competitive challenges. One of the key challenges within implementing behaviour change programmes is maintaining engagement with users as often behaviour change interventions are aiming to change user habits and habit formation is known to take time. It should also be noted that user relationships between behavioural factors are dynamic and not static and so may change over time. Therefore, a successful behaviour change intervention has to be one that can ensure persistent engagement with flexibility for changing priorities.

Currently there is a lack of literature on implementing behaviour change interventions across different building or user typologies. Given that eTEACHER involves various pilot building typologies, both domestic and non-domestic, with a multitude of different users, it is vital that the context behind each building is understood fully. Therefore, the challenge for eTEACHER is to design a solution which meets the needs of different user groups and requirements of different building types in one ICT based tool.

As mentioned in Section 1.1 the aim of Task 1.2 is to collect data and analyse the end-user behavioural issues within the eTEACHER pilot buildings and, through characterisation of these issues, make recommendations on the design of the eTEACHER ICT tool (alongside Task 1.3, which focuses specifically on the ICT element of the design recommendations), which consider the varying typologies.

2 Data Collection Methods

2.1 Introduction

Task 1.1 investigated key concepts to enable effective behaviour change design and within D1.1 the COM-B behavioural model was introduced, a framework used to describe the influences on a behaviour. The COM-B framework, shown in Figure 1, highlights three key influences on human behaviour. Core to the framework is the assumption that users' capability (physical or mental) and their opportunity (social or physical) relates to their motivation to carry out a specific behaviour and that each of these constructs influences and is influenced by the behaviour itself.

Figure 1 COM-B Model (Michie, Stralen and West, 2014)

Within D1.1 the COM-B model was recommended as an aid to help the design of data collection methods for Task 1.2 due to the importance of understanding the capability, opportunity and motivations of users within each eTEACHER pilot building in relation to specific energy behaviours, taking into consideration the technical, infrastructural and behavioural factors influencing energy use in each building. This meant uncovering users' motivations towards energy efficiency and their attitudes towards energy conservation schemes and the importance of improving energy use within each building. However, users' motivations are influenced by their capability and opportunity and therefore it is important to understand the capability of users regarding their agency towards specific behaviour changes and interventions. The opportunities for change within each pilot building relate to the wider context for specific behaviour change, taking both the building context into consideration as well as the technical feasibility within the project (technical capabilities, monitoring requirements, budget constraints etc.) Within eTEACHER the social opportunity could play a key part in the successful uptake of the ICT tool as it includes whether social norms and expectations support or hinder the performance of behaviour, so engagement with users is key to ensure that social norms are formed, integrating the use of the eTEACHER tool within each building and the users.

To discover the current end-user energy behaviours as well as the capabilities, opportunities and motivations of users within the eTEACHER pilot buildings, four main data collection methods were used: pilot building site visits, project partner worksheets, building user questionnaires and a technical focused workshop bridging together the project requirements within work package one, two and three.

2.2 Pilot building Site visits

As part of the T1.2 data collection, site visits were carried out to each of the eTEACHER pilot buildings. These visits were not only a means to gather data on each pilot building but also to better appreciate the buildings, their users and the potential for implementing a behaviour change intervention within the building.

During the visits, five main areas of information were gathered to create a richer picture of each of the pilot buildings and some of the user behavioural issues. The five main areas included:

1. **User types** – who are the different users of the building?
2. **Building use** – what is the building used for? What is the primary function of the building? Any additional uses?
3. **Energy system and management** – what type of heating/cooling systems are used? Any other energy uses in the building? Is there any energy management in the building – system or person? Who has access to change settings – Building Energy Management Systems, temperatures etc.?
4. **Data** – what data is available currently – energy, occupancy, users' perceptions? Is data collected on a whole building level or is it separated in any way? Is the data used for anything currently? Do users of the building see any energy data for the building, and if so in what format?
5. **Behaviour change** – who is it that should/can be targeted for behaviour change in the building? Any distinctive problem behaviours currently in the building? Any desired behaviour change?

Notes and photographs from each of the pilot site visits have been included in the relevant building appendix (Appendices 9.1-9.9).

2.3 Partner worksheet

As presented in D1.1 (Morton, Reeves & Bull, 2018, Appendix B P56), project partners were given a worksheet to complete following the online behaviour change training sessions, which formed part of WP1 T1.1 work. The worksheet was developed to introduce the concept of the Enabling Change Framework and how it may apply to the eTEACHER pilot buildings, as well as being a means to start the initial data collection on the pilot buildings, their users and any prominent energy behaviours.

Of relevance to T1.2 was 'Step 1: Building user overview' and 'Step 3: Identify specific behaviours of the building'. The findings from both of these steps can be found in the relevant building appendix (Appendices 9.1-9.9).

2.4 User behaviour survey/questionnaire

A key part of T1.2 was to collect data from building users regarding their use of the building and energy related behaviours; therefore, a user questionnaire was used within Task 1.2. Due to time constraints and an initially low awareness of the eTEACHER project in each pilot building, it was decided to distribute the questionnaire during the workshops being held as part of Task 1.3, therefore covering a range of building user types. It was vital that the questionnaire was designed to be as clear and concise as possible given the range of different building users being included in the T1.3 workshops. Therefore, the questionnaire was split into seven main sections, covering the requirements of Task 1.2 and Task 1.3;

1. All about you – this allowed collection of some basic demographic data on the building users, particularly the age brackets of users
2. ICT & you – aimed at uncovering data on ICT ownership and use of ICT
3. The building & you – this allowed identification on user types and use of each building by relevant user types as well as ICT usage within the building
4. Energy & you – aimed at uncovering more about users' attitudes towards energy use and understanding as well as identifying current energy behaviours occurring in each building
5. Comfort & you – this allowed collection of data regarding how comfortable users were in the buildings and what agency and access they had to altering the thermal environment
6. Motivation & you – aimed at discovering building users' motivation and potential engagement with an energy conservation scheme
7. Importance of others & you – this allowed collection of data on potential impacts of social norms within each building and the opportunities for encouraging energy communities to enhance engagement as part of eTEACHER.

The questionnaire distributed to the building users can be found in Appendix 9.10.

In total, 115 questionnaires were completed across the 12 pilot buildings. It should be noted that when the data from the completed questionnaires was inputted into SPSS (version 22.0, IBM Corporation) for analysis, it was found that some questions may have caused some confusion with the participants. The two questions which caused some confusion were over the definition of Energy managers as it was discovered in Djanogly and the Council House that the respective people who were in control of the energy systems within the building were not classed as energy managers but rather just as building staff. Secondly the question surrounding how often users used the building cause some confusion with students, as a number of student participants selected that they used the building on a weekly basis instead of daily (due to consideration of the weekend in the daily definition). Given that these errors were identifiable, an amended analysis file was created which included the corrections to the original data set as listed in Table 2.

Table 2 Changes made to original questionnaire data file for analysis

eTEACHER participant	Definition of change made to original data file
P96	User category changed from STAFF to ENERGY/FACILITY MANAGER/CREW
P103	Use of building changed from WEEKLY to DAILY
P106	Use of building changed from WEEKLY to DAILY
P108	Use of building changed from WEEKLY to DAILY
P115	User category changed from STAFF to ENERGY/FACILITY MANAGER/CREW

2.5 Technical workshop

As mentioned in Section 2.1, a technical workshop was used to bridge together the project requirements within work package one, two and three, ensuring that the opportunity for behaviour change interventions was acknowledged from a technical feasibility understanding. To do this relevant project partners came together in Dresden, Germany for a one-day workshop. Within eTEACHER, the design of the ICT tool is influenced by the connection between WP1, WP2 and WP3. WP1 is seen as the basis for the eTEACHER project and the recommendations made within WP1 factor into the ICT design work packages, as well as the demonstration work package (WP4). The workshop was used as an opportunity for work package leaders from WP1, WP2 and WP3 to introduce their understanding and work plans to each other as a means to gain a mutual understanding of each other's work and what is needed from each work package in order to ensure the success for the design of an ICT-based tool.

The workshop was led by DMU (behaviour change researchers) and was used to introduce some of the initial behaviours identified within each of the eTEACHER pilot buildings and potential ideas for design recommendations. A key objective of the workshop was to identify what was technically feasible and therefore an emphasis was put on understanding the current situation in each pilot building regarding behaviours being exhibited and the data available on such behaviours. To assist all partners' understanding of each pilot, a master table was created ahead of the workshop by WP1. This table aimed to showcase each pilot building, user requirement classifications identified, building users' behaviours (split into every day users and managerial user behaviours) and the data available. A snapshot of part of the table can be seen in Figure 2.

The user requirements listed were:

1. Lighting
2. Heating & Cooling
3. Appliance use
4. Window & Door use

5. Engagement
6. Others – Hot water etc.

eTEACHER Pilot Buildings		School buildings		
		Djanogly, UK	Torrente Ballester High School, Miajadas, Spain	Arco Iris Kindergarden, Miajadas, Spain
User Requirements	**Behaviour & Data**			
Lighting	User Behaviour - **use of lighting; leaving lights on** Manager Behaviour - **choice of efficient lighting; choice of controls, inc. possible automation**	All building users influence	All building users influence (lights tend to be left on in empty classrooms)	All staff can access light switches which rely on manual use in afternoons -often left on when not needed.
	Data - electricity consumption of lighting in building (Red - electricity not split into lighting use, Amber - only split into lighting use for whole building, Green - split into lighting use at apt./floor/room level)	Only have whole building electricity - sub metering required to separate out lighting use.	Only have whole building electricity - sub metering required to separate out lighting use.	Only have whole building electricity - sub metering required to separate out lighting use.

Figure 2 Example of information included in Master Table created for Dresden workshop

To emphasise the challenge of monitoring specific behaviours in each of the buildings, the data availability was colour coded using a traffic light system (green = data available currently on the behaviour, orange = data available on the behaviour but on a whole building level, red = no data available on behaviour). Project partners discussed each relevant user requirement and data availability issue in turn and decisions were taken forward regarding recommendations and how best to proceed – whether specific behaviours should be focused on and what was involved for monitoring that behaviour (monitoring kit and specific implications regarding data flows).

3 End-User behaviour

3.1 Introduction

User behaviour forms a large part of the eTEACHER project given the desire to create energy savings and improve well-being within each eTEACHER pilot building through enabling behaviour change of the energy end-users. Therefore, WP1 needed to focus on understanding more about all end-users within each building, their agency within the building as well as their attitudes and motivations towards energy savings. This section presents some of the results found on end-user behaviour in each of the eTEACHER pilot buildings from the pilot site visits, partner worksheet and building user questionnaire, as introduced in Section 2. The results show a detailed picture of who the users are in each building, how they use the buildings, recommendations for target users and current end-user energy behaviours being exhibited within each pilot building.

3.2 Users of case study buildings

In addition to the variation in building type and use within eTEACHER, there are also different user types within each of the buildings. Through the use of the project partner worksheets and site visits, all user types within each eTEACHER building were identified, as summarised in Table 3. Different building users will likely use each of the eTEACHER pilot buildings differently depending on what type of users they are. This means that the way they use the building will vary, the duration for which they are in the building will vary, their agency within the building and ultimately their engagement towards an ICT-based tool enabling behaviour change will vary. Therefore, it is important to identify all users of each building and their use of each building to specify which users should be targeted by eTEACHER.

Table 3 User types identified within each eTEACHER pilot building

eTEACHER building	User types
InCity (4 separate blocks – A, B, C & D)	Building manager/energy manager Tenant/Owners Facility crew
Villafranca	Building manager/energy manager Staff – Administrative Staff – Doctors/nurses Staff – Cleaning crew Patients
Guareña	Building manager/energy manager Staff – Administrative Staff – Doctors/nurses Staff – Cleaning crew Patients
IES Torrente Ballester	Building manager/energy manager Staff – teaching Staff – general (incl. administrative staff, kitchen staff, cleaners and maintenance) Students
CEI Arco Iris	Building manager/energy manager Staff – teaching Staff – general (incl. administrative staff, kitchen staff, cleaners and maintenance) Infants (4months – 3 years) Parents
OAR	Building manager/energy manager Staff One off users' - Members of public
Av. Godofredo Ortega y Muñoz Residential Apartment Block	Building manager/energy manager Tenant/Owners Facility crew
Council House	Building manager/energy manager Staff – administrative Regular users – councillors, court hearing attendees, stakeholder meeting attendees One off user's – events, ceremonies, members of public
Djanogly City Academy	Building manager/energy manager Staff – teaching Staff – general (incl. administrative staff, kitchen staff, cleaners and maintenance) Students

The building user questionnaire was distributed to users during Workshop Ask, part of Task 1.3, as the workshop aimed to recruit a representative sample of all building users from each building, therefore aiming to achieve a balanced picture relating to the use of the eTEACHER buildings and their users. However, certain building users, particularly those who only occasionally use the building, were harder to recruit and as such Figure 3 shows the building users types which were recruited to take part in Workshop

Ask for T1.3 and those who completed the questionnaire (detailed in Section 2.4) from each of the eTEACHER pilot buildings.

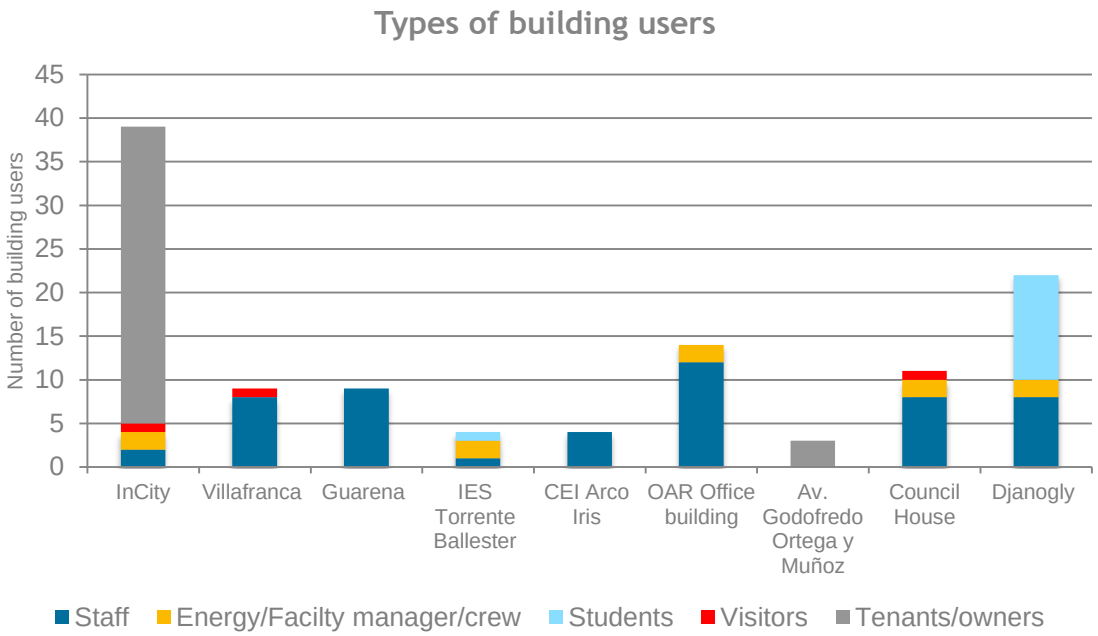


Figure 3 Building user typologies represented in each eTEACHER building within the building user questionnaire

As can be seen in Figure 3, the number of building users from each of the pilot buildings did vary significantly which was mainly down to access issues, time constraints of building users (particularly those who may only use the buildings for a short period of time) and the fact that the Workshop was scheduled to last two hours which may have put off some users. However, as Figure 3 shows, most buildings had a range of building user types represented. Within the residential properties this was typically apartment owners/tenants and energy/estate staff, within the Health Care Centres it was typically staff members, in Schools it was typically staff and students with some energy/estate staff and in the Office buildings staff were the main representation with some energy/estate staff also present.

The age of building users' needs to be considered during the design, as different age groups have different levels of understanding and therefore terminology used by the eTEACHER interventions should be aware and designed accordingly for the age brackets of target building users. Figure 4 shows the different age brackets represented within the questionnaire responses, demonstrating a large variation in the ages of building users.

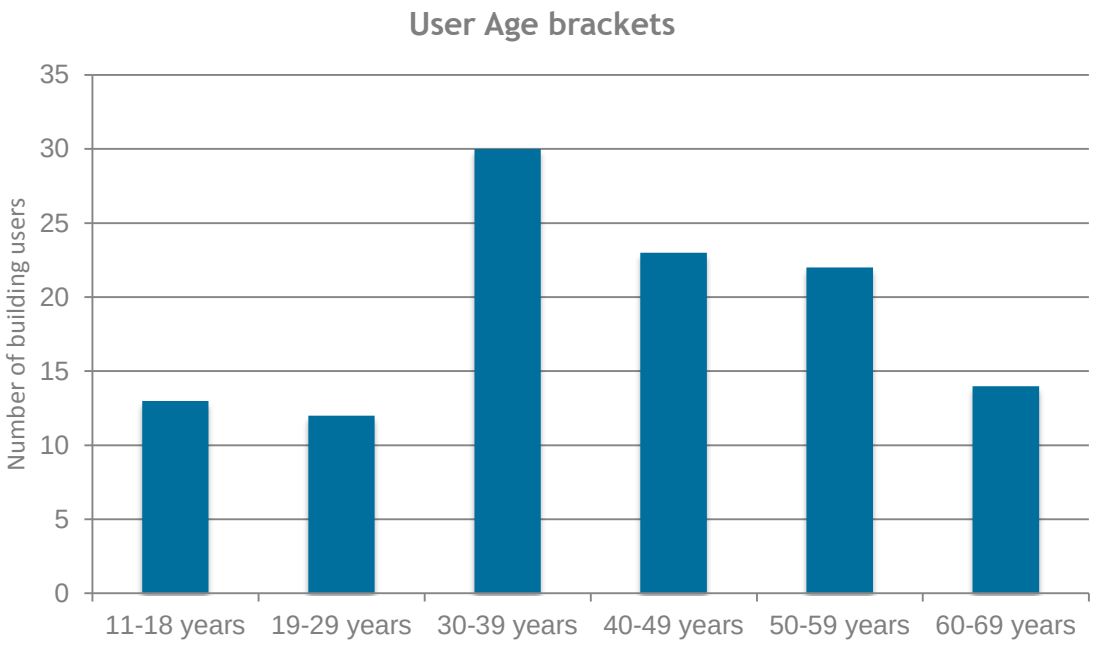


Figure 4 Age brackets represented across eTEACHER buildings within the questionnaire responses

How often users actually use the pilot buildings is another key consideration for the eTEACHER tool as those who use it rarely may be less likely to engage with the eTEACHER project and interventions. Figure 5 shows that 90% of the users which completed the questionnaire use the pilot buildings on a daily basis, with only 5% indicating yearly, rarely, or gave no answer. Within the sample of building users 77% stated that they typically spend between 6 and 12 hours within the building on a daily basis, as shown in Figure 6.

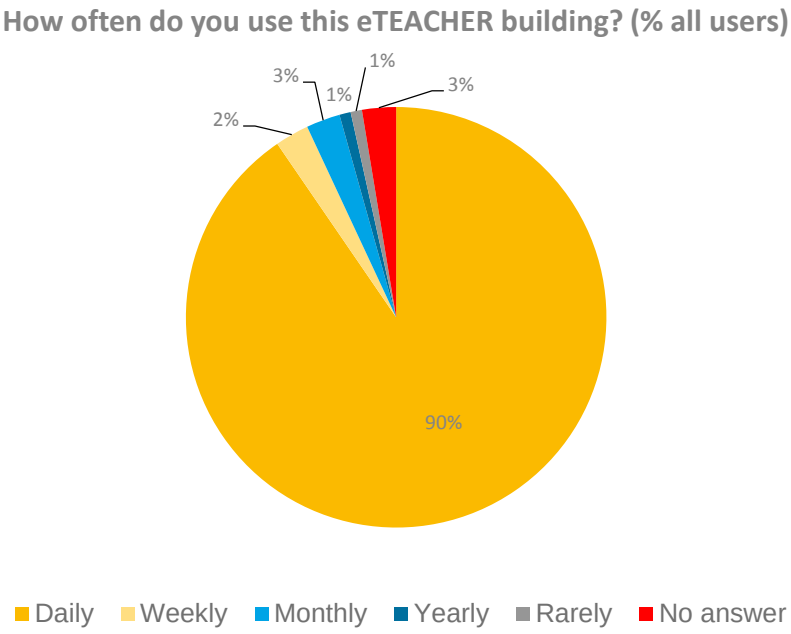


Figure 5 Questionnaire responses highlighting how regularly building users use eTEACHER pilot buildings

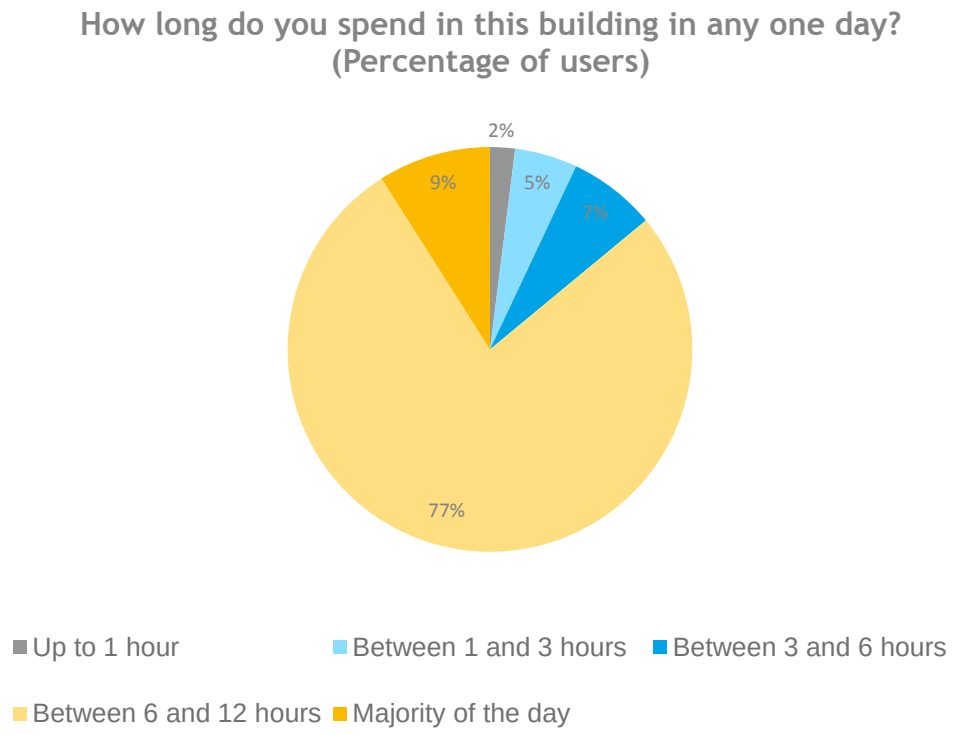


Figure 6 Building users' duration spent within eTEACHER pilot buildings on a daily basis

Therefore, most of the building users who completed the questionnaire typically spend a high proportion of their day within the pilot buildings. This indicates that the users represented within Workshop Ask are ideal target end-users for the eTEACHER interventions as they are likely to engage with them over time and are therefore more likely to alter their behaviours within the buildings, given that new habit formation does take time, as mentioned in Section 1.3.

3.3 Target end-users for eTEACHER

Given the data collected on each of the eTEACHER pilot buildings and the representation of building users who were happy to participate in the Workshop Ask/Building User questionnaire, recommendations are given in Table 4 relating to which end-users in each building should be targeted for the eTEACHER ICT based tool intervention.

Table 4 Recommendations of target end-users for eTEACHER within each pilot building

eTEACHER building	Recommendations	Target end-users
InCity and Av. Godofredo Ortega y Muñoz	As energy use within each individual apartment is likely to vary significantly, it is important to target the current occupiers of the apartments, be that the owner or tenants. The energy manager and facility staff should also be targeted by eTEACHER as they have control over the building's heating system and settings for communal areas of the building.	Apartment owners or tenants Energy manager and facility staff
Health Care Centres Villafranca and Guareña	Within the health care centre members of the public are normally using the building to attend appointments or seek emergency medical assistance, and therefore the time they spend in the building may vary. However, it is likely to be that they have irregular use of the building. Given this and the fact they are there for medical assistance, it is unlikely that members of the public will engage with eTEACHER. The building manager is external to the building (Regional Public Health Service) and therefore only has sporadic use of the building. Similarly, the building facilities are managed/maintained by third parties (either through public maintenance service or subcontractors). For regular engagement with eTEACHER the recommended target would be all staff who use the building consistently (doctors, nurses, cleaners, emergency crew, etc.).	All staff and potentially the building management of facilities
IES Torrente Ballester	During the site visit it was noted that previously there has been campaigns involving the students which have aimed to conserve energy (via lighting), water and to reduce waste; therefore, students would likely engage with eTEACHER and should be considered as a target within the eTEACHER design. The school is managed externally (by Regional Public Education Service) and therefore any major changes (such as refurbishment) need to be signed off by the external management. As the building manager is not an everyday user of the building, the main target for eTEACHER should be the staff within the building (including the facility manager).	All staff (including the facility manager) and students
CEI Arco Iris	Within the kindergarten the children are aged between 4 months old and 3 years old and therefore eTEACHER should not focus on them. Similarly, the infants' parents/guardians are only in the building for a short period of time each day to drop off and collect the infants and so are unlikely to engage with eTEACHER. Within CEI Arco Iris, it was identified that the receptionist typically checks heating settings within the building and makes weekly checks on the boilers as well as ensuring lights and splits are off at the end of each working day.	All staff
OAR and Council House	Within the office buildings, eTEACHER should target all staff members (including the building manager, energy manager and facility staff) as they are the most regular users of the building. Members of the public typically spent a short period of time in the building and on an irregular basis and therefore are unlikely to engage with eTEACHER. In OAR it was also noted during the site visits that the members of public only have access to a small proportion of the building on the ground floor so are unaware of many of the energy use conflicts identified within the building.	All staff Energy manager/facility staff
Djanogly City Academy	Within Djanogly it was noted that the students are keen to be actively involved with eTEACHER and therefore likely to engage fully and should be considered as a target in the eTEACHER design. HVAC settings are controlled through facility staff and therefore it is vital to engage with these staff members as well as teachers and administrative staff.	All staff (including the facility manager) and students

3.4 User behaviours in each pilot building

This section describes current energy related behaviours occurring within each of the eTEACHER pilot buildings. These behaviours were identified from behaviours noted during pilot site visits and those reported within the building users' questionnaire. Within the questionnaire, users were asked to select all behaviours that they were aware of occurring within the building from the following list:

- Lights being left on in empty rooms
- Heating being left on when not needed
- Computers being left on stand-by overnight
- Chargers being left plugged in but not being used
- Additional (and often unnecessary) heat sources being used
- Thermostats set too high
- Heating being left on in areas not being used
- Computers being left on when not in use
- TVs being left on
- Air-conditioning on when not needed
- Additional cooling sources being used
- Inefficient use of appliances (dishwashers half full, washing at high temperatures etc.)
- Other

The option of 'Other' was given to allow users to identify any other examples of energy being wasted in the building that they were aware of.

3.4.1 InCity residential buildings

The InCity residential buildings include four separate blocks of apartments, referred to as buildings A, B, C and D. The questionnaire responses included representatives from all of the separate apartment blocks as well as facility/building energy staff who work across all four of the buildings. Figure 7 shows which energy behaviours were reported as currently occurring within the InCity residential properties. As it can be seen, all of the suggested behaviour examples were selected by at least one of the building users from the examples given, although the percentage of users reporting each behaviour varied. The most prominent behaviours being reported within the InCity residential properties were:

- Lights being left on in empty rooms (100% of users)
- Heating being left on when not needed (85% of users)
- Computers being left on stand-by overnight (69% of users)
- TVs being left on (74% of users)
- Air-conditioning on when not needed (72% of users)

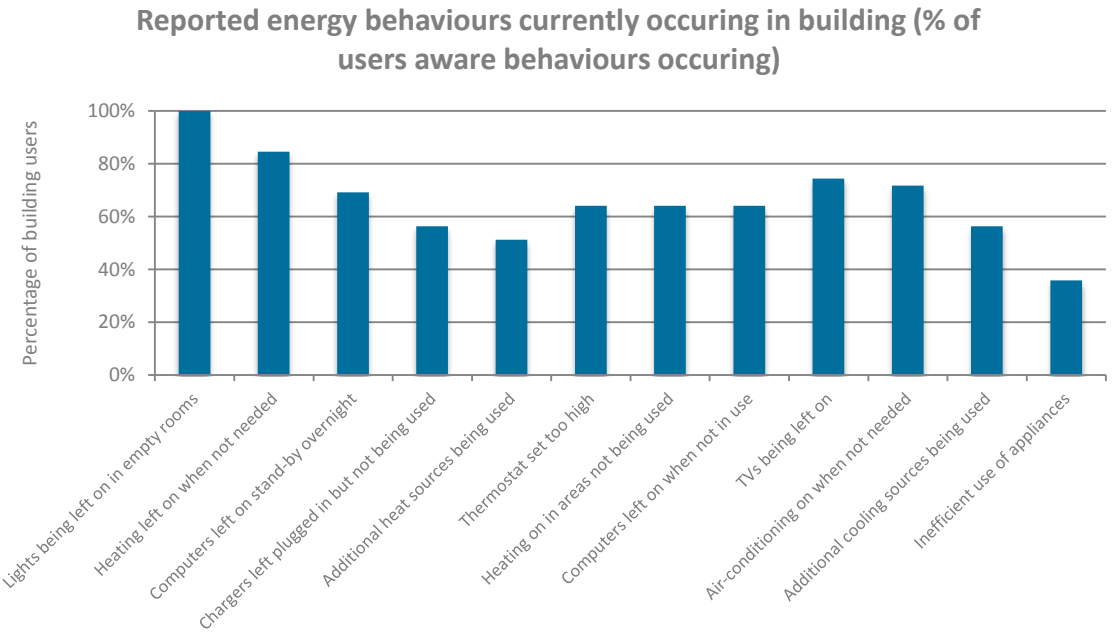


Figure 7 Reported energy behaviours currently occurring in the InCity residential buildings

During the pilot visit it was reported that a common complaint within the building surrounds the heating and hot water. This is due to the building management system setting the maximum temperature for the heating and hot water within the buildings and the fact that residents can only lower the temperature in their apartments through radiator valves. Therefore, residents are often complaining that the heating or hot water is not set high enough. It is also worth considering that the InCity buildings are four separate buildings and therefore each has slightly different coordinates and may have varying levels of incoming solar radiation or be affected by wind differently. To see if this causes an obvious difference in the behaviours being reported in each of the buildings, Figure 8 shows the percentage of each building's users reporting the behaviours which occur in their building. The energy manager and facility staff have access to all four buildings and therefore their responses to the behaviours across all buildings are shown by InCity ABCD label.

As Figure 8 shows, there is typically a very similar picture to what behaviours are occurring across all of the buildings with only Building C users reporting it is less common for additional heat sources to be used within that building. The energy manager and facility staff all reported (100% of responses) that lights being left on, heating being left on, computers left on stand-by or when not in use, thermostat too high and additional cooling sources being used as common energy behaviours occurring currently across all of the buildings.

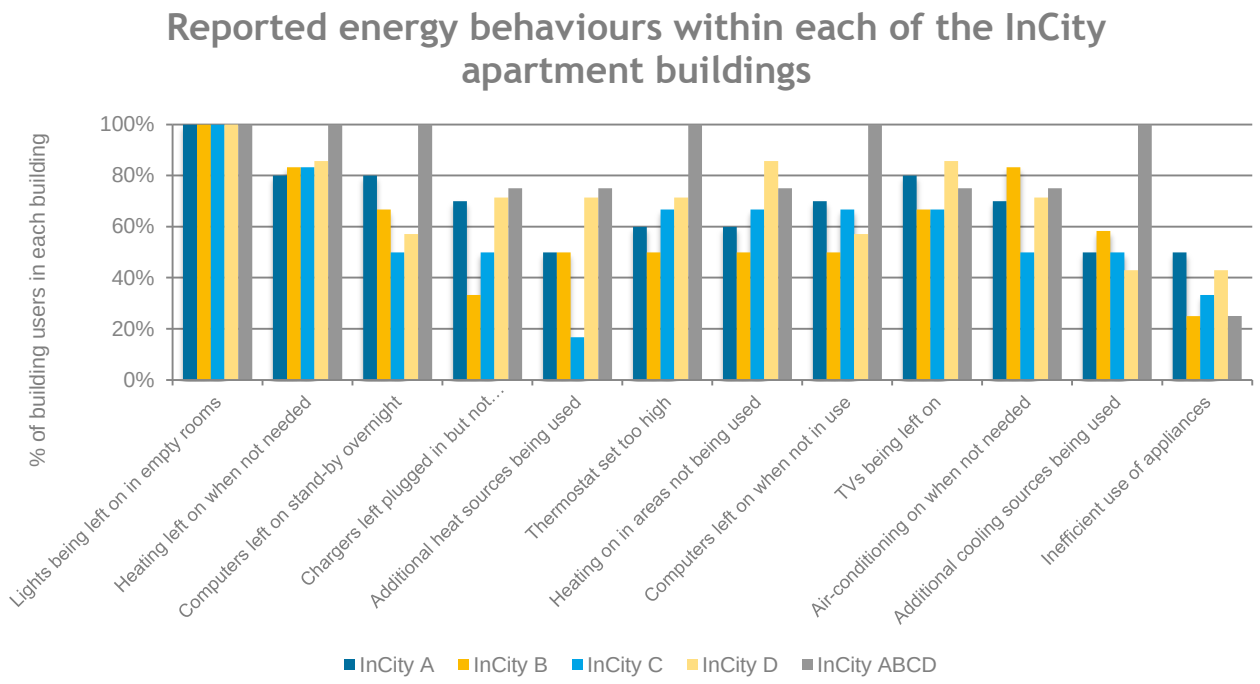


Figure 8 Reported energy behaviours currently occurring within each of the InCity residential buildings

3.4.2 Villafranca Health Care Centre

In the Villafranca Health Care Centre the building is typically used daily for appointments and emergencies between 8am and 3pm with the emergency department remaining open 3pm till 8am. Cleaning crew tend to use the building 3pm till 7pm daily. The questionnaire responses included representatives from different staff types within the building. Figure 9 shows which energy behaviours were reported as currently occurring within the Villafranca Health Care Centre. As it can be seen all of the suggested behaviour examples were also selected by at least one of the building users from the examples given, although the percentage of users reporting each behaviour varied. The most prominent behaviours being reported within the Villafranca Health Care Centre were:

- Lights being left on in empty rooms (100% of users)
- Heating being left on when not needed (100% of users)
- Computers being left on stand-by overnight (78% of users)
- Additional heat sources being used (78% of users)
- Heating on in areas not being used (78% of users)
- Computers left on when not in use (78% of users)
- Air-conditioning on when not needed (78% of users)

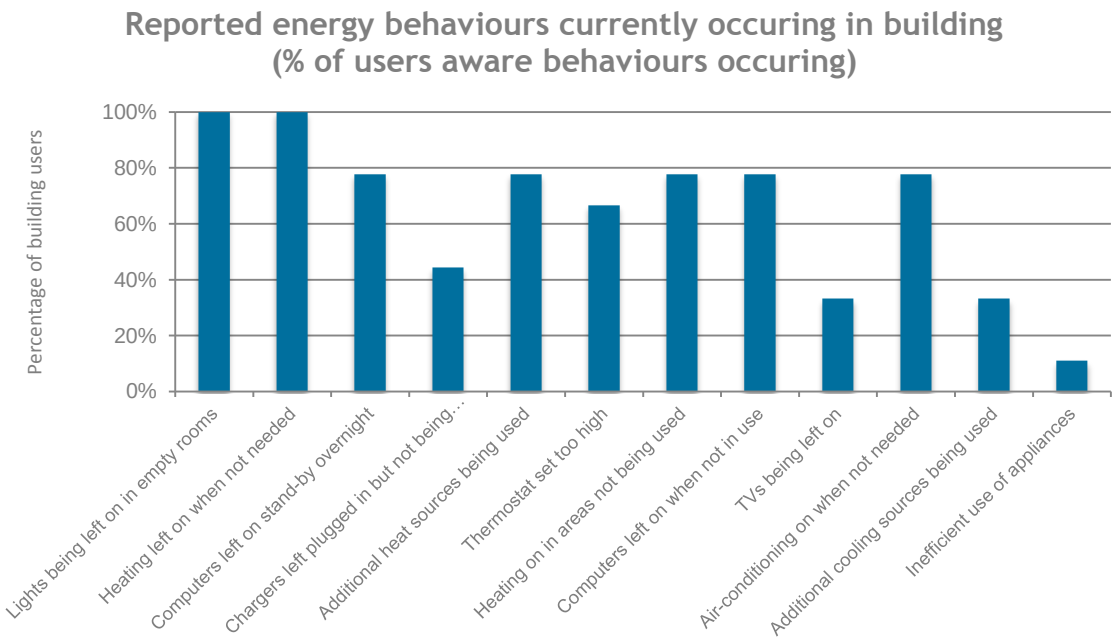


Figure 9 Reported energy behaviours currently occurring in the Villafranca Health Care Centre

During the site visit it was observed that there were many individual room or zone thermostats located within consultation rooms or even outside of rooms in the main hallway used as waiting space. Therefore, temperature settings are currently available to both staff and patients. The main issue identified during the visit was that a lot of heat is lost from the main entrance doors letting large drafts into the building. There is also a fan heater above the entrance, so a high proportion of the heat generated from this is likely lost out of the entrance, which is wasted energy. It was also reported during the visit that staff often open windows to improve their own personal comfort even when the heating is on.

3.4.3 Guareña Health Care Centre

In the Guareña Health Care Centre the building is typically used daily for appointments and emergencies between 8am and 3pm with the emergency department remaining open 3pm till 8am. Some staff will work longer hours than those of the typical daily schedule and when this happens lights are often left on. The questionnaire responses included representatives from different staff types within the building. Figure 10 shows which energy behaviours were reported as currently occurring within the Guareña Health Care Centre. As it can be seen, not all of the suggested behaviour examples were selected, with no users indicating that the thermostat is set too high or that there is inefficient use of appliances in the building. As with other eTEACHER pilot buildings, the percentage of users reporting each behaviour varied. The most prominent behaviours being reported within the Guareña Health Care Centre were:

- Lights being left on in empty rooms (67% of users)
- Computers being left on stand-by overnight (67% of users)
- Additional heat sources being used (78% of users)

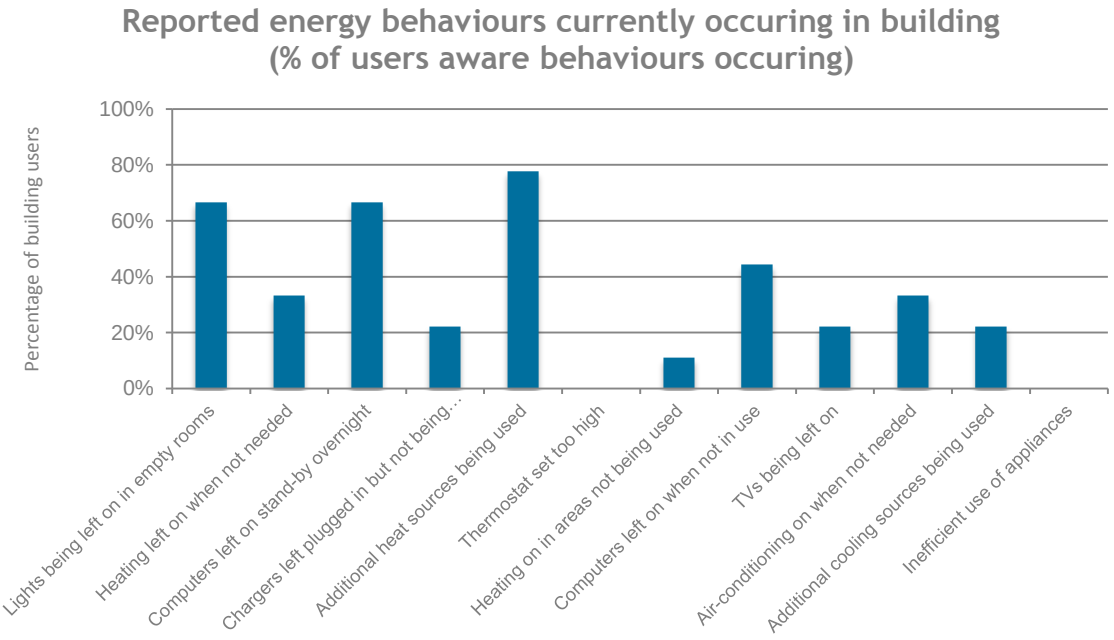


Figure 10 Reported energy behaviours currently occurring in the Guareña Health Care Centre

During the site visit, it was observed that the Guareña health care centre has a similar problem to the Villafranca health care centre in that main entrance doors, and even side entrance doors, appear to be letting a high proportion of heat energy escape out of them. During the visit, signs were visible on the side entrance door asking users to ensure that the doors were closed behind them. There were signs observed on the toilets which asked users to ensure that lights were switched off after use to try and conserve lighting energy consumption. It was also reported during the visit that not all rooms have individual thermostat controls and a large proportion of the rooms are controlled by thermostats which are kept behind the main reception desk. Staff were reported as requesting receptionists to alter specific thermostats to ensure that their own consultation rooms are to their own comfort preferences.

3.4.4 IES Torrente Ballester High School

The IES Torrente Ballester High School building is typically used during weekdays from 8am – 2pm by students and cleaning crew tend to use the building 3pm till 7pm during term time. In July only the teachers use the building and it is closed during August for the summer break. The questionnaire responses included representatives from different staff types and one student. Figure 11 shows which energy behaviours were reported as currently occurring within IES Torrente Ballester High School, as it can be seen that not all of the suggested behaviours were selected, with no one reporting that the thermostat is set too high, TVs being left on or the inefficient use of appliances. It should however be noted that the responses are from four building users, constituting a low representation of all of the building users, and the percentage reporting each behaviour did very significantly. The most prominent behaviours being reported within the IES Torrente Ballester High School were;

– Lights being left on in empty rooms (100% of users)

- Computers being left on stand-by overnight (75% of users)
- Additional heat sources being used (75% of users)
- Computers left on when not in use (75% of users)

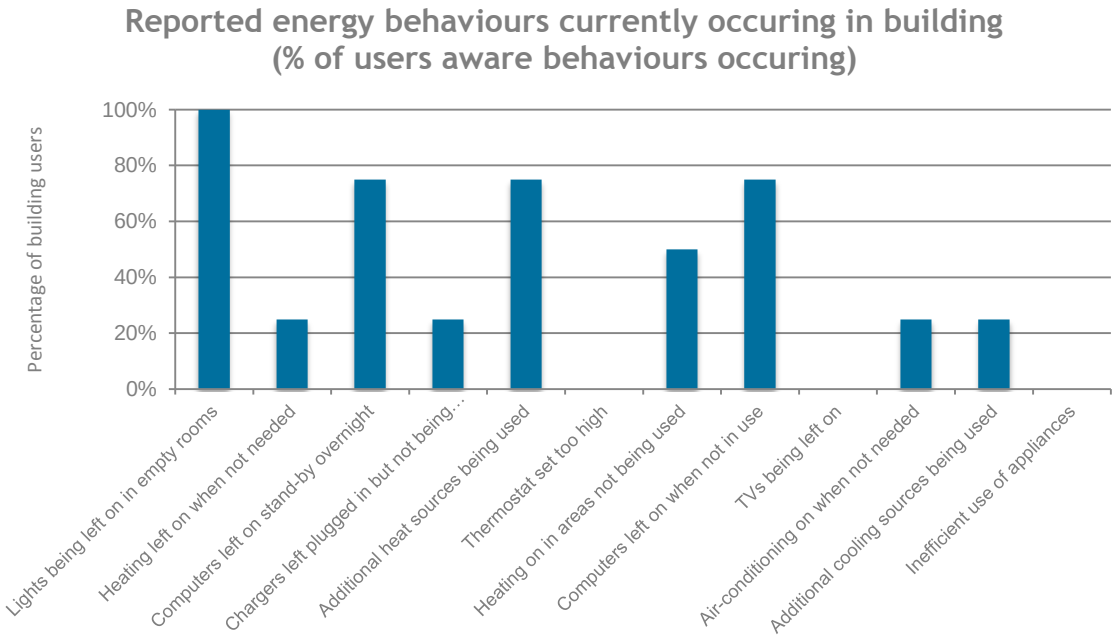


Figure 11 Reported energy behaviours currently occurring in the IES Torrente Ballester High School

During the site visit to Torrente Ballester High School, it was observed that classrooms have numerous electronic appliances used to enhance teaching. Most classrooms are fitted with an overhead projector and a desktop computer for teachers to use, as well as laptops for the students to use during classes. A further 16 classrooms have smart whiteboards installed for teachers and students to use. Yet it was also reported during the visit that computers and screens are often left on when not in use, although the staff desktop computers are programmed to switch off at 2pm (end of lessons). Lights being left on was another reported issue during the visit, particularly in hallways, which administrative staff often check on using the surveillance cameras to identify which hallway lights have been left on. However, it was noted that the toilet lighting has been automated via motion sensors. Staff also reported that often classrooms become uncomfortable for them and students, but not all have adjustable radiator valves, and therefore windows are often opened when the heating is still on, wasting heating energy. However, it was noted during the visit that there were handmade signs in numerous locations encouraging users to be conscious of behaviours which could be implemented to conserve energy e.g. turning lights off or turning taps off after use. This holds promise for eTEACHER engaging with building users.

3.4.5 CEI Arco Iris Kindergarten

The CEI Arco Iris Kindergarten building is typically used during weekdays from 7.30am – 3.30pm by staff, infants and parents. The questionnaire responses included representatives from different staff members. Figure 12 shows which energy behaviours were reported as currently occurring CEI Arco Iris Kindergarten. It

can be seen that not all of the suggested behaviours were selected, with no one reporting that the heating was on in areas which are not being used or that TVs are being left on. It should however be noted that the responses are from four building users, similarly to the IES Torrente Ballester High School building, constituting a very low representation of building users, and the percentage reporting each behaviour did very significantly. The most prominent behaviours being reported within the CEI Arco Iris Kindergarten were;

- Lights being left on in empty rooms (100% of users)
- Heating being left on when not needed (75% of users)
- Computers left on when not in use (100% of users)
- Air-conditioning on when not needed (75% of users)

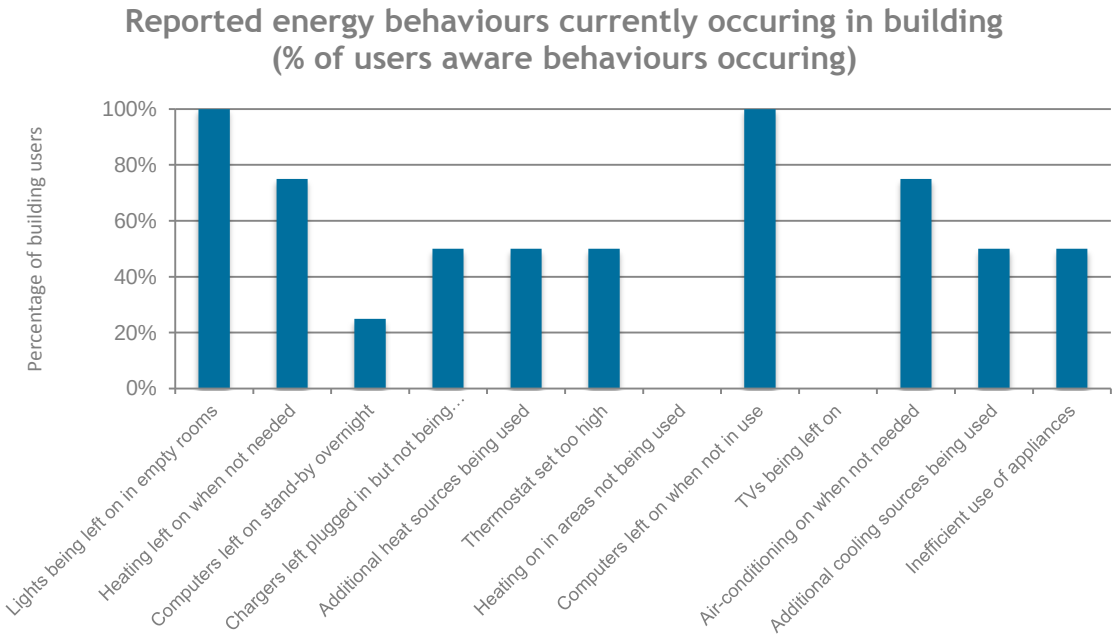


Figure 12 Reported energy behaviours currently occurring in the CEI Arco Iris Kindergarten

During the site visit it was reported that the heating system within CEI Arco Iris is programmed to come on from 7am until 11am or sometimes 12pm, even though the building is typically occupied until 3.30pm. Within the building there are a number of energy intensive appliances within the kitchen and laundry room, but these will be vital to the running of the kindergarten and it may not be possible to improve the energy consumption here other than to replace the appliances with more energy efficient ones, which does not involve behaviour change. Staff reported within the questionnaire that often heating is on when not needed but during the site visit it was reported that although most radiators do have adjustable valves, staff do not use these. Lighting within the building is programmed to be on in the morning but is manually controlled during the afternoon, although it is often left on when not needed, as confirmed in the questionnaire responses.

3.4.6 OAR

The OAR County Council of Badajoz office building is typically occupied during weekdays from 8am until 3pm, but opens later on Thursday and some Tuesdays from 4pm-8pm. Staff are also allowed to work flexible hours so can recover hours during these later openings. Outside of the core hours the building is also used by security staff and cleaning crews. The questionnaire responses included representatives from different staff members within the building. Figure 13 shows which energy behaviours were reported as currently occurring within the OAR office building. As it can be seen, similar to other eTEACHER buildings, not all of the suggested behavioural examples were selected, with no users indicating that TVs were left on or inefficient use of appliances in the building. As for the behaviours reported as occurring in the building the percentage of users reporting each behaviour varied. The most prominent behaviours being reported within the OAR office building were:

- Additional heat sources being used (93% of users)
- Computers being left on when not in use (57% of users)
- Additional cooling sources being used (57% of users)

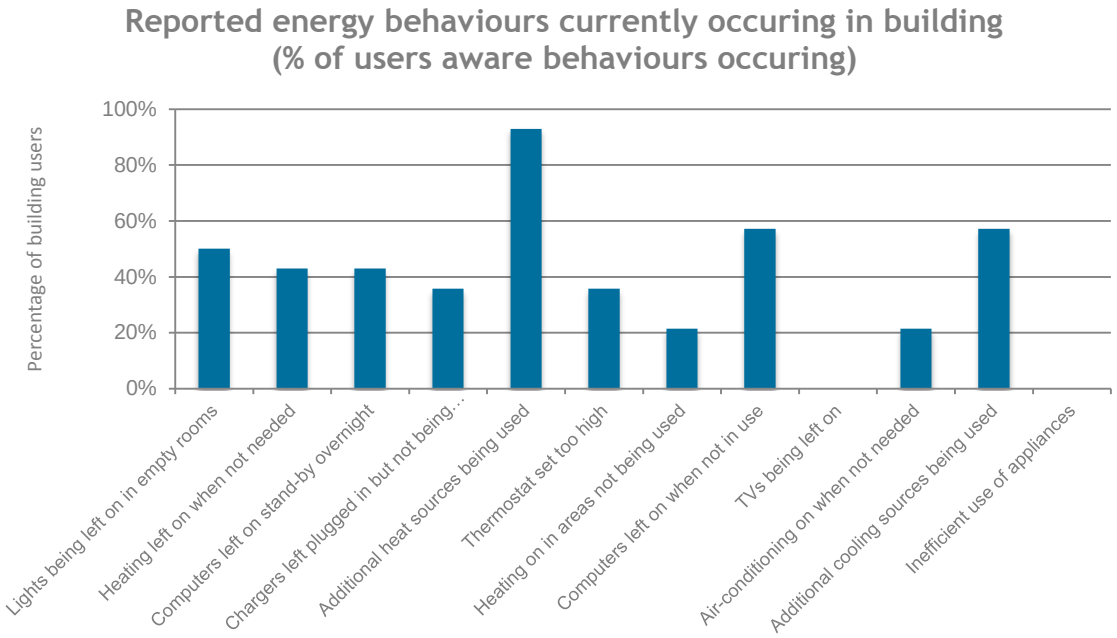


Figure 13 Reported energy behaviours currently occurring in the OAR County Council of Badajoz office building

During the site visit the key complaint/behavioural issue identified was around personal comfort of staff within the building. Often in summer, given extreme temperatures, the building does become uncomfortably warm due to the large spaces within. There is conflict between staff members who think the building is too warm and those who believe it to be too cold. The reason behind this is the air flow system installed in the building is ceiling mounted, therefore often occupants feel that they are cold even when the average temperature may be deemed to be of a reasonable and comfortable temperature. Staff cannot alter the temperature in zones as the thermostats are locked behind tamper proof cases. To try and relieve some of the conflict a screen was installed on one of the floors which displays the current indoor

temperature and humidity level. However, during the visit this screen showed 27.7°C and yet numerous staff members were observed to have portable heaters on underneath their individual desks.

During the site visit the BMS of the building was shown, but it was reported that it currently is not being used to programme schedules etc. as there is not sufficient knowledge on how best to use the system. Currently, members of security turn the central HVAC and lighting on first thing in the morning from a central cabinet and then the cleaning crew switch these off in the evening.

3.4.7 Av. Godofredo Ortega y Muñoz Apartment Block

The Av. Godofredo Ortega y Muñoz residential building includes a total of 30 separate apartments. The questionnaire responses included representatives from some of the residential apartments. However, it should be noted that the responses are from three building users which is a very low representation of all the building users. Figure 14 shows which energy behaviours were reported as currently occurring within the Av. Godofredo Ortega y Muñoz residential properties. As it can be seen, like other eTEACHER buildings, not all of the suggested behaviour examples were selected, with no users indicating that TVs were being left on or that air-conditioning was on when not needed. The most prominent behaviours being reported within the Av. Godofredo Ortega y Muñoz residential properties were:

- Lights being left on in empty rooms (100% of users)
- Chargers left plugged in but not being used (100% of users)
- Heating on in areas not being used (100% of users)

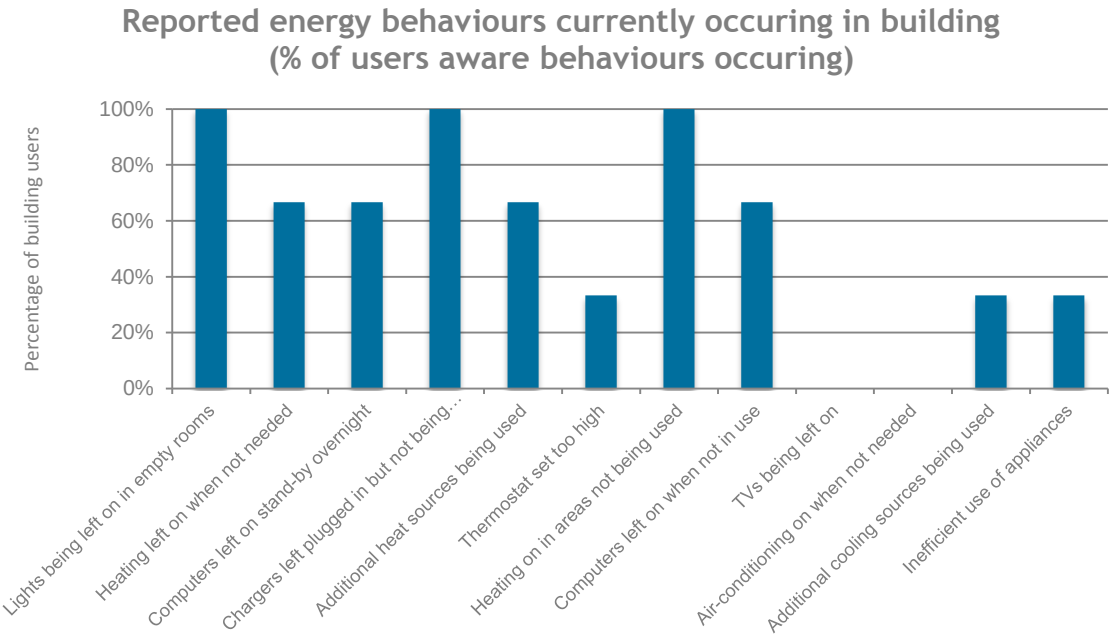


Figure 14 Reported energy behaviours currently occurring in the Av. Godofredo Ortega y Muñoz residential buildings

During the site visit and with the questionnaire it was not possible to get the opinion and views of the building energy manager and as such it was not possible to uncover the common complaints to building management from residents. During the visit, however, it was reported that resident's energy bills are formed of 70% from their individual consumption and 30% from communal maintenance and consumption costs. The central heating comes from four boilers with cascade connections to the individual apartments. Electricity is also used for communal amenities such as hallways, entrances and elevators.

3.4.8 Council House

The Council House office building is typically occupied Monday to Saturday, opening at 8.30am and typically closing at 4pm, although some staff may work longer hours and events are often held within the building which can mean the building is occupied up to 16 or even 20 hours of a day. The questionnaire responses included representatives from different staff teams within the building. Figure 15 shows which energy behaviours were reported as currently occurring within the Council House office building. As it can be seen, all of the suggested behaviour examples were also selected by at least one of the building users from the examples given; however, the percentage of users reporting each behaviour varied. The most prominent behaviours being reported within the Council House were:

- Lights being left on in empty rooms (100% of users)
- Heating being left on when not needed (91% of users)
- Computers being left on stand-by overnight (82% of users)
- Additional heat sources being used (91% of users)
- Computers left on when not in use (82% of users)

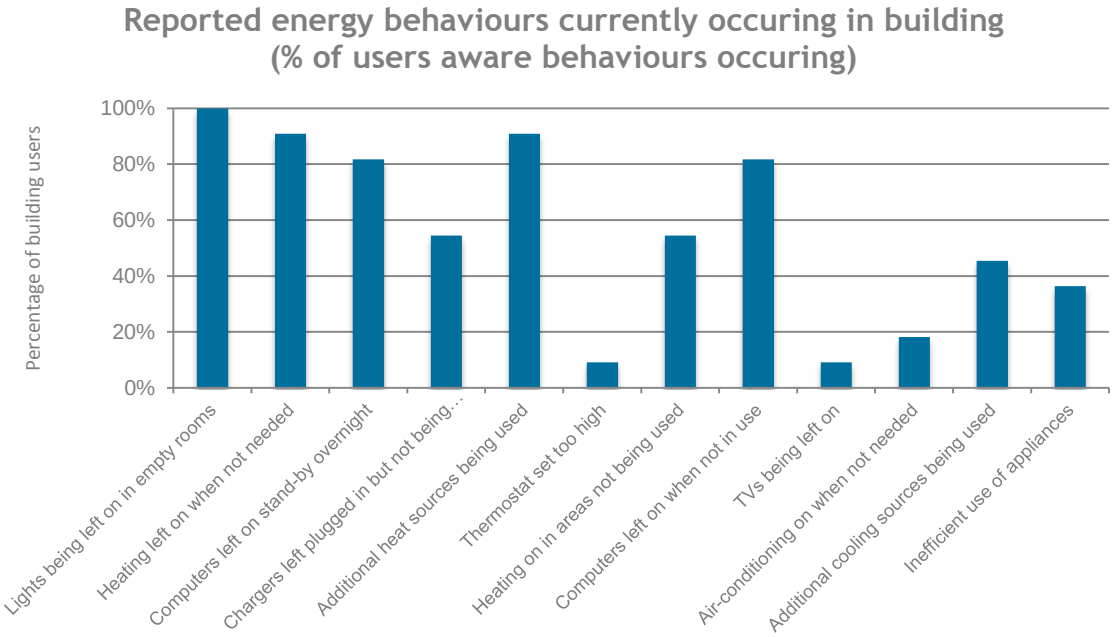


Figure 15 Reported energy behaviours currently occurring in the Council House

During the site visit, individual comfort was highlighted as being a key issue in the building with many staff plugging in portable heaters and portable fans to achieve their own desired comfort level. However, it was noted that personal comfort expectations vary massively and even within small offices one person can be using a fan whilst their adjacent colleague has a heater on. The BMS controls the heating in the building and it is set to come on at 7am and go off once the desired temperature is achieved. However, the caretaker pointed out during the visit that thermostats are not located in ideal locations for the building, with one even being located on the ceiling in one room. The caretaker also reported that it is extremely difficult to change anything within the building as it is a heritage listed building and therefore needs approval first. The energy use within the building is also controlled by central council and the caretaker is simply told to try and make savings where possible. The caretaker did report that the staff within the building could benefit from becoming more educated about their energy use behaviours and the implications of such behaviours. During the visit, it was also noted that the Council House is in the process of finalising plans to undergo a building-wide LED lights installation– particularly in the glass dome which has over 100 bulbs illuminating it. Lighting is a common complaint within the building with some areas seen to be too dark while others are thought too bright or artificial.

3.4.9 Djanogly City Academy

The Djanogly City Academy building is typically occupied weekdays from 6am till 7pm by students, staff and cleaning crew (students start at 8.30am and typically finish 4.30pm or 12pm on Fridays). On Sundays the school hall is used by a local church from 10am till 1pm. During January to March Saturday schools also use the building 9am-12pm, with some summer schools also using the building during the summer break. The questionnaire responses included representatives from different staff members and students from different year groups. Figure 16 shows which energy behaviours were reported as currently occurring within Djanogly City Academy. As it can be seen all of the suggested behaviour examples were also selected by at least one of the building users from the examples given, but the percentage of users reporting each behaviour varied. The most prominent behaviours being reported within Djanogly were;

- Lights being left on in empty rooms (77% of users)
- Chargers being left plugged in but not being used (64% of users)
- Computers left on when not in use (86% of users)
- TVs being left on (64% of users)

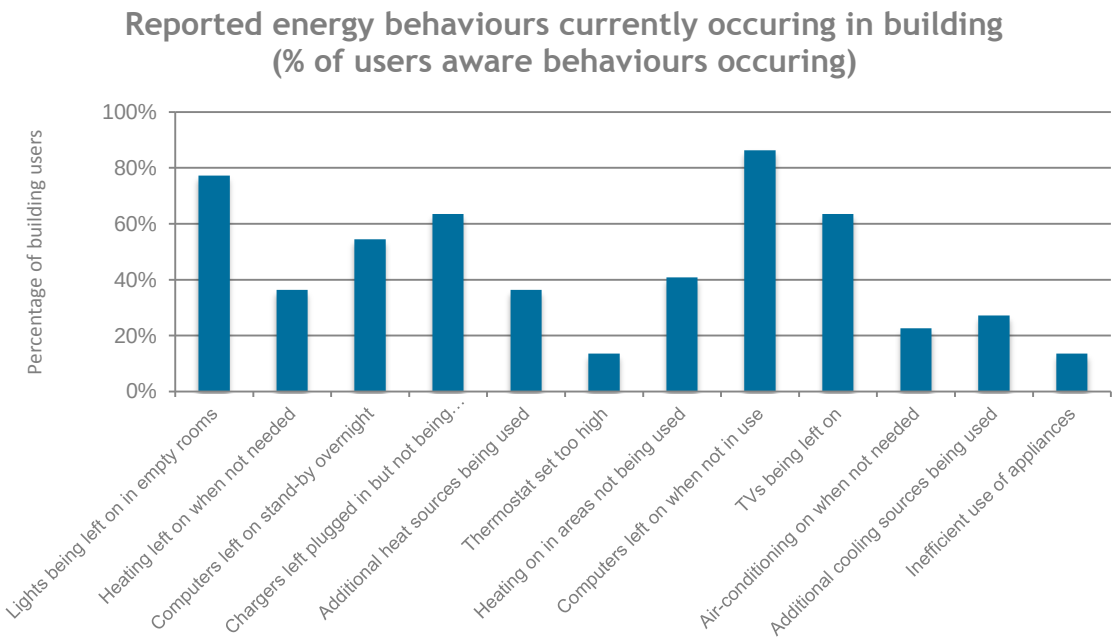


Figure 16 Reported energy behaviours currently occurring in Djanogly City Academy

During the site visit the heating system was discussed, as often staff complain about their own individual rooms as being uncomfortable, which tends to be dependent on the location in the building and what the lesson type is that is being carried out in that room. The cooling and heating system are located at one end of the building and currently it is having to work too hard and at maximum capacity to ensure that heat reaches the other end of the building. A main problem is found with the main hall as often in winter this gets far too cold to use and classes must be moved into smaller rooms to ensure staff and students remain comfortable. The building does benefit from a lot of natural light but in summer this can cause some issues with rooms overheating and glare.

It was reported during the visit that there is often issues with lights and computer equipment being left on when not in use, particularly at the end of the day. It is thought that after moving the end of the school day from 3.30pm to 4.30pm, staff are now so pressurised to finish up on time and rush home that they often forget to turn things off. Currently emails are sent to staff if projectors etc. have been left running overnight but most lights and equipment are checked by the facility crew at the end of the night. Given the size of the school and number of classrooms this is not an efficient method for ensuring everything is switched off at the end of the day. It was also reported that some of the screens within the school cannot be switched off completely as if they are the full system running on them needs to reboot once switched back on so potentially a large amount of energy could be getting wasted by these screens being left on.

3.5 Summary of behaviours identified across eTEACHER buildings

When all the eTEACHER pilot building responses were grouped together, Figures 17 and 18, a clear picture can be achieved of what behaviours are currently the most prominent across all buildings and it highlights

the variation of these behaviours across the pilot buildings. As part of the analysis into behavioural issues in the eTEACHER pilots, the buildings were clustered into building typologies; residential, offices, schools and health care centres. This analysis showed that; within residential properties lighting and heating behaviours are most prominent; in office buildings lighting, additional heat sources and computer use behaviours are key; in schools, behaviours surrounding lighting and computer use ranked highly; and in health care centres lighting and additional heat source use behaviour was the most prominent. To analyse how each of the behavioural issues ranked across all the buildings the average percentage of all building's users reporting the specific behaviours across all of the eTEACHER pilot buildings was taken. From this, the key behavioural issues became apparent and the top five behavioural issues identified were;

1. Lights being left on in empty rooms (87% of all building users)
2. Computers left on when not in use (70% of all building users)
3. Heating left on when not needed (65% of all building users)
4. Computers left on stand-by overnight (63% of all building users)
5. Additional heat sources being used (63% of all building users)

Therefore, the key end-user behaviours identified within Task 1.2 are lighting use behaviours, heating & comfort related behaviours and computer use behaviours.

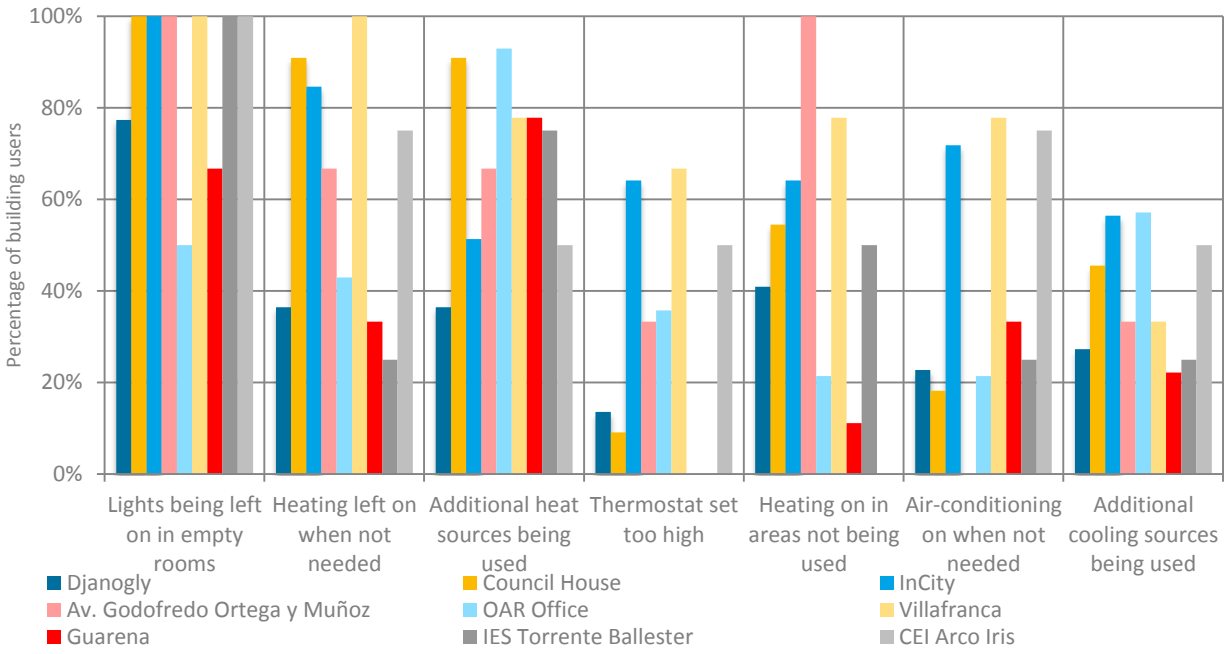


Figure 17 Subset 1 of behavioural examples and occurrence in all eTEACHER pilot buildings

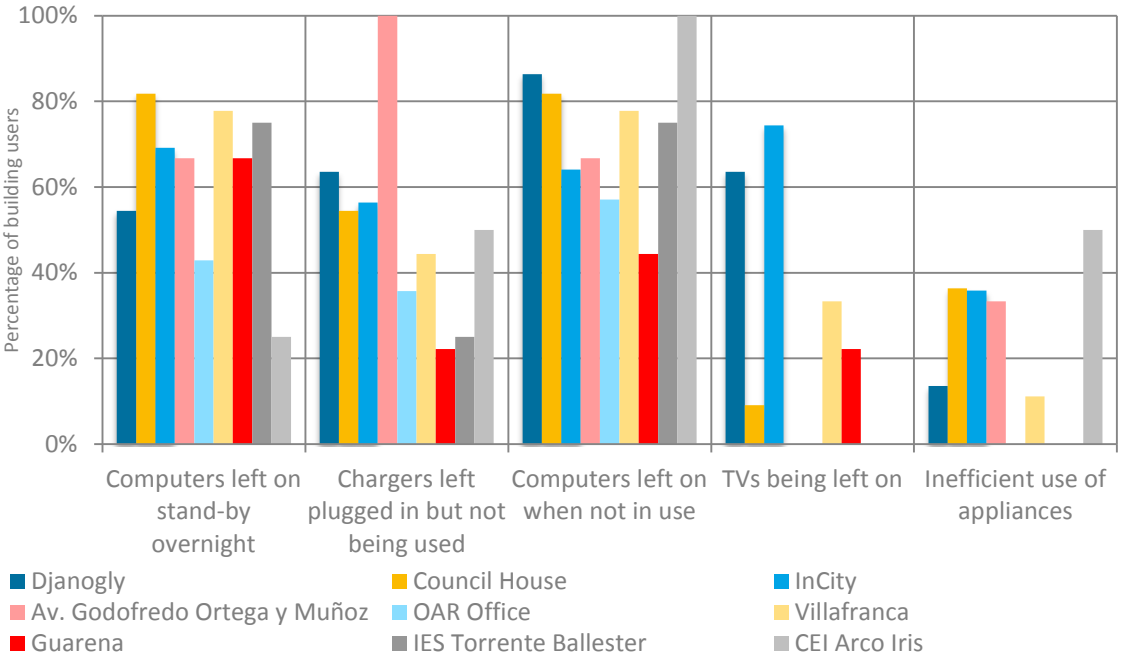


Figure 18 Subset 2 of behavioural examples and occurrence in all eTEACHER pilot buildings

4 Users' energy-related needs and using COM-B to identify potential impact and requirements of eTEACHER interventions

4.1 Introduction

Depending on the function of the building, users' energy-related needs will vary. The different building typologies within the eTEACHER project mean that the energy-related requirements will differ across the sample. Domestic properties are likely to put more emphasis and importance on achieving personal comfort compared to a health care centre where the focus is likely going to be on ensuring patients are treated satisfactorily which may necessitate the use of specialised medical equipment. As introduced in Section 2.1 the COM-B behavioural framework can be an aid in identifying the potential impact and requirements of the eTEACHER interventions on specific end-user behaviours. Behaviours can be influenced by the motivations of a user, which are influenced in turn by the capability and opportunity of the user and their surrounding environment. For eTEACHER the capability of users will include their awareness and understanding towards the energy conservation needs within their building. The opportunities of users will be dependent on the physical and social environment within the building for behaviour change, especially related to specific behaviours which may be targeted by eTEACHER interventions. Motivations of users can influence users' engagement with eTEACHER and will be dependent upon users' attitudes and views towards energy efficiency. This section of the report introduces the specific energy-related needs with the eTEACHER pilot buildings and presents the current capability, opportunity and motivations within each eTEACHER building which can have impact upon the effectiveness of the eTEACHER interventions resulting in behaviour change.

4.2 Energy-related needs in pilot buildings

Energy-related needs within the eTEACHER pilot buildings include lighting; electrical appliance use (computers, ICT, medical equipment etc.); heating, ventilation and cooling; cooking; hygiene requirements (bathing, use of washing machines, dishwashers etc.); building facilities (elevators, swimming pool, retail units etc.) and personal appliances/entertainment. The variation in energy-related needs of the eTEACHER buildings adds complexity in targeting specific behaviours, particularly if some building users see certain energy-use as essential and are reluctant to change their behaviour. Ultimately, it must also be remembered that to most building users, energy use is invisible, and therefore it is important to understand user attitudes and motivations towards energy use within each building. From Section 3 of this report the key behaviours identified as being prominent across all of the eTEACHER buildings were lighting use, computer use and heating use/comfort expectations.

Comfort of building users can have an influence on other factors within a building such as users' productivity or sense of general well-being. Leaman (1995) reported that users who are dissatisfied with temperatures, air quality, lighting and noise levels in an (office) environment are more likely to report that this affects their productivity. Oseland & Bartlett (1999) similarly reported a link between productivity and users' satisfaction in the facilities and services within an (office) building. Users often feel more productive

when they believe they have control over the physical environment which they are in (Whitley et al, 1996). Leaman (1995) also reported that users are often more 'forgiving' about unsatisfactory environmental conditions if they are kept informed about how quickly facility team members are responding to any complaint. This is an important factor to consider for enhancing the appeal of eTEACHER to building users, should the design allow users to log complaints and receive feedback on the status of complaints in an easy, concise and hassle-free method.

In eTEACHER, 64% of building users are already fairly satisfied with the comfort levels in the buildings, shown in Figure 19, although some users did report being unsatisfied with the current comfort levels in the buildings.

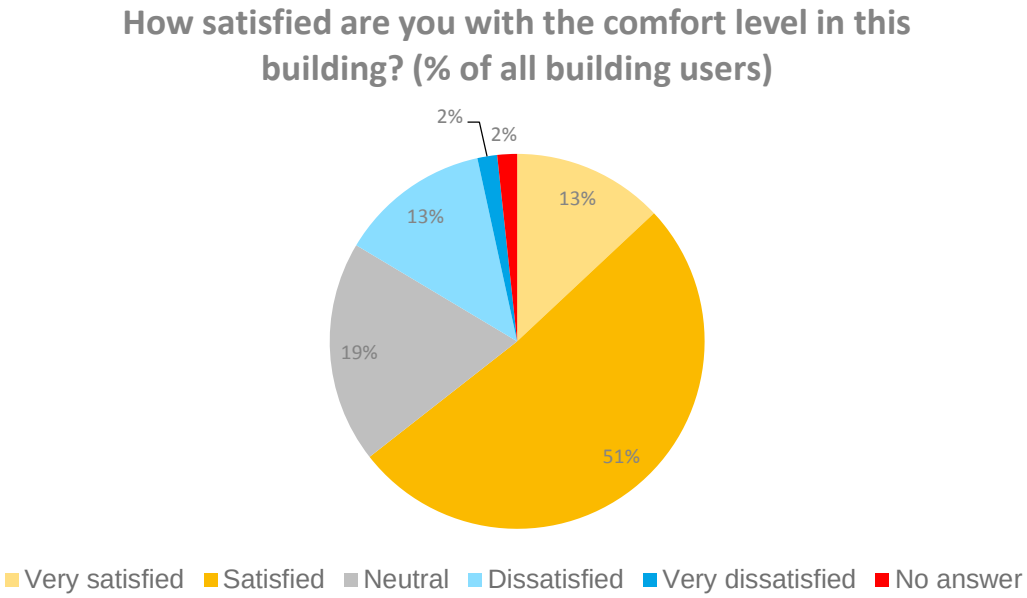


Figure 19 Average comfort satisfaction level across all eTEACHER pilot buildings

Figure 20 shows the comfort satisfaction of building users specific to the individual eTEACHER pilot buildings. In three of the eTEACHER buildings none of the building users identified as being neutral or dissatisfied to any degree with the comfort levels currently. However, it is worth noting that these three buildings all had a low representation of building users in the respective samples.

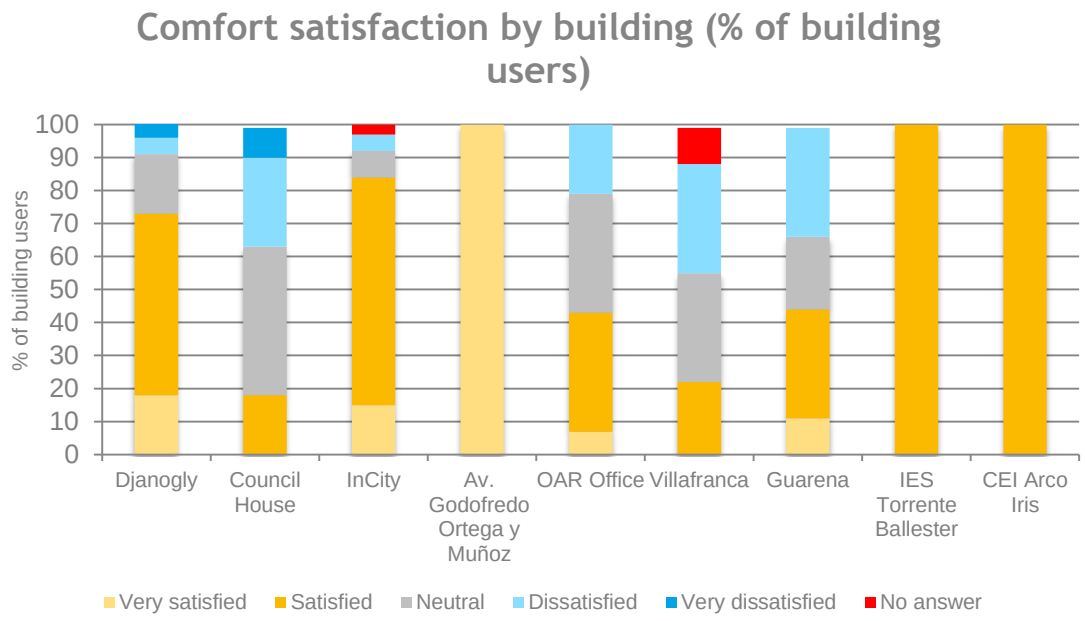


Figure 20 Comfort satisfaction level within each eTEACHER pilot building

When building users were asked to identify sources of discomfort within their building, shown in Figure 21, only Av. Godofredo Ortega y Munoz building users reported no sources of discomfort. So, even with CEI Arco Iris and IES Torrente Ballester users indicating they were satisfied with the comfort levels, there are still sources of discomfort that they identified in the buildings. Table 5 reports the main sources of discomfort for each of the eTEACHER buildings based on the highest percentage of building users reporting it.

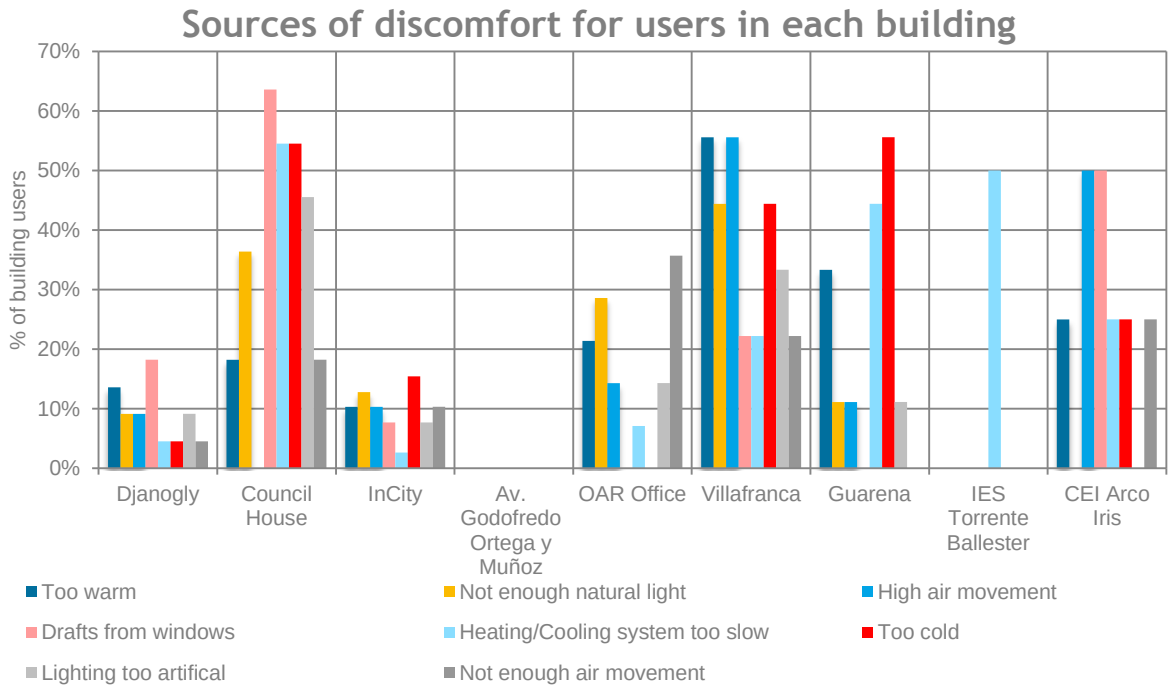


Figure 21 Reported sources of discomfort to users in each of the eTEACHER pilot buildings

Table 5 Main sources of discomfort reported in each eTEACHER pilot building

eTEACHER building	Main sources of discomfort	
InCity	Too cold (15%)	Not enough natural light (13%)
Villafranca	Too warm (56%)	High air movement (56%)
Guareña	Too cold (56%)	Heating/cooling system too slow (44%)
IES Torrente Ballester	Heating/cooling system too slow (50%)	
CEI Arco Iris	Drafts from windows (50%)	High air movement (50%)
OAR	Not enough air movement (36%)	Not enough natural light (29%)
Council House	Drafts from windows (64%)	Too cold & Heating/cooling system too slow (both 55%)
Djanogly City Academy	Drafts from windows (18%)	Too warm (14%)

In order to understand fully whether these sources of discomfort and satisfaction levels within each building can be improved through eTEACHER the capability, opportunities and motivations within each building need to be considered.

4.3 Capability of users within eTEACHER pilot buildings

Capability of users within eTEACHER includes both the physical and/or psychological ability to enact a specific behaviour. Physical capability refers to having a physical skill which allows the user to exhibit a specific behaviour. For eTEACHER, physical capability can refer to users' capability to use relevant ICT to ensure that they can engage with the eTEACHER interventions in order to achieve behaviour change. Psychological capability refers to the capability to engage in specific thought processes with sufficient comprehension and reasoning. Within eTEACHER this psychological capability refers to the users being aware of the need for conserving energy within the buildings and having enough understanding and knowledge to follow any eTEACHER interventions.

As the eTEACHER interventions are revolving around the design of an ICT-based tool, mainly focused on the idea of an app, understanding the users' capability in relation to ownership and use of ICT in each building is important. Figure 22 shows the use of ICT devices within eTEACHER pilot buildings separated by user types. As it can be seen students have no use of smartphones within the school buildings being investigated, which is due to school policies regarding the use of smart phones during school hours. Therefore, if students are to be targeted, an alternative platform for the ICT tool shall need to be included. Considering additional ICT devices which can be used alongside smartphones will ensure all users have the

possibility to engage with the eTEACHER tool, as not all users have access to smartphones in the eTEACHER buildings, including one of the key energy facility staff in one of the eTEACHER buildings.

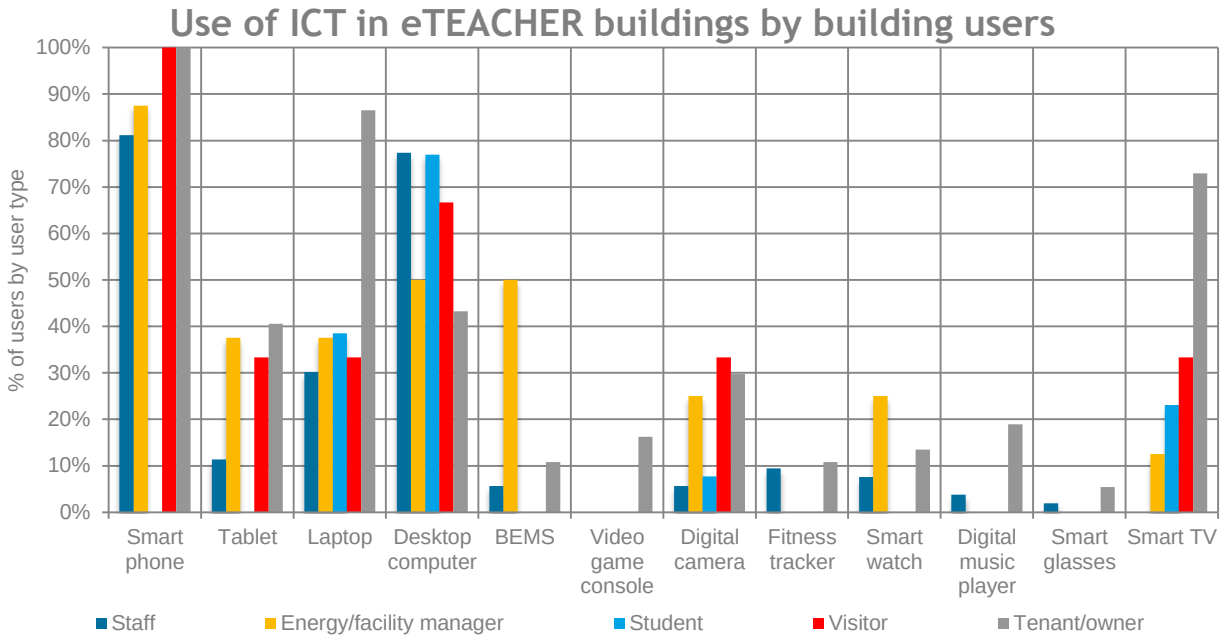


Figure 22 Use of ICT in eTEACHER pilot buildings by user typology

The frequency of use of ICT devices within eTEACHER buildings is an important factor to be considered. If users have regular access to the relevant ICT devices for eTEACHER then it means that there is a good chance for engagement with the eTEACHER interventions. However, if the access is limited or even restricted then the eTEACHER tool is unlikely to be used by these users. Most building users have regular use of either a smartphone, laptop, tablet or desktop computer so a tool which could be accessed across these platforms would ensure the majority (if not all) users have access and the capability to engage with eTEACHER.

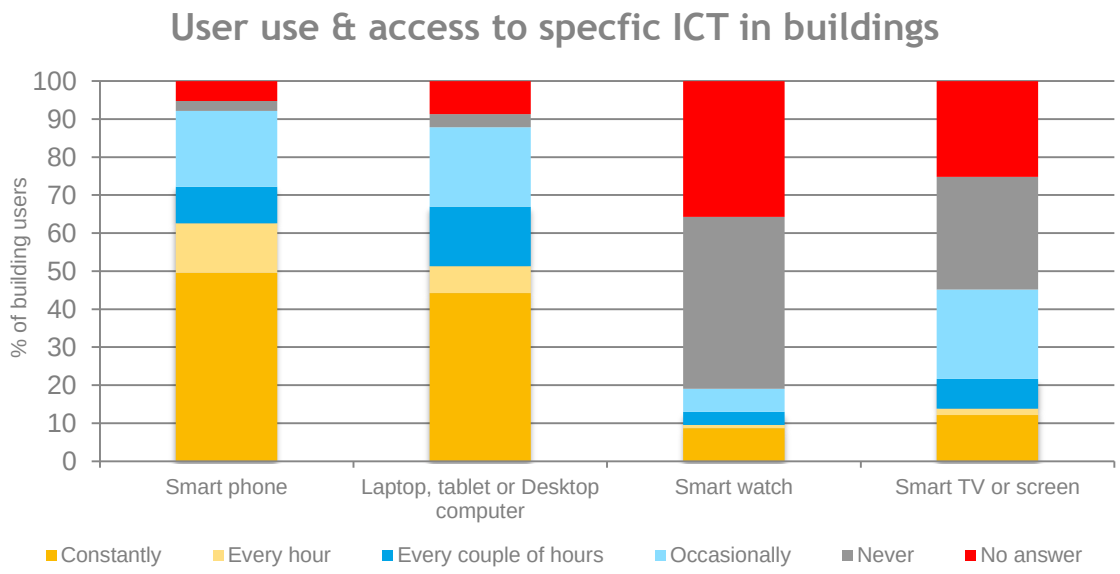


Figure 23 Frequency of use of specific ICT relevant to eTEACHER across pilot buildings

For eTEACHER the psychological capability of users refers to their understanding, awareness and beliefs relating to energy conservation, as those who are unaware or can't comprehend the eTEACHER tool's message are unlikely to engage with it. User awareness of energy use within the eTEACHER pilot buildings is fairly high, shown in Figure 24, with 38% of users very aware of energy use in their building. Only 15% of users indicated that they are not very aware or never think about energy use in the building. User awareness of energy can be influenced by users' beliefs in the importance of conserving energy. Within eTEACHER, 82% of users indicated that they believe saving energy is very important in their respective pilot buildings. 17% of users reported they thought it was somewhat important, with the remaining 1% of users not answering that question.

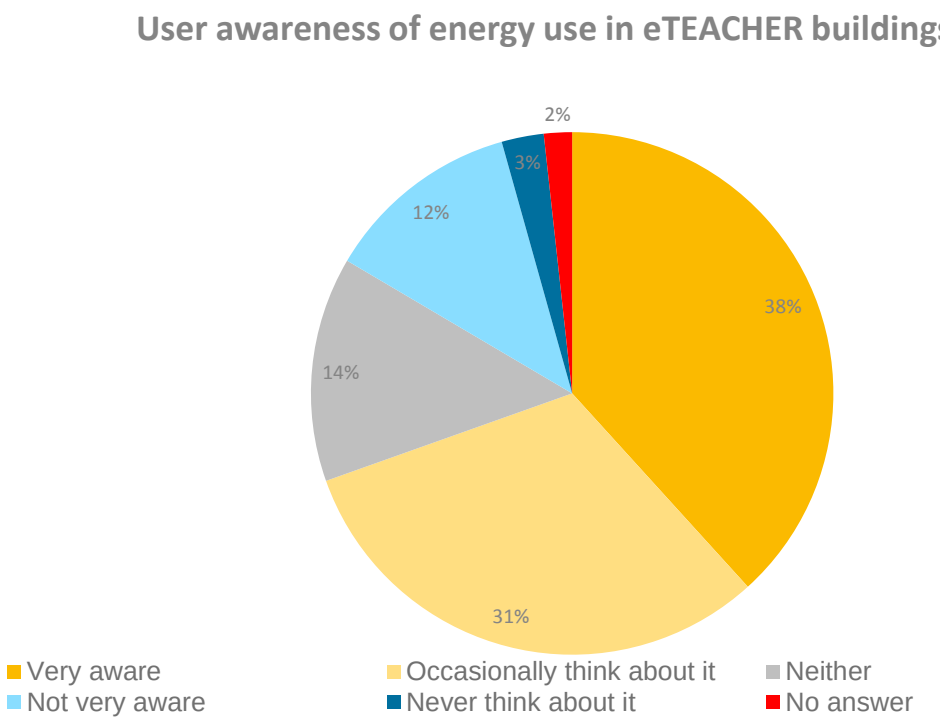


Figure 24 eTEACHER building users' awareness of energy use in the relevant building

For eTEACHER, it is important to understand what users relate best to when talking about energy. As previously mentioned, energy is typically invisible to users as they only really become aware of their use through bills and often struggle to connect specific energy behaviours to the resulting energy used due to that behaviour or action. Within the building user questionnaire, users were asked to identify how they best understood energy; by consumption (kWh), cost, percentage as a comparative use or as their carbon footprint. Figure 25 presents the results from each of the building user types. Actual energy use in kWh was indicated as being strongly understood by visitors, residential tenants and owners and staff members. Cost ranked quite highly across all user types, especially with energy/facility managers and staff, indicating that many of the users controlling the energy systems within the eTEACHER buildings may be driven by cost savings rather than specific kWh savings.

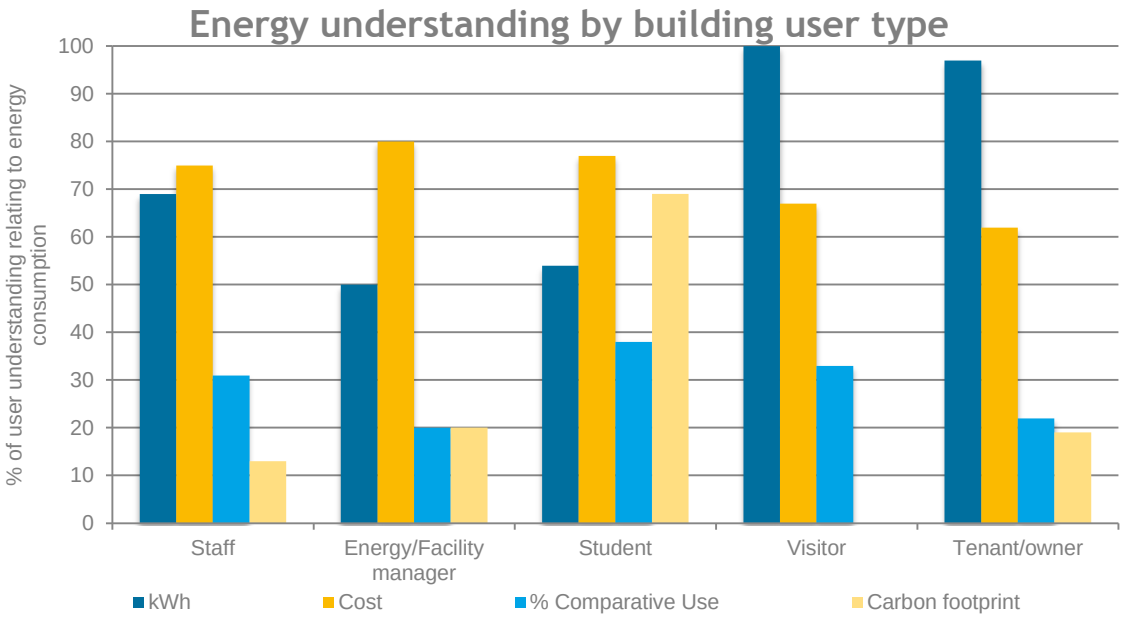


Figure 25 User understanding relating to energy within buildings

4.4 Opportunities for users within eTEACHER pilot buildings

Opportunity of users within eTEACHER includes both the social and/or physical environment that enables a specific behaviour. Social opportunity relates to the opportunities possible due to cultural beliefs that dictate the way we think about things. Physical opportunities relate to the opportunity afforded by the environment, and this is a key consideration for eTEACHER. This means for specific behaviour change to be successful, users have to have the relevant physical opportunities available so that they can change their behaviour. So, for changing lighting use behaviours, users require access to the lighting controls. This appears to be the case across all eTEACHER buildings. However, some specific circumstances will need to be taken into consideration in the design of interventions around lighting; one being that, within the Council House, it was noted during the site visit that some light switches are not located in the room which they control. To be able to identify whether users' lighting use behaviour has changed or not, the energy consumption for lighting needs to be monitored and ideally at a room level if possible, as this could identify the users who have changed behaviours and those who haven't, following the implementation of eTEACHER. However, the detail to which lighting is monitored within the eTEACHER buildings, whole building vs. room level, will be dependent on budget limitations and the hierarchy of measurement importance.

With comfort related behaviour, the opportunity for users across the eTEACHER buildings will vary depending on the users' agency towards altering the thermal environment to suit their comfort needs. Figure 26 shows what users are currently doing as a means to control and/or adjust the thermal

environment to suit their needs. Currently, a high proportion of users adjust their thermal environment through the opening and closing of windows in the building or through the use of window blinds or shades as a means of reaching a comfortable environment.

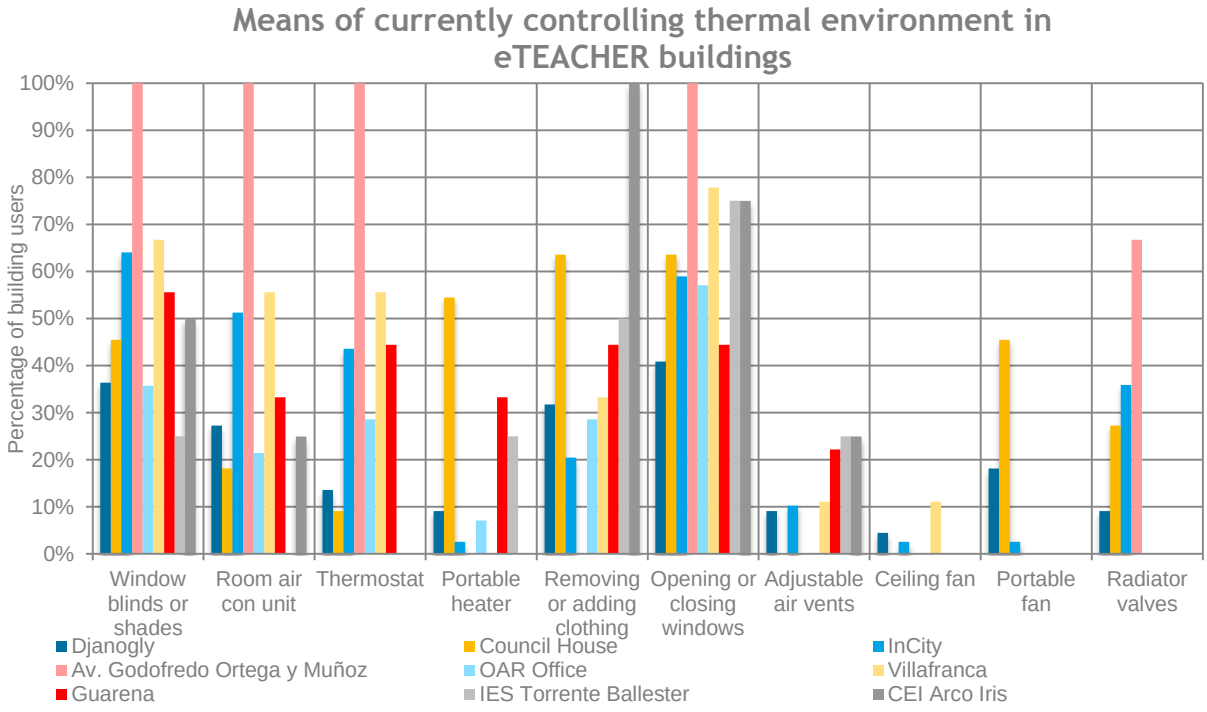


Figure 26 Building users current means of controlling/adjusting the thermal environment

In total, 61% of building users reported the ability to control and alter the thermal environment within the eTEACHER buildings. Other users reported not being able to control their thermal environment satisfactorily, highlighting that not all users have the opportunity to adjust settings. 40% of the building users indicated that they are restricted from adjusting the thermal environment of the building. This restriction comes from various barriers within each building. Figure 27 shows the restrictions identified in each of the eTEACHER buildings. Within Djanogly, the main restrictions revolved around temperatures, thermostat settings and radiator settings in the building, which agrees with the findings of the site visit as only facility management crew have control over these. In particular, the radiator valves are tamper proof to stop students messing with them, but this means individual staff members do not have the opportunity to change them either. A similar situation in seen in the Council House, with users indicating restrictions from altering temperatures, thermostat settings and radiators, again with facility management having control over these settings. Within the OAR office building, a high proportion of users indicated they were restricted from altering the temperature, thermostat settings, heating/cooling schedules and air conditioning use. Within OAR, staff are restricted from altering thermostats through use of tamper proof casings being locked surrounding the thermostat. Given that the BMS is currently not used to its full potential within the OAR building, it could be that advice is given to staff with access to this as a means to programme settings through this, and staffs' satisfaction levels are recorded until a suitable compromise is

reached. Although it is unlikely to please all staff as reported earlier, Leaman (1995) found staff are more 'forgiving' if they are at least informed of what is happening to improve the thermal environment. Therefore, for eTEACHER the consideration of feedback being made available to those restricted on the status of any alterations to the thermal environment should be taken as a means to improve user satisfaction.

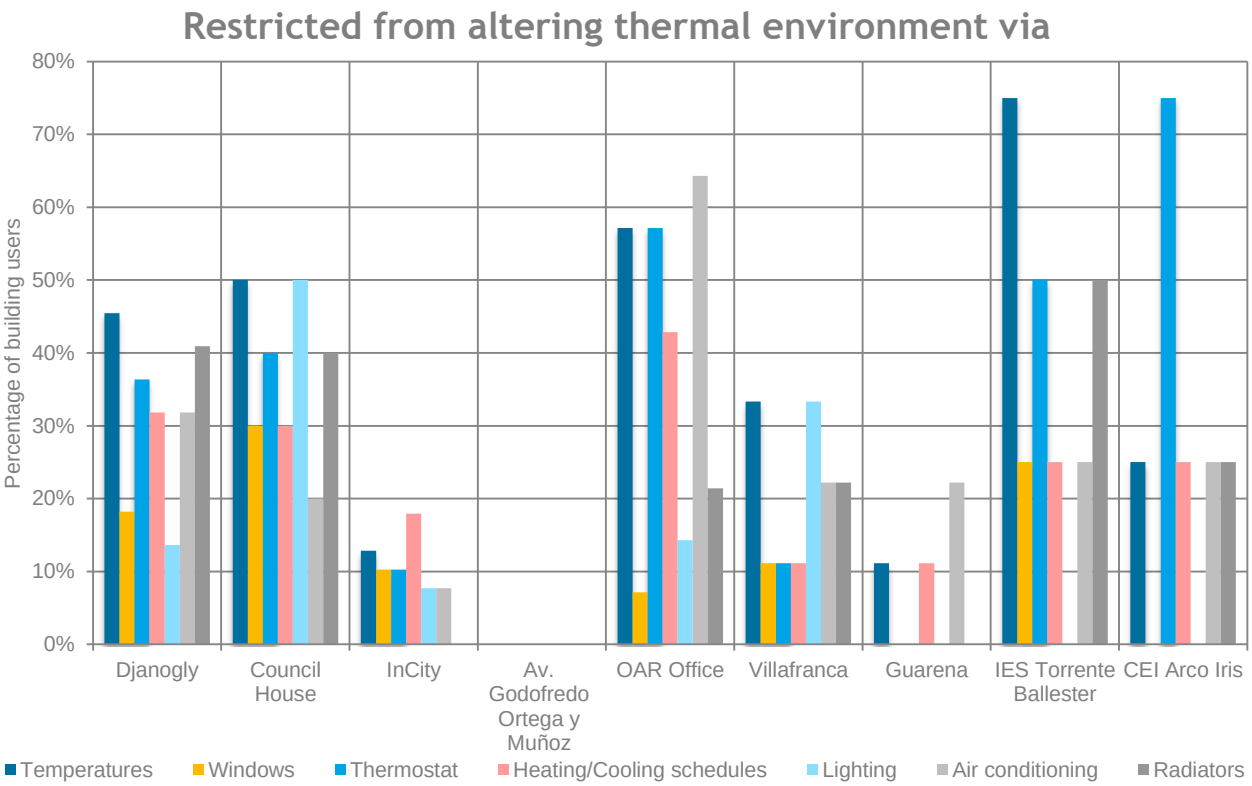


Figure 27 Users restricted in altering the thermal environment in each eTEACHER pilot building

Those users who are restricted in altering the thermal environment themselves often need to contact the energy manager or facility management teams in order to request that something is done to improve their comfort. Only 38% of all the building users said that they had reported an issue within their building relating to energy use and/or their own comfort, the highest being in CEI Arco Iris where 100% of the users indicated they had reported an issue. The two health care centres in Spain and the Council House in the UK also had a high percentage of users reporting that they had raised issues within the buildings (78%, 67% and 64% respectively). Of those indicating that they had not reported any issues within the eTEACHER buildings, the most common justification was that they had found no issue to report (33% of users); however, 11% of users reported not having enough time to do so and 7% reported not knowing the relevant person to contact.

Therefore, when designing the eTEACHER tool, the opportunities for users within each building need to be taken into consideration. Advice on thermostat settings etc. may need to be targeted to those with the agency to alter the settings and not users' who already feel restricted in changing these settings.

4.5 Motivation of users in eTEACHER pilot buildings

Motivation of users within eTEACHER includes both reflective and automatic mechanisms that activate or inhibit a specific behaviour. Reflective mechanisms include users' reflective processes which often involve evaluations and plans. Within eTEACHER, this can be considered as users' reflections towards energy efficiency interventions. Automatic motivation is when users involve emotions and impulses arising from associative learning and/or innate dispositions. For eTEACHER, this could include the influence of others and social norms on users' motivations. Motivation of users within eTEACHER is of key importance given that the project's success will revolve around users' engagement with the eTEACHER interventions and, therefore, ensuring that users are motivated to engage (and have the capability and opportunity to engage) is a vital part to be considered within the design. 90% of the building users expressed an interest in knowing more about the energy used within the eTEACHER pilot buildings. They indicated a preference to knowing more information on energy saving advice for the building, the total energy consumption and the temperature within rooms, as shown in Figure 28. There was also a strong indication from users that they would also like advice, which could help improve their comfort within the eTEACHER pilot buildings.

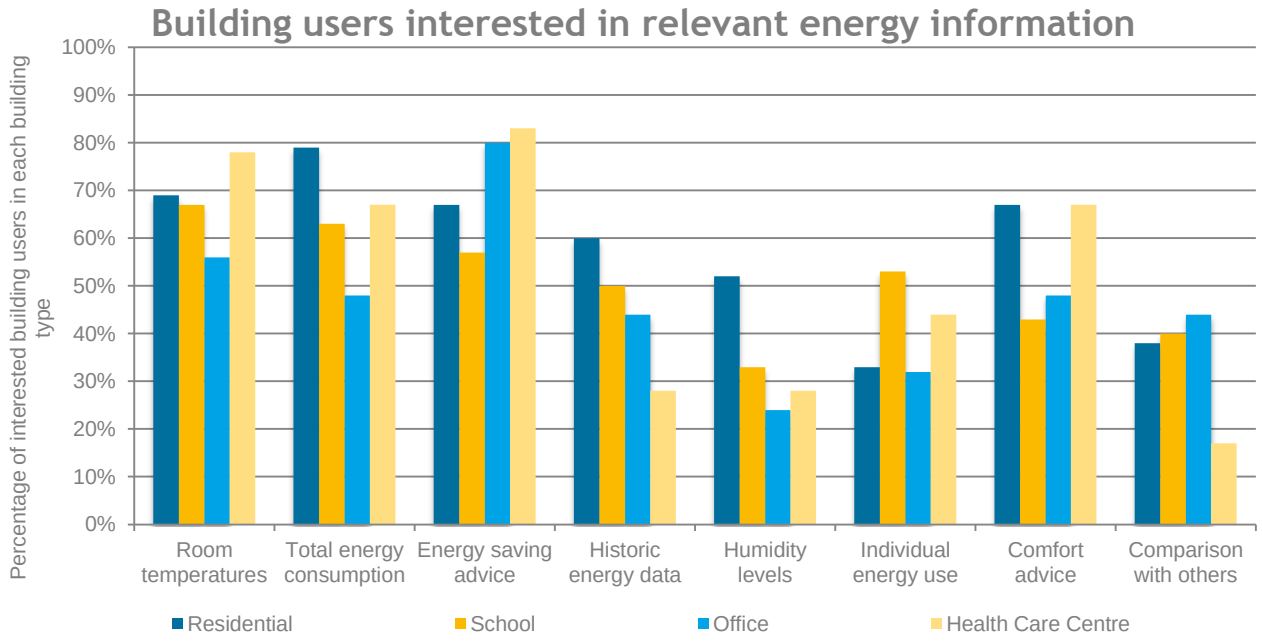


Figure 28 Interest in energy related information by users within building typologies

For eTEACHER, improving users' motivation towards engaging with the interventions designed can be achieved by ensuring that the interventions relate to what users perceive as being important to them. Part of the motivation for users to engage with the tool will revolve around what users recognise as the benefit they are gaining from using the tool. In the building user questionnaire, users were asked to rank what they see as being the most important factors to them related to saving energy, the results of which are shown in Figure 29. Users were given six different categories: environmental impact, cost, personal comfort, ease,

personal benefit and how others view them, which they were asked to rank from 1-6, with 1 being the most important factor to them and 6 being the least important. Commonly ranked as the most important factor to users were: the environmental impact, cost and personal comfort. Therefore, eTEACHER should emphasise the benefit to users relating to the environmental impact, improvements to their personal comfort and the cost saving potential, to encourage engagement with the tool. The least important factor to users was how others viewed them. However, when asked about the importance of others regarding energy use in the building, 83% of users indicated it was either very important or somewhat important to them, indicating that social norms within the pilot buildings may still have an influence on users.

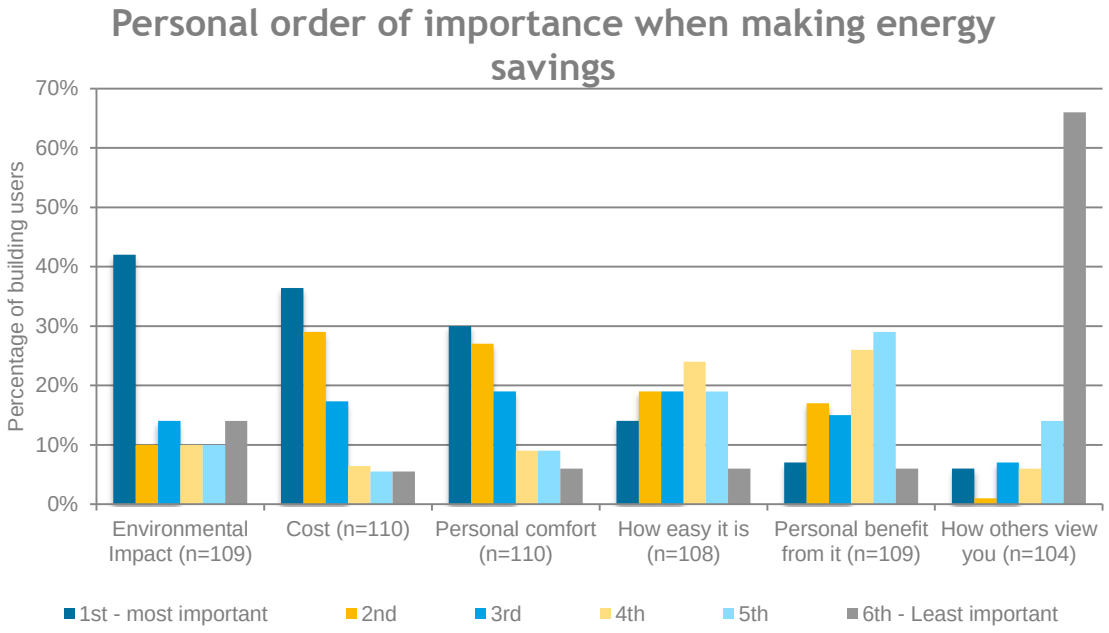


Figure 29 Personal importance relating to energy savings

To assess how inclined eTEACHER building users may be to engage with the eTEACHER interventions, users were asked about the likelihood of them taking part in an energy saving scheme within the pilot buildings. 35% of users indicated that they would be extremely likely to take part with a further 42% indicating that it was very likely they would participate. Only 3% of the users completing the questionnaire indicated that they would not take part at all, which is a fairly small percentage. This shows that the majority of the eTEACHER building users are likely to acknowledge the eTEACHER interventions. Participation with the interventions is likely to be influenced by the manner of intervention rollout (Task 1.4 details how best to engage with users to ensure successful participation). As such, users were asked about what methods for implementing the eTEACHER tool were likely to be successful and ensure that they were fully aware of the interventions, shown in Figure 30. The best methods to engage users were found to be posters around the buildings, emails sent directly to users and announcements on TVs/screens around the building. These methods are obviously depending on the availability of screens for announcements, relevant user mailing lists and permission to put posters up around the buildings. For the residential properties it is highly

unlikely that mailing lists will be available so posters and perhaps leaflets to individual apartments are the best options.

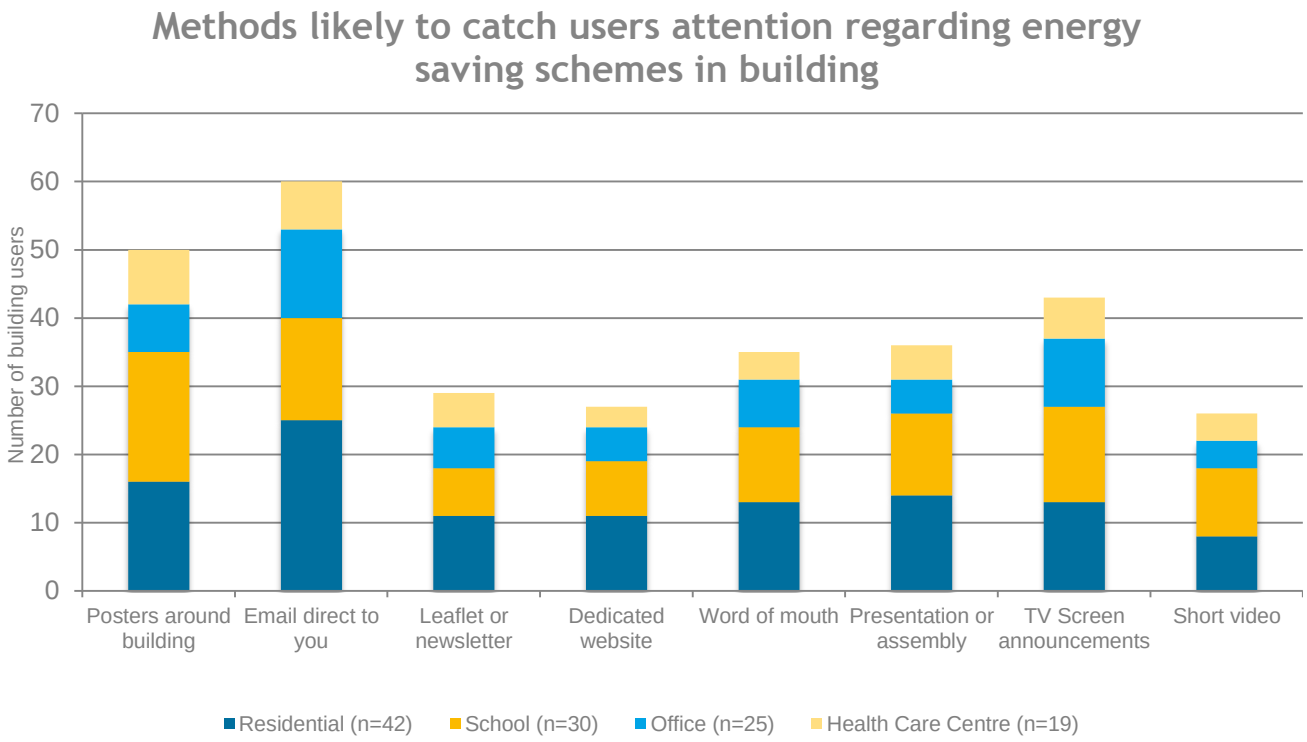


Figure 30 Methods likely to interest users in eTEACHER interventions rollout

To encourage users' motivation to participate with eTEACHER various different methods could be used and these options were given to users for them to indicate the likelihood these methods would have for encouraging them to participate. The options listed to users and the percentage of users indicating they would be encourage by were;

- Personalised energy use information (60%)
- Monetary rewards (43%)
- Competitions (26%)
- Regular updates (31%)
- Improved image for the building (38%)
- Encouragement from others (12%)
- Recognition for taking part (27%)
- Significant environmental impact (61%)

The most successful methods which could encourage users to participate were if it results in significant environmental impact and if it involves personalised energy use information.

Previous research has shown that engagement of users is key to the success of any behaviour change programme as behaviour change requires time and, therefore, if you keep users engaged with an

intervention longer, there is a higher probability that behaviour change will occur and be sustained. A method for enhancing engagement is the building of a community with users, where they feel part of a larger group and share experiences and knowledge. Within eTEACHER this could be a design option which could be included in the eTEACHER tool. In order to assess users' likeliness to engage in knowledge sharing with other building users, they were asked which information would they like to know from other building users and what information would they be happy to share with others, as seen in Figures 31 and 32. Users indicated an interest in knowing information from others on energy improvement suggestions, energy saving tips & advice and any building improvement suggestions. This shows that a high proportion of users would like to be able to access information on making energy savings and improvements specific to their building. Similarly, this was the same kind of information that users were most happy to share with other building users from their own experiences.

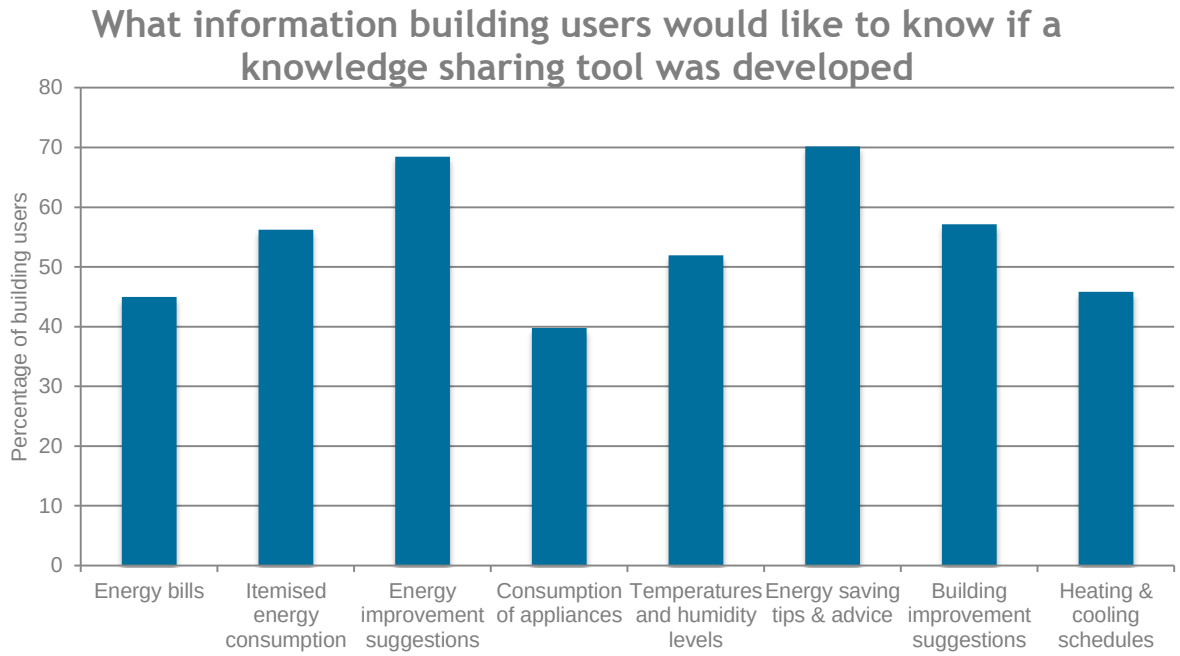


Figure 31 Users' interest in information received through a knowledge sharing tool

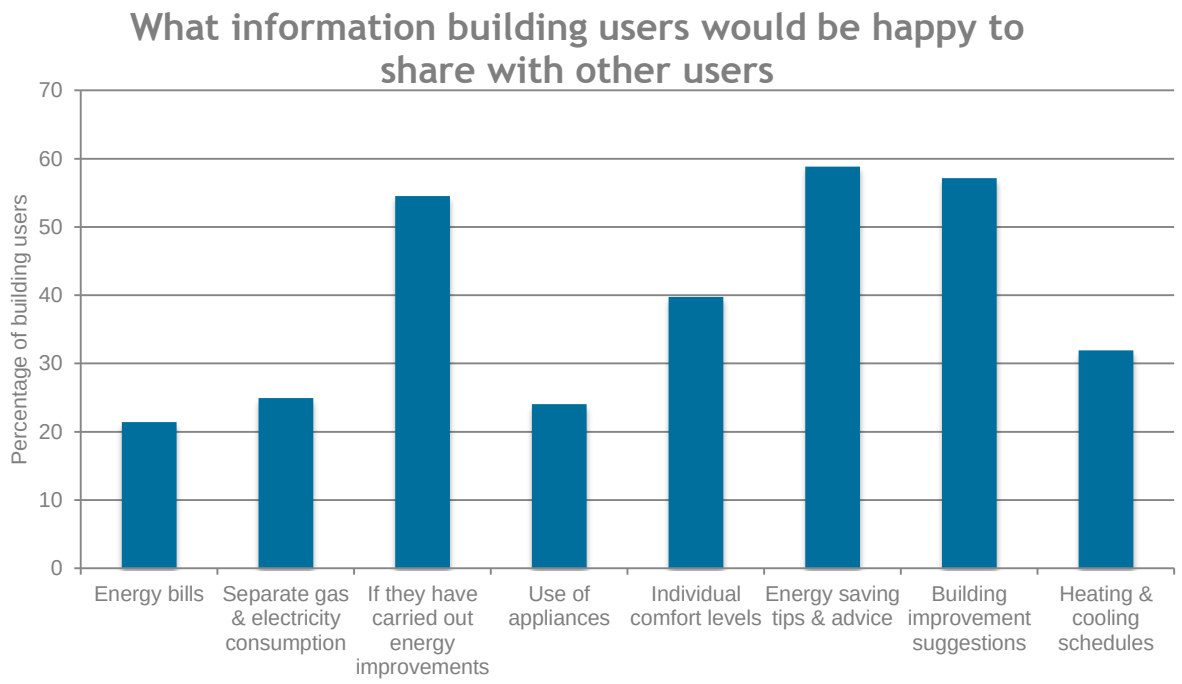


Figure 32 Users' preference in own information happy to share with others in a knowledge sharing tool

4.6 Summary of users' energy-related needs for eTEACHER

Within this section, **comfort has been identified as being a significant factor for users** of the eTEACHER pilot buildings. However, the opportunity to improve individual's comfort is not available in all eTEACHER buildings and this should be taken into consideration for the design of the eTEACHER interventions, particularly if the interventions involve giving advice to building users. Users' capabilities to engage with eTEACHER have shown that multiple platform options are needed for eTEACHER to be successful in all buildings as not all building users have smartphone access, while some are even prohibited from using smartphones whilst in the building. There is a high level of interest by the building users towards conserving energy within the eTEACHER pilot buildings and are more likely to be motivated by eTEACHER if it emphasises the environmental impact, the cost savings and the improvement to personal comfort through engagement with the eTEACHER tool.

5 Technical feasibility for eTEACHER tool and behaviour change

As introduced in Section 2.5, a technical workshop was arranged as part of the data collection methods used for Task 1.2. The technical workshop was used to bridge together the project requirements within work package one, two and three, ensuring that the opportunity for behaviour change interventions was acknowledged from a technical viewpoint.

5.1 Key objectives of Dresden workshop

The three key objectives from the technical workshop are summarised below;

1. Consider the technical capabilities of ICT design partners and identify what "is possible" for eTEACHER in terms of meeting user requirements within the scope of what is economically and technically feasible – what behaviours can be targeted and monitored to assess whether changes in specific behaviours have occurred.
2. Explain WP2 & WP3 in more detail and link both to WP1 user requirements, giving a mutual understanding across all work packages and relevant project partners.
3. Define project requirements and specifications for a monitoring system which can measure behaviour change.

5.2 Key outcomes relating to design recommendations

One of the key outcomes of the workshop was the decision between partners that the ICT tool should be **one app which fits across all buildings and user types**. Prior to the workshop two ideas had been circulated about whether the tool should be one app, which can branch across all of the eTEACHER pilot buildings and users, or whether tailored ICT interventions would be specified for each pilot building resulting in multiple versions of the eTEACHER tool.

As introduced in Section 2.5 a Master table was created prior to the workshop which listed all user requirements/behaviours identified and the relevant status for data availability to facilitate discussions between partners, shown in Figure 42, relating to design recommendations for the ICT tool design and monitoring specifications. From discussions surrounding the user requirements and behaviours identified within the pilot buildings, the decision was taken that the eTEACHER ICT tool should focus on behaviours relating to lighting use, appliance use and user comfort, as these were the most prominent behaviours identified as issues within the pilot buildings.

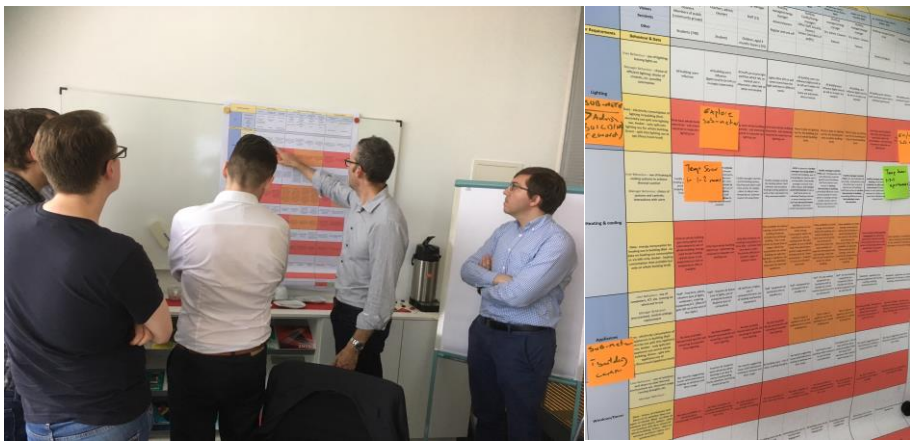


Figure 33 WP1, WP2 and WP3 relevant project partners discussing key user behaviour requirements and implications through use of Master table

A key consideration for WP1 revolved around the monitoring potential within the eTEACHER buildings, as part of the evaluation for the success of the eTEACHER tool involves assessing whether the tool enables behaviour change within the pilot buildings. Therefore, it is essential that user behaviours can be measured to an extent, with a baseline measurement of behaviours essential prior to the implementation of the eTEACHER interventions. The monitoring potential and specification was discussed in detail during the workshop and multiple decisions resulted from these discussions. The use of a blended approach with whole building level data plus more detailed room/apartment level data within a representative sample size for each building was decided. From this, a hierarchy of data monitoring requirements was decided involving the following;

- Building level – lighting to be sub-metered, appliances to be sub-metered, heating consumption data for whole building (only if easy and within budget), outdoor air temperature and solar radiation
- At room/apartment level – temperature and CO_2 sensor, smart sockets, window & door sensors (and blinds if appropriate) – depending on budget constraints. (additional measurements should be investigated to see whether sensors can have additional measurements such as lux, humidity, motion etc. within budget)

Within each building a sample of rooms/apartments should have detailed monitoring kit installed. However, it was acknowledged that the number of rooms/apartments will be determined by budget limits; eTEACHER should aim for at least 10% of the building as the minimum sample size to give a good representation of the building. It was also acknowledged that the cost of sub-metering within each building may vary significantly depending on the complexity of the energy systems and technologies within each building.

The monitoring requirements agreed within the workshop were classified using the traffic light colour coding to highlight what monitoring must be installed (green), what should be installed if budget allows (amber) and what was identified as being beneficial but acknowledged as being out of the eTEACHER project budget (red). These requirements are shown visually in Figure 43.

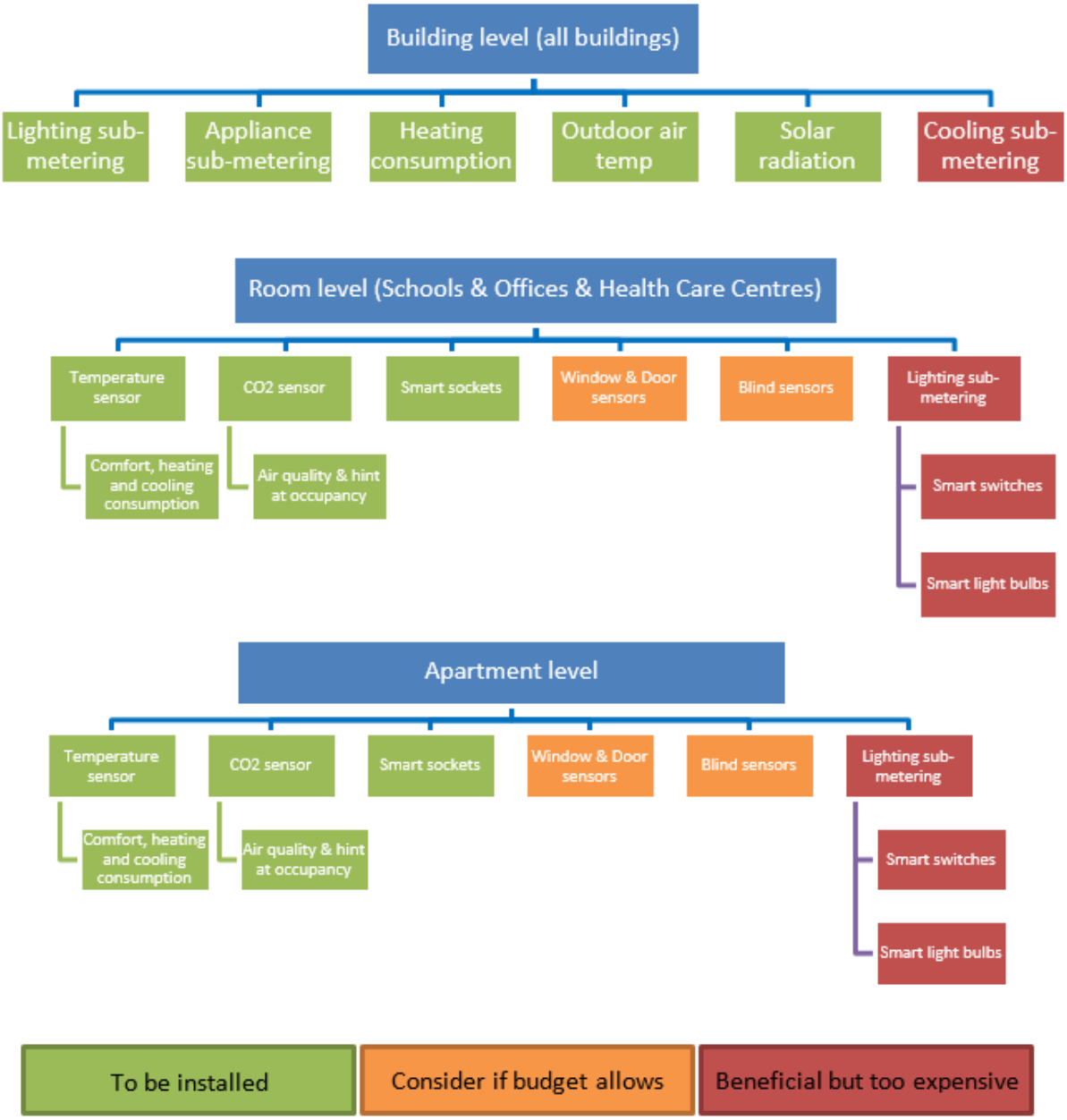


Figure 34 Hierarchy of data monitoring requirements agreed upon during workshop

5.3 Summary of technical feasibility

The outcomes from the technical workshop which should be taken into consideration in the design recommendations for the eTEACHER tool are summarised below:

- One app which can be used across all buildings and user types
- The level of detail for monitoring data is dependent on budget – recommendations must cover those identified in green and amber
- Design requirements/recommendations should focus on 1 app which is functional across all buildings and focus on user behaviours within buildings relating to lighting/comfort/appliance use.

6 Recommendations

Based on the findings from T1.2, recommendations can be suggested to enhance the design of the eTEACHER tool which take into account the different building types and user types being targeted by the eTEACHER interventions. As the eTEACHER tool is expected to be one app, which can work across all eTEACHER building types and user types, numerous variables have been taken into consideration. Due to this, our recommendations are given using the MoSCoW acronym characterisation. The MoSCoW acronym stands for Must have (M), Should have (S), Could have (C) and Won't have (W). The MoSCoW prioritisation framework was developed by Clegg & Barker (1994) and has been used frequently for project management, business analysis and software development as a means of prioritising specific criteria by importance. Within the recommendations given: 'Must' recommendations are those which definitely need to be included within the design; 'Should' recommendations are required to be included if possible (time & budget depending); 'Could' recommendations are those which could be included if feasible and 'Won't' recommendations are those which will not be included in the design due to factors identified during Work Package 1 and project discussions, yet may be worth keeping in mind for future projects or enhancements of the eTEACHER tool. Table 6.1 summarises the recommendations based on the findings within Task 1.2.

Table 6 eTEACHER design recommendations

Issue	Description	MoSCoW Recommendation(s)
Mixture of building types and user types	The added complexity of having a range of building types and users within the eTEACHER sample requires that the design take this into consideration. Energy managers will respond differently to specific info/data compared to regular everyday building users.	• (M) be one app, as discussed and decided by project partners. • (S) have layers within the app so that different users can access data as appropriate for their activities and agency within the building. • (M) have profile creation possible so that users can identify what kind of user they are in the building, allowing for tailored recommendations to be sent accordingly. • (M) be able to identify which building the users are from, and which rooms they use. • (C) allow users to select what sort of information/data they would like to receive.
Range of user ages	The range of ages of the target eTEACHER building users is very diverse and therefore the level of understanding and comprehension will vary within the sample.	• (M) use language and terminology that is accessible to all building users – therefore cannot be overly complex. • (S) use clear and concise text. • (C) provide options for text size, which may help some users.
App to be used across multiple countries	To add to the complexity of eTEACHER, it is being demonstrated in buildings ranging across three European countries.	• (M) Include options for English, Romanian and Spanish languages to be selected by users. • (C) Have multiple languages to select from for those users who are not fluent in English, Romanian or Spanish.
Capability of	Not all building users have access to smartphones within the	• (M) be accessible across multiple platforms

users	eTEACHER buildings and some are even prohibited from the use of smartphones. Therefore, alternative platform options need to be considered if we want to target all users. eTEACHER building users' understanding of energy is strongest when using cost and/or kWh. In general, using visual methods to communicate energy data is an effective approach to engage most users.	– smartphone, tablet, laptop and desktop computer. • (W) supply ICT equipment to users to access the eTEACHER app on. • (M) Factor different understandings of energy into the design. Show savings and consumption data in cost and kWh consumption, using intuitive visual methods, to ensure comprehension for all users. • (S) put less focus on carbon footprint when referencing environmental impact as this was poorly received by building users.
Opportunities for users	Within eTEACHER pilot buildings, not all users have the opportunity to change behaviours due to restrictions within the buildings. This predominantly involved users being restricted in altering the thermal environment.	• (M) consider the opportunity available in each building. • (S) give advice around window use and/or blind/shade use and use of clothing to improve the thermal environment as this advice can be targeted to all users. • (S) target advice specific to HVAC system use to energy managers/facility staff/those users with the agency to alter behaviours. • (C) enable users to enter building-specific target behaviours into the app, to take into account local issues and opportunities.
Motivations of users	Some building users within the eTEACHER pilot buildings have a keen interest in energy use within the building and in using eTEACHER. Their feedback regarding what information they would like and what influences them needs to be taken into consideration. These users, and many others, may be more likely to continue to use eTEACHER if Gamification principles are employed to sustain engagement and motivation to use eTEACHER.	• (M) emphasise the benefits of the eTEACHER tool to users in terms of cost savings, environmental impact and potential benefits to personal comfort when using eTEACHER. • (S) include information on room temperatures, total energy consumption, energy saving advice and comfort enhancing advice. • (S) use a range of Gamification principles, such as rewards for daily use, social comparison, challenges and 'unlocking' extra features as progress is made. • (C) have a separate tile on the app menu which has a daily energy saving tip – this could be generic across all building types and users but changes daily to keep interest. • (C) also add comparison data for users, including before/after and comparison with other users/buildings.
User behaviour – lighting	Lighting use behaviour was identified as being one of the key behaviours to target across all buildings. 87% of all building users reported that lights are regularly left on in the buildings. Lighting Behaviours include: – Turning off lights when leaving a room or at end of day (all users) – Checking lighting levels and needs during day – reducing use of unneeded lights (energy/facility managers or staff) – Replacing bulbs with more energy-efficient ones	(M) sub-meter lighting energy at a whole building level at the very least. (S) aim to sub-meter lighting to room/apartment level. (C) give lighting use advice which factors in the natural sunlight available (with links to Lux measurements if possible). (C) have a daily reminder for switching off lights or set as a weekly challenge to gain a "reward". This latter approach keeps reminders salient, as daily reminders might be ignored after a couple of weeks.

	(residents and building managers) – Installing improved lighting and controls (building managers) – Making use of natural light more (all users)	
User behaviour – appliances	Appliance use behaviours were reported as being key problems across most eTEACHER buildings, particularly in relation to the use of computers. 70% of building users reported computers being left on when not in use; 63% reported them being left on standby overnight. Appliance use behaviours include: – Ensuring appliances are not left on standby overnight – Changing default settings or manually using sleep/hibernate modes and 'screen off' when computer is not in use – Turning off computer if away from desk for any length of time – Turning off own computer at end of the day – Changing power mode to be more efficient – Choosing more efficient hardware and default settings (building managers) – Turning off chargers once fully charged – Turning off TVs/screens at end of the day – Turning off projectors when not in use – Turning off medical equipment if possible (staff)	(M) sub-meter appliance use, at the very least on whole building level but ideally at appliance level. (S) aim to monitor computer usage, given that it is identified as being a key energy use behaviour across all buildings. (S) give advice to all about remembering to switch off computers/appliances at end of the day. (C) include appliance energy saving tips in the daily tip section of the app. This could be combined with information on the energy savings from changes in behaviour (e.g. from switching to hibernate/sleep instead of leaving a workstation left on).
User behaviour – comfort	Heating use and comfort preferences were also reported as being an important behaviour to target across all buildings. 65% of users reported that the heating is often on when not needed in the eTEACHER pilot buildings. 63% also reported that additional heat sources are used by some to improve their own personal comfort. Heating use and comfort behaviours include: – Reducing thermostat temperature for heating – Managing temperature via clothing or activity rather than heating/cooling whole space – Increasing air-conditioning temperature set for cooling (energy manager/facility staff) – Ensuring that air-conditioning and heating not on at the same time (residents or energy manager) – Ensuring that if heating is on, windows and doors are kept closed (if possible) to keep the heat from escaping (all users) – Choosing more efficient systems or better use of system settings (energy/building manager) – Reducing use of personal fans/heaters within the building	(M) sub-meter HVAC consumption on whole building level. (S) target advice on effective settings for HVAC to building managers/energy facility staff. (S) target advice to improve personal comfort to all building users.
User behaviour - engagement	Engagement with the eTEACHER interventions is a vital part of the design of the ICT tool. Without widespread user engagement with the tool, eTEACHER's success will be limited. Engagement behaviours include – Self-reporting energy-related behaviours in response to in-app activities and challenges – Reporting comfort levels to app in response to prompts (all users) – Viewing energy consumption of whole building (all	• (M) record users' engagement with eTEACHER tool in order to analyse how they use the tool, how prolonged their use is and what features they respond best to. • (S) allow users to report and discuss issues within the building, but also receive feedback from Facility Management regarding the progress of the issues. If resolved as reported, users are more 'forgiving' of unsatisfactory conditions if they are made aware of progress.

	users) – Viewing energy consumption of own room/apartment – Using eTEACHER tool to report any building issues (e.g. overheating, too cold, equipment failures etc.) with Facility Management (all users) – Using eTEACHER tool for Facility Management to report back to users the status of any issues in building (all users) – Viewing energy data for specific appliance use – Discussing energy-related issues, such as sharing tips and suggestions with other building users	• (S) encourage prolonged engagement by showing personalised energy information (building level at least, room level ideal). • (C) use charts/rewards/pledges/ladder to show personal improvement made (environmental impact & cost) through personal actions taken in the building. • (S) take user preferences into consideration regarding styles of app (future research would be needed with building users to gain their feedback on this).

These recommendations have been taken into consideration alongside the outputs from Task 1.3 and Deliverable 1.1 to generate an eTEACHER Design brief, found in Appendix 9.11.

7 Work Package 1 Summary

This report has presented the analysis of end-user behavioural issues within each of the eTEACHER pilot buildings and used these findings to produce recommendations for the design and specifications which should be taken into consideration in the design of the eTEACHER tool.

Parallel to this task, WP1 has also been carrying out T1.3, ICT-based engagement and behavioural change for energy efficiency in buildings, and T1.4, Specifications for eTEACHER "Enabling Change" framework. T1.3 focused on the ICT requirements for the eTEACHER tool and sought to bring together users' opinions and attitudes towards various ICT elements and potential design features for eTEACHER with project partners' expectations and experiences. The full details of this task and the resulting recommendations for the design of the eTEACHER tool can be found in Deliverable 1.3. As mentioned in multiple sections of this report, the engagement of building users' within eTEACHER pilot buildings throughout the project is an essential part in achieving a successful deployment of the final tool and to ensure prolonged engagement with it to ensure energy savings and behaviour change are achieved. Within D1.1, the Enabling Change framework was identified as being a relevant method for ensuring engagement with building users which takes into consideration the context of each eTEACHER building and the target users. Task 1.4 aimed to specify the approach which should be taken in each of the eTEACHER pilot buildings relating to engagement throughout the design stage and in relation to the implementation stage. The full specifications can be found in detail within Deliverable 1.4.

In order to synthesis the recommendations resulting from Task 1.2, Task 1.3 and Task 1.4, an eTEACHER design brief has been put together which encompasses all of the relevant recommendations which need to be considered and incorporated within the design of the eTEACHER ICT intervention tool. This design brief can be found in Appendix 9.11

Going forward, an important part of linking WP1 recommendations will be to ensure a relevant and robust methodology is planned which can capture baseline data on the specific behaviours being targeted by the eTEACHER interventions and that the success of the eTEACHER interventions can be evaluated to state whether behaviour change occurred or not. This behavioural baseline and evaluation methodology forms part of the work collaborating with WP4.

8 References

Anderson, W. and White, V. (2009). *Exploring consumer preferences for home energy display functionality. Report to the Energy Savings Trust*. Bristol. Centre for Sustainable Energy. Available at: https://www.cse.org.uk/downloads/reports-and-publications/behaviour-change/consumer_ preferences_for_home_energy_display.pdf

Clegg, D., and Barker, R. (1994). *Case method fast-track: a RAD approach*. Reading. Addison-Wesley Publishing. ISBN: 020162432X

Coleman, M. J., Irvine, K. N., Lemon, M. and Shao, L. (2013). Promoting behaviour change through personalized energy feedback in offices. *Building Research & Information*. 41 (6). pp. 637-651

Darby, S. (2006). *The effectiveness of feedback on energy consumption. A review for DEFRA of the literature on metering, billing and direct displays.* Oxford: Environmental Change Institute.

EEA. (2013). *Achieving energy efficiency through behaviour change: what does it take?* Copenhagen: European Environment Agency. ISSN 1725-2237

Grossberg, F., Wolfson, M., Mazur-Stommen, S., Farley, K. and Nadel, S. (2015). *Gamified Energy Efficiency Programs - ACEEE Report Number B1501.* Washington D.C.: American Council for an Energy-Efficient Economy.

Hargreaves, T., Nye, M. and Burgess, J. (2010). Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy*. 38 (10). pp. 6111-6119

Leaman, A. (1995). Dissatisfaction and office productivity. *Facilities*. 13 (2). pp. 3-19.

Michie, S., Van Stralen, M.M. and West, R. (2014). The Behaviour Change Wheel: A guide to designing interventions. [Online] Available at: http://www.behaviourchangewheel.com [Accessed on 30th January 2017]

Morton, A., Reeves, A. and Bull, R. (2018). Key Concepts Summary. Deliverable 1.1 of the eTEACHER project funded under the European Union's Horizon 2020 research and innovation programme GA No: 768738. Brussels: eTEACHER consortium.

Murtagh, N., Nati, M., Headley, W. R., Gatersleben, B., Gluhak, A., Imran, M. A. and Uzzell, D. (2013). Individual energy use and feedback in an office setting: A field trail. *Energy Policy*. 62. pp. 717-728

Oseland, N. and Bartlett, P. (1999). Improving Office Productivity: A guide for Business and Facilities Managers. Singapore. Longman.

Parker, D., Hoak, D. and Cummings, J. (2010). Pilot evaluation of Energy Savings and Persistence from Residential Energy Demand Feedback Devices in a Hot Climate. In: *ACEEE 2010 Summer Study on Energy Efficiency in Buildings.* [online] Pacific Grove, California. ACEEE. Available at: https://aceee.org/files/proceedings/2010/data/papers/2117.pdf [Accessed 24 November 2017]

Siero, F. W., Bakker, A. B., Dekker, G. B. and van den Burg, M. T. C. (1996). Changing Organizational Energy Consumption Behaviour through Comparative Feedback. *Journal of Environmental Psychology*. 16. pp. 235-246

SPSS software. IBM Corporation. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp

Ueno, T., Tsuji, K. and Nakano, Y. (2006). Effectiveness of Displaying Energy Consumption Data in Residential Buildings: To Know is to Change. In: *ACEEE 2006 Summer Study on Energy Efficiency in Buildings.* [online] Pacific Grove, California. ACEEE. Available at: https://aceee.org/files/proceedings/2006/data/papers/SS06_Panel7_Paper22.pdf. [Accessed 24 November 2017]

Whitley, T. D. R., Makin, P. J. and Dickson, D. J. (1996). Job Satisfaction and Locus of Control: Impact on Sick Building Syndrome and Self-Reported Productivity. In: 7th International Conference on Indoor Air Quality and Climate. Nagoya, Japan.

Wolfe, A. K., Malone, E. L., Heerwagen, J. and Dion, J. (2014). *Behavioural Change and Building Performance: Strategies for Significant, Persistent, and Measurable Institutional Change.* Richland, Washington: U.S. Department of Energy, DE-AC05-76RL01830

Wood, G. and Newborough, M. (2003). Dynamic energy-consumption indicators for domestic appliances: environment, behaviour and design. *Energy and Buildings*. 35. pp. 821-841

Wood, G. and Newborough, M. (2007). Energy-use information transfer for intelligent homes: Enabling energy conservation with central and local displays. *Energy and Buildings*. 39. pp. 495-503

9 Appendices

9.1 Detailed data collection for each pilot building – Residential, Romania

InCITY, Romania

Summary of building: 4 blocks of residential properties in Romania

Responsible eTEACHER partner: Institutul de Cercetari Electrotehnice (ICPE)

1. **Pilot site visit**

Date: 5th July 2018

Notes from visit:

InCity is an apartment complex consisting of four apartment blocks with a total of 502 apartments (across the four blocks). It was built in 2009 by the developer Anchor Group and is now operated by the InCity Residence Owners Association. The complex has green areas, a children's playground, a fitness centre, an indoor pool and some retail units. Below the apartment blocks is a two level parking garage with 530 parking spaces. Around 40% of the apartments are currently rented out.

Within the four apartment blocks there are 13 different types of apartments ranging in sizes from 63m^2 to 265m^2. Floors 1-14 consist of eight different apartments on each floor (2x studio, 2x 1 bedroom and 4x 2 bedroom apartments). On floors 15-17 there is a total of 10 apartments which extend over the multiple floors – with access only possible on the 15th floor. The InCity Residence Owners Association operates all the core of each apartment block, the staircase, elevator, roof & parking.

The primary energy being used in the apartments is thermal energy (heating in apartments, commercial spaces and common spaces), electricity (common space consumption, apartment and commercial use have separate individual connections), natural gas (backup heating/hot water supply, apartments have individual connections) and diesel (back-up diesel generator for emergency supply to common spaces). Electric and gas are used at an apartment level but there is no data available on this. The apartment blocks are heated by district heating but there are also four natural gas boilers in the complex for whenever the district heating fails (this can be up and running within 15 minutes).

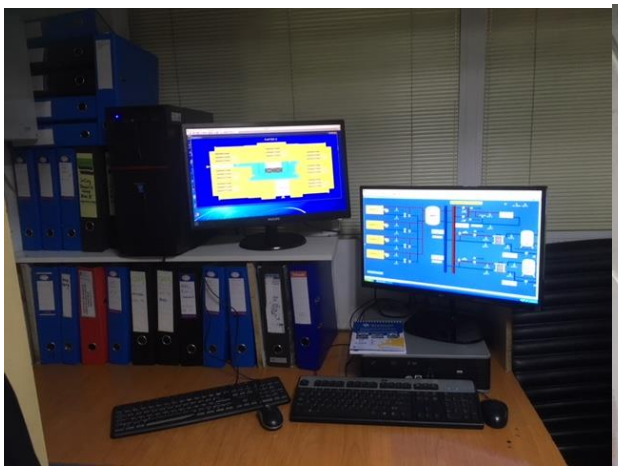
There are two BEMS systems used, one of which was installed in 2009 (when built) which covers Building A, B, C & common areas (parking), and the second in 2017, which covers Building D. Within the BEMS, the heating, hot water and cold-water use can be seen at an apartment level. There is no interconnection between the two BEMS systems and neither are connected to the internet, so data storage is on a local level only.

During the visit, it was reported that the BEMS system sets the heating temperature which is distributed to all apartments. In each apartment, the temperature can be adjusted to be cooler by using the radiator valves, but it cannot go any warmer than what has been set in the BEMS system. Some residents do

complain that the temperature is not warm enough for them. The facility team log any complaints/issues raised by the residents on paper and keep a record of all 'call-outs' and what was done to alleviate the problem. Other complaints include the water being too hot or too cold and common spaces being too hot/cold, which is common given the extreme weather conditions experienced (very hot summers and very cold winters).

Photographs of interest from visit:



2. Online behaviour change workshop worksheet

Worksheet completed by: Institutul de Cercetari Electrotehnice (ICPE)

Task 1: Building user overview

Table A1 List of Building users relating to InCity residential pilot buildings

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Owners/renters	Living space	Control over heating (manual thermostat at each heater) and over cooling (A.C split unit system). Have influence over electrical appliances and lighting consumption, hot and cold-water consumption within individual apartment.	To be further investigated
Facility manager/Energy manager/Technical team	Operate the buildings	Control over heating (at building level) and hot water (at building level). Can also influence cold water consumption at a building level and electricity consumption at a building level for communal spaces.	To be further investigated

Task 3: Identification of specific behaviours in building

Table A2 Specific behaviours identified in InCity residential pilot buildings

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Thermal comfort	Apartment owners/renters are likely to carry out behaviours relating to their thermal comfort on a daily basis (both heating and cooling	Low/Medium/High level of impact depending on each person's individual comfort level	To be further investigated	To be further investigated

	seasons) at an individual apartment level			

Annex Task: Understanding the building

Table A3 Initial data collection for understanding InCity residential pilot buildings

Who are ALL the users of the building?	Apartment Owners / Renters, Facility Manager
How many users in total are there for the building?	Approximately 2000 persons
What are ALL the uses of the building	Residential
What is the occupancy profile like (times occupied etc.)?	n/a
What energy consuming devices are present in the building?	A long list (To be further investigated)
What type of heating/cooling system is used?	Heating: District Heating Supply and heat exchangers at building level Cooling: Only A.C. split unit systems in apartments
Are areas of the building controlled differently to others?	Yes
Are individual apartments (if applicable) metered/monitored separately?	Yes
Are individual apartments (if applicable) charged for their individual energy use?	Yes
Who has control over heating/cooling settings in the building?	Facility Manager / Energy Manager (building level) Apartment Owners / Renters (apartment level)
Who has control over lighting/ventilation in the building?	Lightning: Facility Manager / Technical Team
Is there different facility managers/energy managers for different buildings/areas?	No, 1 person for all 4 demo buildings
What controls are available to users?	Heating control based on individual heating radiator thermostat
What energy data is available currently?	Heating, Electric, Gas, Wot Water, Cold Water
Is any data collected based on whole building use or is it separated in any way?	Data is available at building level and/or, common spaces level and apartment level
If applicable, is the data collected from the BACS system used?	Yes (not all the data!)
What occupancy data is available currently?	No data
Is occupancy data based on whole building or separate areas?	n/a
Is there any comfort level data available – temperatures, humidity, and user satisfaction?	No data (no sensors available)
Do users of the building have any influence in how energy is used in the building?	Low influence
Do users see any information on energy use in the building currently?	Some information
If so, in what format is the data displayed in?	Apartment Invoice
What energy information will the users of the building relate to most?	To be further investigated

How would the users of the building ideally like the information to be displayed?	To be further investigated
Do the users of the building have any issues with the building use currently?	To be further investigated

9.2 Detailed data collection for each pilot building – Health Care Centre, Spain

Health Care Centre, Villafranca de los Barros, Spain

Summary of building: Health Care Centre in Spain

Responsible eTEACHER partner: Agencia Extremeña de la Energía (AGE)

1. Pilot site visit

Date: 9th January 2018

Notes from visit:

The Health Care Centre is open typically 8am-3pm for all services, but also has an emergency department which remains open 3pm-8am. Cleaning crews tend to use the building 3pm-7pm.

There are monitoring systems currently in place including energy consumption (whole building level, lighting consumption and HVAC consumption), chiller use (overall electricity consumption, supply water temperature and return water temperature), internal air temperature (near the reception desk), outdoor temperature and the number of people entering and exiting the building.

During the visit, it was observed that many HVAC thermostats were located in hallways/corridors outside the relevant rooms, so are accessible to all building users (staff and patients). Similarly, light switches are also accessible by all users and often rooms had lights left on during the visit. It was also reported that the automatic entrance door tends to create a lot of problems with heat escaping due to this opening frequently. There is also a heater directly above this door so most of the energy produced from it will be escaping straight outside most of the time. People also tend to open windows even when the heating is on.

It was reported that the HVAC system is left on during afternoons/evenings even though it is only the emergency department that gets used during those hours.

Photographs of interest from visit: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FRAILE MAYORAL
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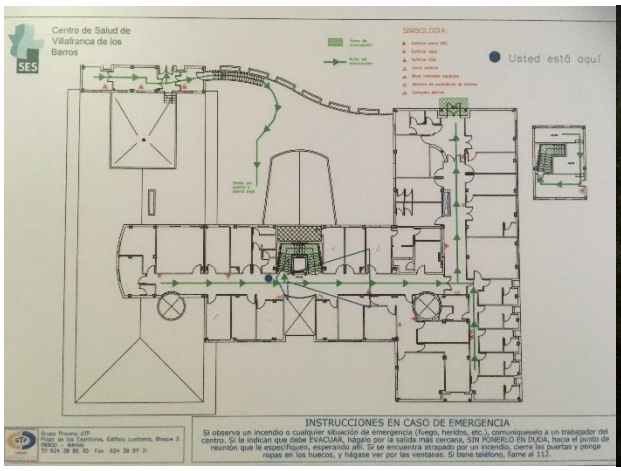
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2. Online behaviour change workshop worksheet

Worksheet completed by: Agencia Extremeña de la Energía (AGE)

Task 1: Building user overview

Table A4 List of Building users relating to Villafranca Health Care Centre pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Staff – Doctors & nurses	Place of work	Lighting, heat and air-cooling system and ventilation by windows. Doctors and nurses can only control the systems (HVAC and lights) from their own offices.	Staff should act according to instructions given by building facility manager; however, this advice is often not followed. Staff often prioritize individual comfort versus energy efficiency or savings.
Staff – Administrative	Place of work	Lighting, heat and air-cooling system and ventilation by windows. Administrative staff can control systems from their offices (if any) and common areas such as waiting rooms, halls etc.	Staff should act according to instructions given by the building facility manager; however, this advice is often not followed. Staff often prioritize individual comfort versus energy efficiency or savings.
Patients	In the building looking for medical advisor or similar. Often in the building for minutes/hours, just for waiting to see & talk to doctor or receive medical assistance	None – they do have access to thermostats and windows which they can open, but most often patients do not use or touch these items.	Patients contact the staff (particularly those in the administrative section) to request their comfort needs. However, these staff are expected to act according to instructions given by the building facility manager
Building Facility/Energy Managers (either as public maintenance service or as private subcontractors service)	Public maintenance service use to visit the building periodically but not on all days. They generally manage several buildings and decide on several energy issues	All of them	Both services prioritize the energy efficiency and/or savings within the building.

	Private subcontractors' service makes day-to-day maintenance and make managers decision. Can also propose improvements for the building. Typically spend 2-5 hours in the building (building open 24/7).		
Building Manager – Regional Public Health Service (integrated in the Regional Government)	Sporadic visits	General recommendations for all the similar buildings in the region	General recommendations

Task 3: Identification of specific behaviours in building

Table A5 Specific behaviours identified in Villafranca Health Care Centre pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Prioritizing individual comfort over energy efficiency or savings	Staff – both doctor/nurse and administrative staff prioritize comfort in their respective offices and zones during the main running hours of the building. From 8am to 3pm the full building is running; however, 3pm till 8am is only emergencies. The emergency zone accounts for 25% of the total building.	Significant	General information on energy efficiency and savings and specific advice given to the offices and managed zones.	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).
Prioritizing energy efficiency and savings over building user needs	Building facility/Energy managers – both public and private services can act on the building. However, AGENEX suggest emphasis should go on public services as private companies could change in the future.	Significant	Specific information about the buildings and more technical advice on energy efficiency and savings. General information would also be welcomed.	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).

9.3 Detailed data collection for each pilot building – Health Care Centre, Spain

Health Care Centre, Guareña, Spain

Summary of building: Health Care Centre in Spain

Responsible eTEACHER partner: Agencia Extremeña de la Energía (AGE)

1. Pilot site visit

Date: 9th January 2018

Notes from visit:

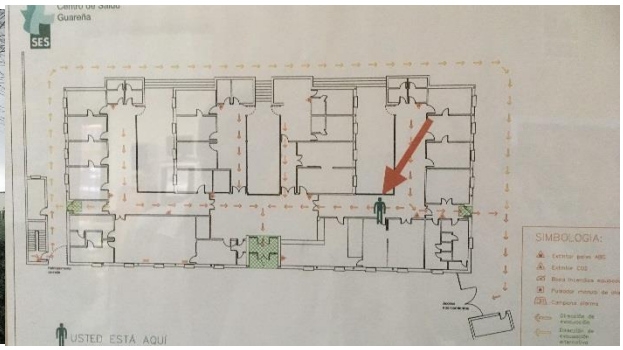
The Health Care Centre is open typically 8am-3pm for all services, but also has an emergency department which remains open 3pm-8am. It covers a range of medical appointments including general medical appointments, dentistry and physiotherapy. Some staff members may work longer hours and normally when this happens lights are left on for them.

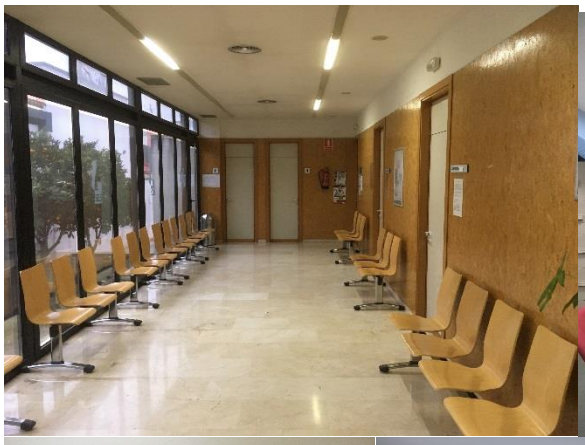
There are monitoring systems currently in place including energy consumption (whole building level, lighting consumption and HVAC consumption), internal air temperature (near the reception desk) and the number of people in and out of the building.

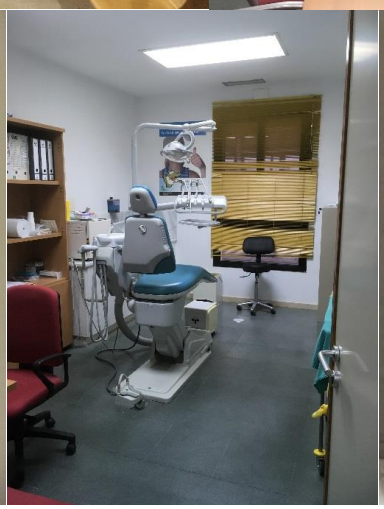
The HVAC system consists of eight air to air heat pumps, 6 of which are indoor and controlled by thermostats located in the reception area. Two outdoor heat pumps are used for the emergency area and the coordination office – thermostats to control each are located in the relevant areas/office. Staff can control these thermostats and also the light switches. Members of the public only have access to the light switches – but reminders have been put up to try to get members of the public to switch lights off after use, particularly in the toilets.

During the visit signs were also seen on the emergency entrance to remind users to shut the door behind them as it tends to stick and will often be left open, letting all the heat escape and the cold in. The building manager (senior doctor) reported that there are no big energy problems in the building in relation to the operation of the building., However, it was mentioned that staff will typically go to reception when they feel cold and request that the thermostats are altered for the relevant area they work in.

Photographs of interest from visit:







2. Online behaviour change workshop worksheet

Worksheet completed by: Agencia Extremeña de la Energía (AGE)

Task 1: Building user overview

Table A6 List of Building users relating to Guareña Health Care Centre pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Staff – Doctors & nurses	Place of work	Lighting, heat and air-cooling system and ventilation by windows. Doctors and nurses can only control the systems (HVAC and lights) from their own offices.	Staff should act according to instructions given by the building facility manager; however, this advice is often not followed. Staff often prioritize individual comfort versus energy efficiency or savings.
Staff – Administrative	Place of work	Lighting, heat and air-cooling system and ventilation by windows. Administrative staff can control systems from their offices (if any) and common areas such as waiting rooms, halls etc.	Staff should act according to instructions given by the building facility manager; however, this advice is often not followed. Staff often prioritize individual comfort versus energy efficiency or savings.
Patients	In the building looking for medical advisor or similar. Often in the building for minutes/hours, just for waiting to see & talk to doctor or receive medical assistance	None – they do have access to thermostats and windows which they can open, but most often patients do not use or touch these items	Patients contact the staff (particularly those in the administrative section) to request their comfort needs. However, these staff are expected to act according to instructions given by the building facility manager.
Building Facility/Energy Managers (either as public maintenance service or as private subcontractors service)	Public maintenance service use to visit the building periodically but not on all days. They generally manage several buildings and decide on several energy issues Private subcontractors' service makes day-to-day maintenance and make managers decision. Can also propose improvements for the building. Typically spend 2-5 hours in the building (building open 24/7).	All of them	Both services prioritize the energy efficiency and/or savings within the building.
Building Manager – Regional Public Health Service (integrated in the Regional Government)	Sporadic visits	General recommendations for all the similar buildings in the region	General recommendations

Task 3: Identification of specific behaviours in building

Table A7 Specific behaviours identified in Guareña Health Care Centre pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Prioritizing individual comfort over energy efficiency or savings	Staff – both doctor/nurse and administrative staff prioritize comfort in their respective offices and zones during the main running hours of the building. From 8am to 3pm the full building is running, however 3pm till 8am is only emergencies. The emergency zone accounts for 25% of the total building.	Significant	General information on energy efficiency and savings and specific advice given to the offices and managed zones.	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).
Prioritizing energy efficiency and savings over building user needs	Building facility/Energy managers – both public and private services can act on the building. However, AGENEX suggest emphasis should go on public services as private companies could change in the future.	Significant	Specific information about the buildings and more technical advice on energy efficiency and savings. General information would also be welcomed.	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).

9.4 Detailed data collection for each pilot building – School, Spain

IES Torrente Ballester High School, Miajadas, Spain

Summary of building: School building (High School) in Spain

Responsible eTEACHER partner: Agencia Extremeña de la Energía (AGE)

1. Pilot site visit

Date: 10th January 2018

Notes from visit:

Torrente Ballester High School is a bilingual high school, so students are taught in both English and Spanish. Met with both the secretary and head of the school during visit, who reported that they are in the middle of trying to refurbish the building but are currently trying to get agreement from management for it to proceed.

School consists of 4 floors – the ground floor holding the administrative offices and small classrooms dedicated to support/special lessons. The 1st and 2nd floors consists of classrooms, with the 3rd floor holding a teachers' room. There is also a second building behind the main school building which is used as a gym. The gym has its own boiler (which is currently not used) but uses the same electricity supply as the main building but it does have its own electricity cabinet in the gym building.

Roughly 450 students (aged between 11-16 years) use the building with around 60-70 staff members (both teachers and administrative staff). The building occupancy schedule is typically 8am-2pm (weekdays) for staff and students with cleaners using the building 3pm-7pm, during term times. In July it is only teachers who use the building, and the school is closed during August. Classrooms typically fit 25-30 students. The first class of the day tends to run 8.15am-9.10am with the last one being 13.15-14.05; recess typically runs 10.55-11.25am for students.

A total of 16 classrooms within the building have smart whiteboards for staff and students to use. Teachers tend to have desktop computers and overhead projectors in their classrooms (which are programmed to turn off at 2pm) with some classrooms also having laptops for students to use during lessons. The laptops tend to be stored within cupboards in the classroom which can charge them. However, they normally do not charge the laptops in this cupboard but at the desk via individual power outlets at student's desks.

During the visit, handmade notices were observed, aimed at encouraging others to save water and energy by ensuring taps were closed off after use and that light switches were off when leaving. When asked about these notices, it was reported that they belonged to a campaign with the students from quite a few years ago. It was reported that it has been quite a long time since the school had an environmental campaign running.

Common problems reported and observed during the visit included many lights being left on in classrooms (even when empty). Light switches are accessible to all building users in classrooms but the main toilets for

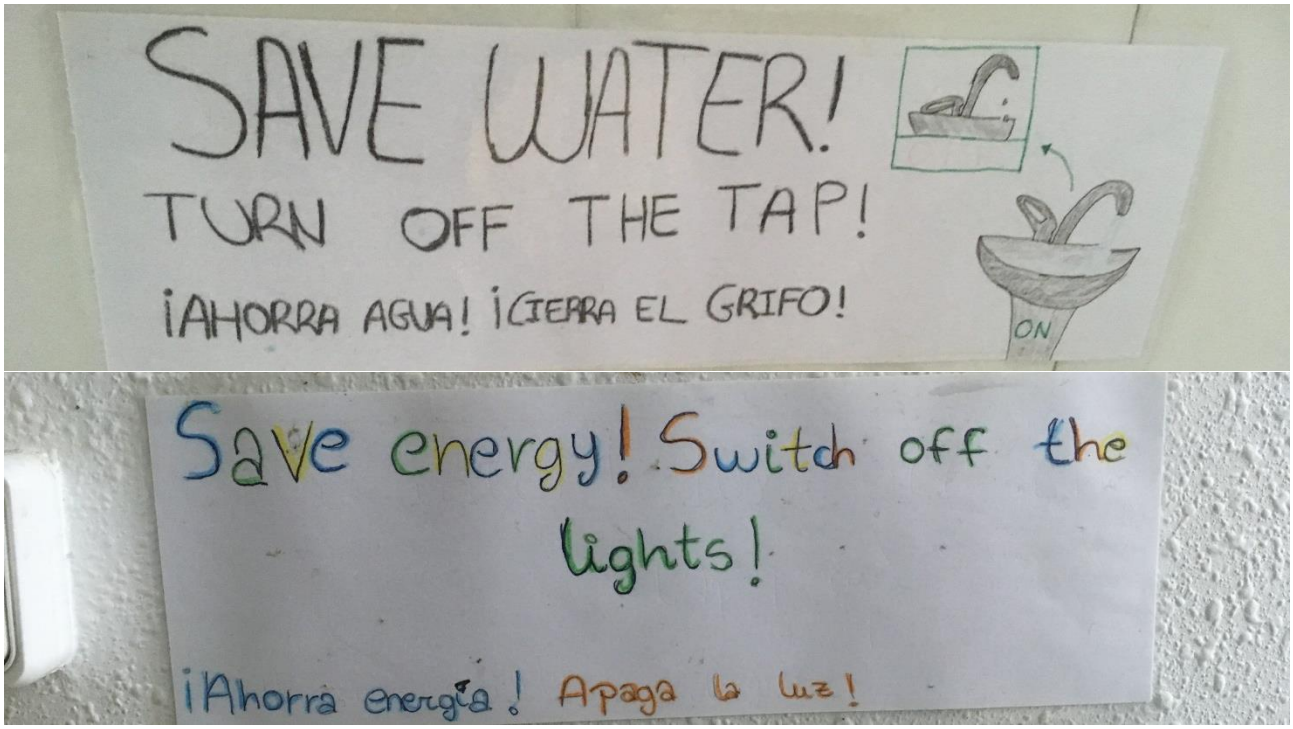
students now have presence sensors connected to the lighting to control when it is on and off. Administrative staff will often use surveillance cameras to identify corridors where the lights have been left on, in order to identify where lights may need to be switched off. Often windows are opened within classrooms by students when the heating is on as some classrooms tend to overheat and students get extremely uncomfortable. Within the classrooms only some of the radiators present can be adjusted by the radiator valves, so most students and teachers resort to using the windows instead. However, when the windows are closed, they are not always closed correctly leading to heat escaping and drafts coming in.

Currently there is no monitoring system in place within the building – only available data is the overall electricity consumption via bills. However, project partner Laura Otero mentioned that it could be possible to reconfigure the smart meter to allow the electricity consumption to be monitored.

Photographs of interest from visit:







2. Online behaviour change workshop worksheet

Worksheet completed by: Agencia Extremeña de la Energía (AGE)

Task 1: Building user overview

Table A8 List of Building users relating to IES Torrente Ballester High School pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Students	Learning – they are in the building from approx. 8am – 3pm	None – they have access to windows (which they can open) and lighting switches. However, teachers frequently check the use of these.	Students should contact the staff (teachers and administrative section) with the aim to request their comfort needs.
Staff – both teachers and administrative	Place of work	Lighting and ventilation by windows by all staff. Only a few offices have air cooling systems; this is a residual consumption. Administrative staff have access to thermostats in the building.	Staff typically prioritise energy efficiency and savings with the aim to promote a good behaviour in the use of resources.
Facility manager	Place of work. Maintain all of the building facilities, including heating system and lighting. In these buildings the management is made by janitors who are responsible for all the issues related to building control (lights, heating system and any other devices like computers)	All of them	Janitor use to prioritize the system operation and comfort instead of energy efficiency.
Building manager – Regional Public Education Service (integrated in Regional Government)	Sporadic visits	General recommendations for all the similar buildings in the region	General recommendations

Task 3: Identification of specific behaviours in building

Table A9 Specific behaviours identified in IES Torrente Ballester High School pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Prioritizing individual comfort over energy efficiency or savings	Staff	Significant as staff can influence energy through use of switched (mainly lighting and windows)	General information on energy efficiency and savings and specific advice given to the classroom	Meetings and advice via entirely visual supports (posters, little books, apps, TV screens in common zone).
Prioritizing energy efficiency and savings over building user needs	Building facility/Energy manager	Significant	Specific information about the buildings and more technical advice on energy efficiency and savings. General information would also be welcomed. In this case AGENEX recommends focusing on the heating system (boiler)	Meetings and advice via entirely visual supports (posters, little books, apps, TV screens in common zone).

9.5 Detailed data collection for each pilot building – School, Spain

CEI Arco Iris Kindergarten, Miajadas, Spain

Summary of building: School building (kindergarten) in Spain

Responsible eTEACHER partner: Agencia Extremeña de la Energía (AGE)

1. **Pilot site visit**

Date: 10th January 2018

Notes from visit:

Arco Iris Kindergarten is a single floored building with various rooms used for different purposes ranging from sleeping accommodation to kitchen and catering facilities. Users of the building include staff, infants and parents (dropping off and collecting of infants). Around 100 infants ranging from 4 months old to 3 years old use the building, with roughly a further 20 members of staff. The building is typically used 7.30am-3.30pm, with the heating system being used from 7am until 11am/12pm.

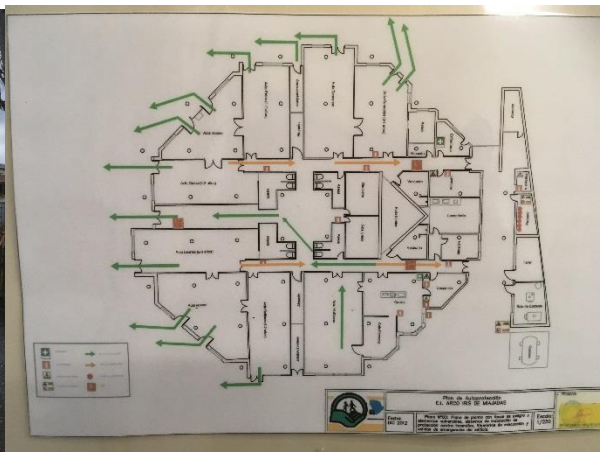
There is a kitchen/catering area for preparing food, including industrial hob, cooker (gas), with an adjacent room for cleaning. There is also a separate room for laundry within the building (containing washing machines and tumble dryers). These rooms may be fairly energy intensive but vital to the running of the kindergarten.

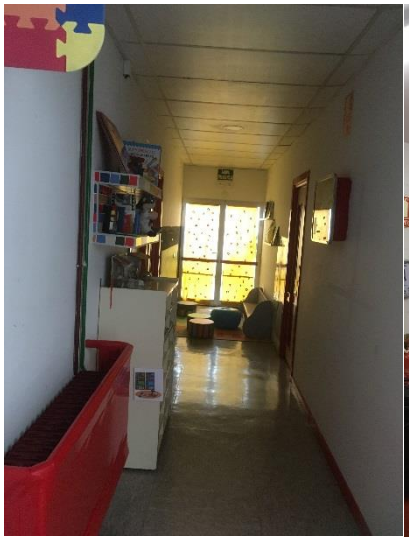
The heating within the building comes from an oil boiler, which they are billed for twice a year (no current monitoring data on usage other than bills). The central heating system consists of radiators in most rooms; however, staff do not usually use/change the settings on these. The radiators also have protective covers over them to ensure that they hurt no infant. The heating has external maintenance; however, the receptionist in the building checks them every Friday as well as checking the boiler status (and ensuring that lights and splits are off at the end of each workday).

Cooling within the building is supplied via splits in most of the classrooms; however, during the summer the infants spend most of the time on the patio and only really use the classrooms for lunch. The splits are programmed to come on a bit earlier than the lunch break and for the siesta break. The lighting in the building is also programmed to a certain extent. It is programmed that all lights are on in the morning but in the afternoon, they need to be switched on/off manually; switches are accessible to all users in classrooms and hallways.

Currently only data on whole building level consumption is known.

Photographs of interest from visit:

2. Online behaviour change workshop worksheet

Worksheet completed by: Agencia Extremeña de la Energía (AGE)

Task 1: Building user overview

Table A10 List of Building users relating to CEI Arco Iris Kindergarten pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Students	Being cared for	None – too young	None – too young
Staff – both teachers and administrative	Place of work	Lighting and ventilation by windows by all staff. Only a few offices have air cooling systems, this is a residual consumption. Administrative staff have access to thermostats in the building.	Staff typically prioritise energy efficiency and savings with the aim to promote a good behaviour in the use of resources.
Facility manager	Place of work. Maintain all of the building facilities, including heating system and lighting. In these buildings the management is made by janitors who are responsible for all the issues related to building control (lights, heating system and any other devices like computers)	All of them	Janitor uses to prioritize the system operation and comfort instead of energy efficiency.
Building manager – Regional Public Education Service (integrated in Regional Government)	Sporadic visits	General recommendations for all the similar buildings in the region	General recommendations

Task 3: Identification of specific behaviours in building

Table A11 Specific behaviours identified in CEI Arco Iris Kindergarten pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Prioritizing individual comfort over energy efficiency or savings	Staff	Significant as staff can influence energy through use of switched (mainly lighting and windows)	General information on energy efficiency and savings and specific advice given to the classroom	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).
Prioritizing energy efficiency and savings over building user needs	Building facility/Energy manager	Significant	Specific information about the buildings and more technical advice on energy efficiency and savings. General information would also be welcomed. In this case AGENEX recommends focusing on the heating system (boiler)	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).

9.6 Detailed data collection for each pilot building – Office, Spain

OAR County Council of Badajoz, Spain

Summary of building: Office building in Spain

Responsible eTEACHER partner: Agencia Extremeña de la Energía (AGE)

1. Pilot site visit

Date: 11th January 2018

Notes from visit:

Staff and members of the general public use the County council of Badajoz office building (OAR). The building is mainly used for the collection of taxes. It is split over three floors, with the upper two floors consisting of mainly open plan office space, individual offices and meeting rooms (of various sizes). The ground floor consists of an area of open plan office space, larger meeting rooms and areas for the public to wait before speaking to a member of staff at designated desk stations. In total around 130 staff work in the building with members of the public varying in numbers. Typically, the office occupancy schedule runs 8am-3pm Monday-Friday with Thursdays 4pm-8pm also being open to members of public. During the winter, the office may also be used 4pm-8pm on Tuesdays by staff as a means to recover hours (working hours are flexible). Outside of these core hours the building is also used by security staff and cleaning crews.

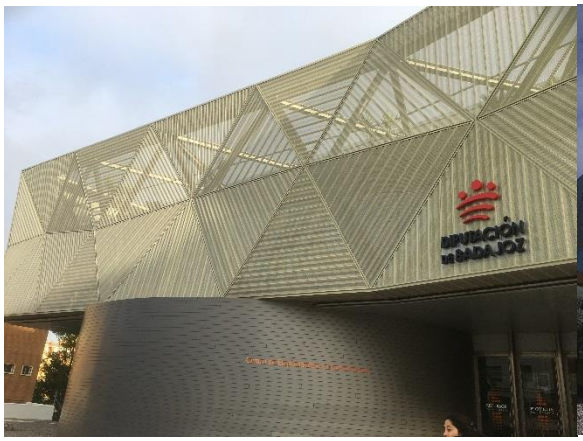
There are currently monitoring systems in place, giving energy data every 15 minutes. Four analysers are present monitoring: overall electricity consumption; HVAC consumption; lighting consumption; and other consumption (appliances etc.). There is a BMS system in the building so there is the potential to program HVAC schedules, register data etc., although they choose not to use it due to not knowing how to operate it. Normally a member of security personnel turns on the central HVAC and lights from the cabinets in the morning/afternoon and then the cleaning crew turn them off in the afternoon/evening. Staff cannot change the temperature of the open plan office spaces as the thermostats are locked behind tamper proof plastic boxes. However, individual meeting rooms have their own room controls which can be altered as needed.

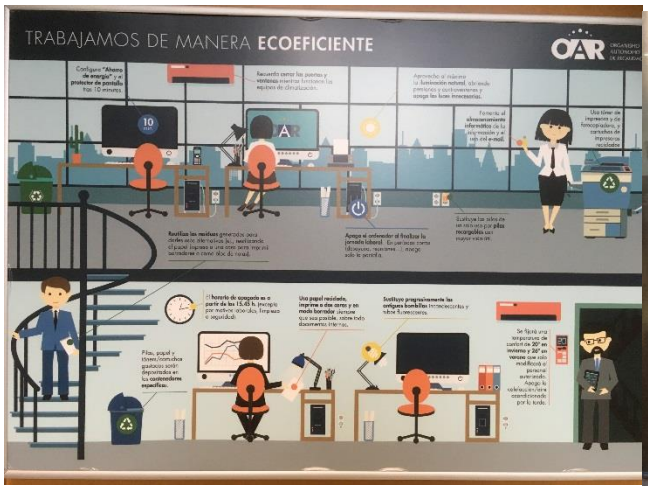
During the visit, a common complaint revolved around personal comfort. It can get up to 40°C in summer so temperature is a large issue, particularly given the large spaces within the building, resulting in many conflicts and tensions between staff as many are uncomfortable. On one floor there is currently a display which shows the temperature and the relative humidity within the office and they would like to install more of these around the building so that staff are aware and can raise their issues if they disagree to ensure a compromise is reached. During the visit this screen showed the temperature to be 27.7°C and yet walking around the office it could be seen that various members of staff had (and were using) portable heaters under their individual desks. They identify the problem as being with zonification as some zones are far too warm and others are far too cold. Staff are encouraged to have environmental awareness, with posters around the building giving advice for how to be more environmentally conscious.

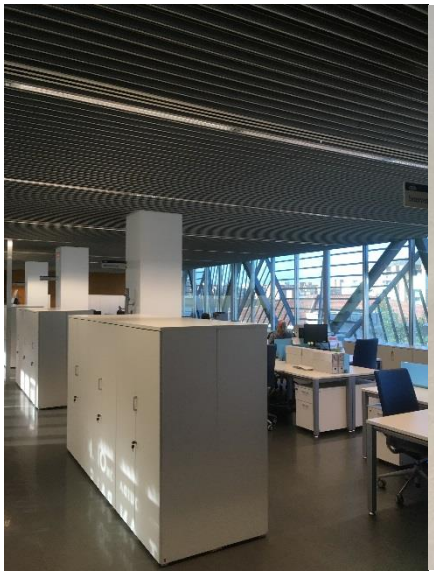
The organisation is very aware of environmental issues and is keen on emphasising their social responsibilities (it has documents online outlining their intentions and key beliefs). They try to be conscious of their consumption of energy, paper, printer ink, waste etc. Every year the company check their energy consumption and aim to improve it year on year, however they do not have a specific target that they are trying to reach.

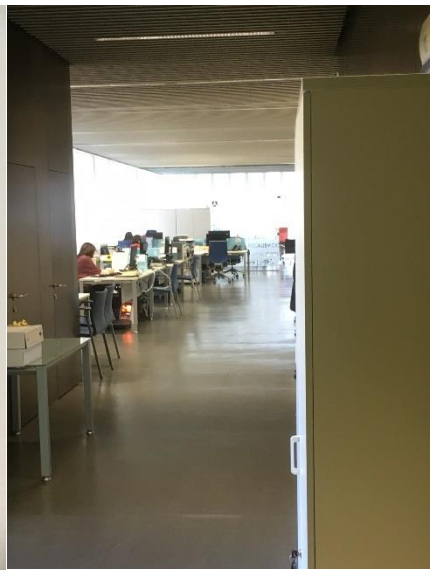
When the building was first opened, there were initially chillers put inside the building, but the design of the chillers required them to be outside, so they needed to find a solution to put the air outside. A cap has since been fitted to each of the chillers to send the air outside. This initial oversight caused many problems during the first year with the building and services including condensation. Previously, there had also been non-automatic doors at the front of the building, which have since been replaced with automatic doors to improve the heat loss from the original doors being left open all the time. Trees have also been planted outside the building to provide shade in the summer to try and keep the building cooler.

Photographs of interest from visit:









2. Online behaviour change workshop worksheet

Worksheet completed by: Agencia Extremeña de la Energía (AGE)

Task 1: Building user overview

Table A12 List of Building users relating to OAR County Council of Badajoz pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Public	Public use the building to come and manage their taxes. They can use the building from 9am till 2pm, and on Tuesday evenings 4.30pm-8pm. On average they may spend around 1 hour in the building.	None	None, despite of this they can make suggestions on the buildings comfort.
Staff	Professionals who work in the building. Staff should act according to the instructions given by the building facility manager, but this advice is not always followed.	Lighting and ventilation by windows for all the staff. Only a few offices have individual HVAC systems. This is a residual consumption. The HVAC system is mainly managed by facility manager	Staff use to prioritize their comfort. They are mainly located in a large open space, so varying comfort expectations within the office.
Building facility/Energy managers	Manage all the building facilities. They belong to the computer and security departments, so do not have deep knowledge on energy issues. However, both departments are responsible for energy issues in the Corporate Social Responsibility of the entity. In general, at least one of them will be responsible whilst the building is open.	All of them	People from both departments use to prioritize the system operation and comfort instead of the energy efficiency.
Building manager, represented by the Director of the entity	Works in the building	Director can influence the whole building. Has big concern with energy efficiency and savings	Director has big concern with energy efficiency and savings – his recommendations use to have a big influence. However, the director does not have specific knowledge on energy efficiency and savings.

Task 3: Identification of specific behaviours in building

Table A13 Specific behaviours identified in OAR County Council of Badajoz pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Prioritizing individual comfort over energy efficiency or savings	Staff	Significant as staff can influence energy through use of switches (mainly lighting and windows)	General information on energy efficiency and savings and specific advice given to the building offices	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).
Prioritizing energy efficiency and savings over building user needs	Building facility/Energy manager	Significant as they manage all of the energy systems	Specific information about the buildings and more technical advice on energy efficiency and savings. General information would also be welcomed. In this case AGENEX recommends focusing on the HVAC system	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).
Prioritize energy efficiency and savings	Entity director	Significant as he gives advice on energy systems	Specific information about the buildings and more technical advice on energy efficiency and savings. General information would also be welcomed. In this case AGENEX recommends focusing on the HVAC system	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).

9.7 Detailed data collection for each pilot building – Residential, Spain

Av. Godofredo Ortega y Muñoz, Badajoz, Spain

Summary of building: Block of residential properties in Spain

Responsible eTEACHER partner: Agencia Extremeña de la Energía (AGE)

1. Pilot site visit

Date: 11th January 2018

Notes from visit:

Visit only possible to exterior of building as building manager unavailable to meet. However, information known about the building by AGENEX was presented.

The building holds 30 individual apartments.

Electricity is used by the individual apartments plus for common areas (lighting, elevator etc.) – each flat pay for their own consumption plus a share of the communal use. Central heating in the building comes from 4 new gas boilers, with a cascade connection in the apartments. The overall gas consumption of the whole building is known, and each apartment has individual meters. However, it is not clear if we can have access to the individual heating consumption as it is managed by an external company. Apartments' bills are accounted for 70% by their individual consumption and 30% by common maintenance/consumption costs.

Photographs of interest from visit:

2. Online behaviour change workshop worksheet

Worksheet completed by: Agencia Extremeña de la Energía (AGE)

Task 1: Building user overview

Table A14 List of Building users relating to Av. Godofredo Ortega y Muñoz Residential pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Owners and residents	To live in. The higher use coincides with normal Spanish schedules.	All of them – only the heating system is centralized but residents can control the temperature (thermostat) in the individual apartments.	People use is with regards to prioritizing their own comfort
Building manager	Manages all the issues related to the common parts of the building (including the heating system). Manager lives in the building, but his office is not located in the building	Central heating (boiler) system. The lighting in common spaces has a residual consumption	Manager uses to prioritize the system operation and comfort but with a regard to energy (money) savings

Task 3: Identification of specific behaviours in building

Table A15 Specific behaviours identified in Av. Godofredo Ortega y Muñoz Residential pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Prioritizing individual comfort over energy efficiency or savings	Owners and residents – mainly adults and influence energy consumption while they are in the apartments	Significant as they control the whole apartment	General information on energy efficiency and savings and specific advice to apartments	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).
Prioritizing energy efficiency and savings over building user needs	Building manager – as they are responsible for whole building common facilities	Significant as he controls the heating system for all of the apartments	Specific information about the building and more technical advice on energy efficiency and savings. General information would also be welcome. In this case, AGENEX recommends focusing on heating system.	Meetings and advice via extremely visual supports (posters, little books, apps, TV screens in common zone).

9.8 Detailed data collection for each pilot building – Office, UK

Council House, Nottingham, UK

Summary of building: Office building within the UK

Responsible eTEACHER partner: Nottingham City Council (NCC)

1. **Pilot site visit**

Date: 12th October 2017 & 28th February 2018

Notes from visit:

User types:

Around 70 members of staff – including office staff,

Daily visitors – varying numbers

Building use:

Council meetings, weddings, private events, public resources such as the Nottingham register office, HM Coroner's Office.

Weddings tend to be held on Saturdays but with some occasionally on a Sunday. Some private events are held there during the evenings also, particularly in the Main ballroom or the dining hall.

The building is typically in use 6 days a week, Monday-Saturday.

Energy systems and management:

There is a BMS in place in the building which controls the heating only. There is no tracking with the system, there are meters within the building but not for individual areas.

There are distribution boards for the electrics on each floor.

The heating system is district heating from Eastcroft. This is fed into the main boiler room of the building and then circulated around the building via two pumps (which feeds the radiators and battery units). The heating system was installed about 18 months ago after the old system broke down.

The old system had panels behind the walls which provided excellent heat to the building, however it was often unreliable whether it would come on or not. "If you heard a loud bang then you knew it was working that day". The new system was only installed after three years of the building going without a heating system! They relied on halogen heaters to heat the building during that time.

The new system is very efficient and "100% times better than the old one as you could never guarantee whether that one would work each day or not".

Thermostats on all the floors and on the roof (for the external air temperature). Main heating controls are located on the 4th floor. Thermostats are not exactly placed in the best areas; one is on the roof of the lord mayor's office!

No gas is used in the building now.

The heating is typically set to come on at 7am and will go off when the desired temperature is reached. During the visit some of the floor temperatures were shown. The 4th floor is where many babies are registered and so the set-point was set to be 25 degrees Celsius.

Giant radiators serve the ballroom by blowing hot air through the vents and these were installed when the building was originally built, "I'd have loved to see the set-up they had back then as a bet it was the dogs!".

Radiators have tamper proof TRVs so individual rooms can be set differently.

Enviroenergy deal with the heating in the building.

Data:

The caretaker doesn't tend to have access to any data and thinks that the BMS probably could record data but wouldn't know how to sort that.

It is to get a baseline for this sort of building as the use of it is so different day to day let alone year to year!

Behaviour change:

The caretaker believes that it is the staff that need to be targeted in particular educated on the best ways to reduce energy use. Visitors come in and out so don't have much impact if they are targeted; however, if staff become more conscious regarding energy then savings could be made – in particular when staff start considering energy when hosting events etc.

The caretaker believes that staff in the building have no clue about energy use, "they are aware of energy but don't particularly care about it". Often the staff members will plug additional heating on through use of heaters etc. as they have no control over the central heating. During the visit one office staff member even had a fan plugged in as she complained the room was too hot. The caretaker also reported "it's not my job to get the staff aware, via posters or emails, but I am often telling them off" and that it's difficult to make everyone happy.

However, not much control on energy use is given to users of the building; it is all central council and a team out with the building that make the cuts or enquire about energy use if it is seen to be much higher than previously. He also stated that they have no set targets regarding energy use within the building. Often, they may ask him to make savings in some way from reducing the use of energy or just tend to enquire why the energy use may have increased.

The caretaker also indicated that it is often difficult to change anything in the building, "you're not allowed to put a nail in the wall without heritage coming down".

Other information gathered:

The senior caretaker has been working there for 13 years.

The windows of the building can be opened, and some do, particularly in summer as some areas of the building can get very stuffy. They are still the original bronzed frame windows, single glazed and highly unlikely that would be changed to double glazed windows due to the building being Grade II listed.

It is 6 floors in total from the boiler room to the roof.

The councillors moved out of the building around 6 years ago and all of the registrars moved in – massive change in how the building was used when this happened. Some coroners may work until 8pm in the evening. Services start around 8.30am every morning but depending on what happens that day you could be there for 16, sometimes up to 20 hours.

The building is in the process of a grant to get all LED lights fitted in the building; around £30,000 worth. The problem is that is a lot of the fittings are very dated and some low energy light bulbs keep tripping. The caretaker stated that often bulbs will go and when he reports them it becomes difficult to get replacement bulbs due to the budget for the building being cut so dramatically over the last few years; therefore, he often gets told to just see if they can make do with the light being out.

The glass dome has over 100 low energy light bulbs illuminating it from behind but many of them have blown (darker patches of dome) and have not been replaced as to replace them it involves having a mechanical platform being used to get up to them. They are likely to be left until the new LED lights are installed.

Photographs of interest from visit:




2. Online behaviour change workshop worksheet

Worksheet completed by: Nottingham City Council

Task 1: Building user overview

Table A16 List of Building users relating to Nottingham Council House pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Facilities managers (full-time)	Take care of the building. Responsible for the general upkeep and identifying/resolving of any issues.	Heating controls directly (both routines and at any given time); lighting; maintenance e.g. radiators, windows, pipes and taps; staff behaviour to some extent. Turn off equipment at end of the day; utility bill management; event organisation/coordination.	On the one hand they must ensure staff and other building users (e.g. councillors, public etc.) are comfortable and are able to perform their functions, but on the other they must ensure that utility bills are under control, especially under the pressure of severe budget cuts within the council.
Office staff (everyday users)	As office environment to perform administrative functions including computer work, calls, photocopying.	Light controls directly (switches in each room); central heating indirectly through interaction with facilities manager, however not directly. To compensate users' plug in heaters/fans to alter thermal environment. In control of desk equipment and charging of personal equipment. Opening/closing doors and windows – affecting draughts. Use of hot water taps.	Lighting complaints – too dark in some areas (e.g. reception) but too bright/artificial in other parts. Generally, complaints of cold hence some use personal heaters; however, some use fans in same room so conflicting comfort preferences. Cold in reception due to draught from main door. FM says generally poor energy/environment awareness.
Regular users (e.g. councillors, stakeholders attending meetings, court hearing attendees)	For meetings or other regular events.	Lighting; hot water taps; draughts with door use; room temperature indirectly through communication with staff; electrical equipment e.g. laptops, projectors etc.	Various: temperature varies considerably between rooms. Parts of the building can be too cold; courtroom "like a greenhouse" in the summer. Lighting not always to satisfaction.
One off user's (e.g. registering of births and deaths, charity balls, council ceremonies)	May attend an event or use service only once or very infrequently.	Depends on the event. Draughts, hot water taps and lighting.	Varies depending on specific service/event. General complaints about lighting e.g. too dark in reception; too bright/artificial in other parts of building. Reception generally too cold in winter due to large draughts from main entrance.

Task 3: Identification of specific behaviours in building

Table A17 Specific behaviours identified in Nottingham Council House pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Use of personal heaters and/or fans	Office staff in offices	Significant – not only inefficient but may also detract from comfort of others.	To what extent users are aware of cost of behaviour (environmental, financial and comfort). How frequently behaviour conducted and whether any resistance or tension. Whether it causes significant temperature fluctuations and therefore discomfort. How easy equipment is to acquire; where the equipment is sourced.	Survey and focus groups with users to understand attitudes, feelings and knowledge. Possible temperature monitoring.
Lights left on in empty rooms & equipment left on when not in use	Office staff, regular users, irregular uses. May occur in offices, function rooms. Most likely to occur at the end of the day or end of events.	Significant, although with lights less inefficient since extensive LED installation.	User attitudes towards leaving lights/equipment on; e.g. with office staff is it absent-mindedness, lack of education or apathy? Whether particular user groups have tendencies to repeat these patterns or the behaviour is more random. Are plugs and switches easy to access – anything preventing switch-off?	Surveys and focus groups with users to understand attitudes. Possibly light sensors to see if lights in particular kinds of rooms are frequently left on. Possibly IT software monitoring computer usage hours.
Doors left open	Potentially all building users at any time of the day.	Rooms vary considerably in terms of temperature, so doors left open likely to be significant cause of draughts.	Which users, if any, are aware of importance of closing doors and which leave doors open most frequently; extent of education on energy efficiency. Are there health and safety considerations e.g. fire hazards.	Survey and focus groups. Ask FM to make observations on which kind of users most often leave doors open. Could look into technology that could monitor this digitally/remotely.

Annex Task: Understanding the building

Who are ALL the users of the building?	FM; office staff; cleaning staff; regular visitors; one-off visitors
How many users in total are there for the building?	70 permanent staff; number of visitors varies greatly
What are ALL the uses of the building	Administration; court hearings; registration of births and deaths; councillor meetings; events such as weddings, presentations, ceremonies and charity balls
What is the occupancy profile like (times occupied etc.)?	Open to public 9-4.30 on weekdays; however, events can run between 8am and 12am. Varying events between those times on weekends.
What energy consuming devices are present in the building?	Computers; printers; photocopiers; projectors; personal heaters and fans; kitchen appliances; cleaning equipment
What type of heating/cooling system is used?	District heating (BMS: Trend)
Are areas of the building controlled differently to others?	Some unused office attached which are currently not lit or heated
Who has control over heating/cooling settings in the building?	FM (John)
Who has control over lighting/ventilation in the building?	FM (John)
Is there different facility managers/energy managers for different buildings/areas?	No; only one manager for entire building
What controls are available to users?	Light switches, equipment on/off
What energy data is available currently?	Half hourly electricity will become available over the next few months. Daily district heating data will also become available in February or March
Is any data collected based on whole building use or is it separated in any way?	Whole building use
What occupancy data is available currently?	Estimation from management, floor by floor based on: fire risk assessment, event records, register appointments
Is occupancy data based on whole building or separate areas?	Whole building
Is there any comfort level data available – temperatures, humidity, and user satisfaction?	None at present
Do users of the building have any influence in how energy is used in the building?	Yes – lights and equipment use
Do users see any information on energy use in the building currently?	Not presently
What energy information will the users of the building relate to most?	Unknown; unlikely to be kWh as staff not energy experts
How would the users of the building ideally like the information to be displayed?	Unknown
Do the users of the building have any issues with the building use currently?	Temperature conflicts; many cold and use personal heaters while others too warm and use fans. Complaints about lighting; in some rooms too dark/dull while in other parts too bright/artificial

Table A18 Initial data collection for understanding Nottingham Council House pilot building

9.9 Detailed data collection for each pilot building – School, UK

Djanogly City Academy, Nottingham, UK

Summary of building: School building (High School) within the UK

Responsible eTEACHER partner: Nottingham City Council (NCC)

1. **Pilot site visit:**

Date: 12/10/17 & 28/03/18

Notes from visit:

User types:

748 students

Around 150 different members of staff – teaching (45-55), support staff, office staff (8), estate staff (cleaners etc.), and kitchen staff

Various numbers of external visitors – members of the public and private letting events

Building use:

Teaching primarily, but also catering, private sports letting on a Wednesday, church group letting on a Sunday. They also have private holiday lettings, for example to a Polish school.

The private lettings tend to only just cover the costs however it also gives staff the opportunity to come in to complete work (e.g. marking) during evenings or at the weekend.

The school is closed on a Saturday and has a total shut down.

Staff are keen to change the use/strategies with the Main hall within the school. It had very expensive lighting (which is more suited to use for productions and shows); however, staff were often using it for standard lessons. In winter given how cold the hall gets some staff even indicated they would put all the lights on to try and generate more heat! Therefore, these lessons were moved to a smaller more suitable room and the main hall is now mainly used for assemblies.

Energy systems and management:

They have a BMS control system in place and a facility assistant who controls the settings and deals with any requests from staff regarding heating/cooling. They also carried out fire alarm tests and flushing tests as well as checking individual lights/appliances (a massively time-consuming task!). The BMS system doesn't "spew out data" but can be used to set times and temperatures etc. It is certainly not used to pull any data on usage out of the system. It also will not tell you what the issue is if anything has gone wrong.

The main monitoring that is carried out is more focused around cost; the electricity bill in particular, so interventions or changes made be made based on larger bills or cost cutting requirements.

The cooling and heating systems are located at one end of the building and although an effective system it is currently having to run far too hard and often running at maximum capacity. However, there are still complaints (particularly in winter) and this is due to the massive loses in efficiency along the system – particularly when trying to heat the rooms furthest away from the main heating unit.

There are not individual sensors in each room and therefore often staff complain about their own rooms being uncomfortable, depending on location and use. Most rooms do have TRVs on the radiators, but these are only adjusted by FM – so that students don't mess around with them.

Separate air conditioning systems were added to 2 rooms last year as these were being used as computer rooms, and the rooms had windows that could not be opened.

Data:

Could gain previous bills from the school for water use and for electricity.

Unsure whether the BMS could generate any data output.

Behaviour change:

Management slightly sceptical that any behaviour change intervention would work. They wouldn't rule anything out but concerned that people may perceive some interventions wrongly, e.g. as additional work! He advised we would need to strongly consider when something is launched and how it is launched, believing that the best time would be a few weeks following New Year as most people have the notion of "turning over a new leaf".

Currently emails all staff regarding data projectors being left running overnight; the school is typically locked up around 7pm most evenings. Most nights each classroom is checked to ensure everything is switched off before the school is locked.

If it was done via staff workshops or competition, it can be guaranteed that not all staff members would get involved. If it was a competition, he could already tell you it would be himself and half of the P.E department that would win – very confident people with a competitive nature. Some staff members would be disadvantaged in these sort of intervention methods for instance only one teacher in IT and he currently would not have the capacity to do the competition as already has too much on and a massive workload.

Students don't tend to have control over any energy settings.

Other information gathered:

Although the building was awarded prizes when built general feeling is that when designed it was not well considered from an educational point of view. The building has floating floors, but also a workshop containing extremely heavy equipment.

The building has a flat roof, which in the long term both efficiency and maintenance wise may end up being more troublesome than originally thought. The roof is currently 12 years old and parts of the material are ripping and being damaged from birds pecking away at it. Their belief is that the design may have had some slight short-termism and lacked consideration in for such things as the lifespan of a flat roof etc.

The windows were reported as being brilliant – triple glazing suspended in a rubber compound so must have been very cost effective as it allowed for rapid construction.

The building does have a lot of natural light due to large windows and the building position; however, in summer this can cause a lot of problems with glare.

The school is currently in the process of moving to new partnership. Currently the school is in a partnership with three other partners and this is being changed to just one, Nova academy trust. They could see that this may cause some problems as the change is likely to occur over the next 12 months but until it is complete it could be hard to get either partnership to take on any responsibilities.

The structure of the school day recently changed from the teaching ending at 3.30pm to now ending at 4.30pm. Therefore, teachers may feel more constraints on their time and often rush at the end of the day to complete some marking then rushing home to avoid traffic – this then means that they forget to turn equipment and lights off more regularly than previously.

About 12 months ago, the old toilets were replaced to ensure that the water use in the building became more efficient. New toilets and sinks now have automatic sensors which control the use of water better, and the room is now made to be open plan so that staff can easily see if there is a problem that may be causing a leak etc.

Photographs of interest from visit:

2. Online behaviour change workshop worksheet

Worksheet completed by: Nottingham City Council

Task 1: Building user overview

Table A19 List of Building users relating to Djanogly school pilot building

User	What do they use the building for	Energy use in building they can control/influence	Issues or concerns they have regarding energy/comfort
Facilities manager	Work – taking care of the building and responsible for general upkeep, identifying and resolving any issues	Full control over central heating system, window use, lighting, maintenance and ensuring all relevant equipment is switched off at the end of the day.	Need to ensure that all staff/students are comfortable and are able to perform their functions. Also need to consider cost of utility bills and keep within building budgets.
Students (748)	Educational classes – also breaks including lunch.	Light switches, use of computers, opening and closing doors and use of hot water taps.	Unknown
Staff (teachers)	Delivering educational classes, assemblies, work preparations, as well as lunches and breaks.	Lights, computer usage, hot water taps, opening and closing doors	Unknown
Staff (cleaners, office, kitchen)	Cleaning, administrative work, preparing and serving food.	Cleaning/office/kitchen equipment use, light switches, opening and closing doors, hot water taps.	Unknown

Task 3: Identification of specific behaviours in building

Table A20 Specific behaviours identified in Djanogly school pilot building

Specific behaviour	Who is likely to perform behaviour, when and where?	Impact of behaviour in terms of energy use	Gaps in knowledge regarding behaviour in building	How could we address gap in knowledge
Leaving lights on in empty rooms	Students, teachers, other staff. Normally at break times and at the end of the day	Likely to be significant	How frequently this occurs; if it is more prevalent in certain rooms or by certain groups; current education and attitudes of users on this	Surveys and focus groups with users to understand attitudes. Light sensors in rooms to identify those which lights are typically left on in
Leaving equipment on such as computers, monitors and projectors	Students, teachers, other staff. Normally at break times and at the end of the day	Likely to be significant	How frequently this occurs; if it is more prevalent in certain rooms or by certain groups of users; current education and attitudes of users on this	Surveys and focus groups with users to understand attitudes. Possibly IT software monitoring computer usage hours
Leaving doors open	Students, teachers, other staff. Normally between lessons and when walking through the building	Cause temperature issues within building as a large proportion of heat is lost between the heat source and the drama hall (other end of the building) – closing doors could prevent draughts to help alleviate problem	Whether this behaviour could have a valuable difference; whether any health and safety complications (e.g. fire safety); whether users are aware/their attitudes to this behaviour	Possible temperature monitoring tests; further communication with FM; surveys and focus groups with users to understand attitudes

Annex Task: Understanding the building

Who are ALL the users of the building?	Students, teachers, office staff, kitchen staff, visitors, event attendees
How many users in total are there for the building?	900 regulars (750 students, 150 staff)
What are ALL the uses of the building	School lessons and performances; sports events; cooking and eating; breaks' office work; meetings; private lettings
What is the occupancy profile like (times occupied etc.)?	Weekdays open 6am-7pm. Pupils in 08.30hrs to 16.30hrs Monday-Thursday; finish 12pm on Friday. Saturday schools operate January – March 9am-12pm. Church let the hall Sundays 10.00hrs to 13.00hrs.
What energy consuming devices are present in the building?	Computers; printers; projectors; interactive whiteboards; photocopiers; kitchen appliances; cleaning equipment.
What type of heating/cooling system is used?	Air-con and gas
Are areas of the building controlled differently to others?	No but, for example, drama hall difficult to heat even at max output as on opposite side of building to heat source origin
Who has control over heating/cooling settings in the building?	FM
Who has control over lighting/ventilation in the building?	FM
Is there different facility managers/energy managers for different buildings/areas?	No
What controls are available to users?	Light switches; equipment on/off
What energy data is available currently?	Half hourly electricity and gas data available from supplier (Robin Hood Energy)
Is any data collected based on whole building use or is it separated in any way?	Whole building use
What occupancy data is available currently?	Staff and student registers
Is occupancy data based on whole building or separate areas?	Separate areas; classrooms, staffroom, office
Is there any comfort level data available – temperatures, humidity, and user satisfaction?	Not presently
Do users of the building have any influence in how energy is used in the building?	Lights, electronic equipment, doors, hot water tap
Do users see any information on energy use in the building currently?	Not currently
What energy information will the users of the building relate to most?	Unknown; unlikely to be kWh as users not generally energy experts
How would the users of the building ideally like the information to be displayed?	Unknown; students may possibly respond well to games and competition
Do the users of the building have any issues with the building use currently?	Complaints that drama hall is cold even when heating is on full settings at source. Windows do not open at front of the building.

Table A21 Initial data collection for understanding Djanogly school pilot building

9.10 Energy, Comfort, the Building & You Questionnaire – distributed during WSA

Group #

eTEACHER

Empowering Energy Education

Energy, Comfort, the building & you!

Questionnaire

The purpose of this questionnaire is to learn more about building users, their energy and ICT use, comfort levels and motivations within this building. These responses will be used to help the design of an ICT tool which can enhance the energy efficiency and comfort in your building. All data collected and processed from this questionnaire will be anonymized and stored in a secure location.

Completing this questionnaire should take around 15 minutes of your time. If you have any questions about this study, please feel free to discuss these with the facilitator of today's session.

eTEACHER Building: _____

Sticker Colour: _____

All about you

Name: _____

Age bracket (tick the appropriate range):

11-18		30-39		50-59		70-79		90-99	
19-29		40-49		60-69		80-89		100+	

ICT & you

1. Which of the following ICT devices do you own personally?

Smart phone		SatNav		Smart watch	
Tablet		Video game console		Digital music player	
Laptop		Digital camera		Smart glasses	
Desktop computer		Fitness tracker		Smart Television	

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2. If you own a smartphone, which of the following do you use it for?

Texts/Calls		Emails		Access News	
Take/edit photos		Play games		Online shopping	
Link with car media systems		Make contactless payments		Fitness tracking	
Entertainment apps		Listening to music		Social media	

3. If you could add any additional function/app to your smartphone, what would you like it to have?

4. If you use apps on your smartphone or tablet, how many different apps do you use regularly (at least once every day)?

0		1-3		4-6		7-10		11-15		16+	

5. Which category best describes your own personal interest in ICT?

Really keen on being ahead of others with the latest ICT	Look forward and enjoy buying new ICT	Interested in new ICT if it makes things easier for me	Only interested in the ICT I use currently	Not interested

The building & you

6. Please select the best category which best describes the type of building user you are.

Staff*	Energy/Facility manager	Student	Visitor	Tenant/owner

*If staff please state your job title: _____

7. Please indicate how often you use this building.

Daily	Weekly	Monthly	Yearly	Rarely

8. How long have you been using this building? Please give a rough estimate:

_____ Years _____ Months

9. How long do you tend to spend in this building in any one day?

Up to 1 hour	1-3 hours	3-6 hours	6-12 hours	Majority of the day

10. Which of the following ICT devices do you use whilst in this building?

Smart phone		BEMS		Smart watch	
Tablet		Video game console		Digital music player	
Laptop		Digital camera		Smart glasses	
Desktop computer		Fitness tracker		Smart Television	

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11. In a given day how often do you use or have access to the following devices in this building?

	Constantly	Every hour	Every couple of hours	Occasionally	Never
Smart phone					
Laptop/Desktop computer or tablet					
Smart watch					
Smart television/screen					

Energy & you

12. Which of the following do you understand in relation to energy consumption?

kWh	Cost	% used compared to previous use	Carbon footprint (CO_2)

13. In general, how aware are you of the energy used in this building? Circle the most appropriate statement.

Very aware	Occasionally think about it	Neither	Not very aware	Never think about it

14. How important do you think it is to save energy in this building?

Very important	Somewhat important	Neither	Not important	Not important at all

15. Can you indicate on the scales given, strongly agree to strongly disagree, how you feel about the following statements relating to energy and this building

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Energy use in this building is important to me					
Energy use in this building is relevant to me					
Energy use in this building is valuable to me					
Energy use in this building means a lot to me					

16. How often do you currently take actions to help reduce energy consumption in this building?

Numerous times each day*	Daily*	Weekly*	Monthly*	Rarely

*If so, what actions do you tend to do?

17. Are you aware of any of the following energy behaviours occurring in the building? (Check all that apply)

Lights being left on in empty rooms		Heating on in areas not being used	
Heating left on when not needed		Computers left on when not in use	
Computers left on stand-by overnight		TVs left on	
Chargers left plugged in but not being used		Air-conditioning on when not needed	
Additional heat sources being used		Additional cooling sources being used	
Thermostat set too high		Inefficient use of appliances (dishwashers half empty, washing at high temperatures)	
Other*			

*If other, please describe examples of energy being wasted in the building

18. Would you be interested in knowing more about the energy used in this building?

Yes		No	

19. If yes, which of the following would you like to know (Check all that apply)

Room temperatures		Humidity levels	
Total energy use		Individual energy use	
Advice on saving energy		Advice on how to get warmer/cooler	
Historic energy data		Comparison with others use	

20. What format would you prefer the information to be in?(Check all that apply)

Visual graphs		Visual images (Smiley face etc.)	
Numerical values		Words/explanatory text	
Interactive data you can manipulate		Comparative data showing other buildings or users	

eTEACHER Questionnaire 5 / 8

Comfort & you

21. In general how satisfied are you with the comfort level of the building?

Very satisfied	Satisfied	Neutral	Dissatisfied	Very dissatisfied

22. If dissatisfied, select which best describes your source of discomfort in the building. Feel free to select multiple options if appropriate.

Too warm		Too cold	
Not enough natural light		Lighting too artificial	
Too much air movement		Not enough air movement	
Incoming sun		Hot/Cold surrounding surfaces	
Drafts from windows		Drafts from vents	
Heating/Cooling system not responding quickly enough		Other*	

*If other, please describe your source of discomfort

23. Do you have any control over changing the thermal environment in the building?

Yes		No	

24. If yes, which of the following do you use to adjust or control the environment? (Check all that apply)

Window blinds or shades		Open/Close windows	
Room air conditioning unit		Adjustable air vents	
Thermostat		Ceiling fan	
Portable heater		Portable fan	
Removing/adding clothing layers		Radiator valves	
Other*			

*If other, please describe what you do.

25. Are you restricted from adjusting the thermal environment?

Yes		No	

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eTEACHER Questionnaire 6 / 8

26. If yes, please select the relevant categories that you are restricted in altering (Check all that apply)

Temperatures		Lighting	
Windows		Air conditioning	
Thermostat		Radiators	
Heating/Cooling schedule			

27. Have you reported an issue in this building relating to energy use/your comfort?

Yes		No	

28. If not, was it due to any of the following reasons? (Check all that apply)

Found no issue		Do not know the relevant person to contact	
Too much hassle to report		Not enough time to do so	
It won't be listened to		Rather not get involved	

29. If you observed the following statements, which would you report to highlight energy saving opportunities? (Check all that apply)

Lighting left on when not in use		Excessive use of lighting	
Excessive use of heating (too hot)		Excessive use of cooling (too cold)	
Windows open when heating on		Equipment left on stand-by overnight	
Inefficient use of small personal electrical items		Inefficient use of large electrical equipment	
Excessive use of small personal electrical items		Excessive use of large electrical equipment	

Motivation & you

30. Please rank the following in order of importance to you when making energy savings,
1 = most important, 6 = least important

Environmental impact		How easy it is	
Cost		Personal benefit from it	
Personal Comfort		How others view you	

31. If an energy saving scheme was introduced in this building, how likely are you to take part?

Extremely likely	Very likely	Somewhat likely	Not at all	Not applicable

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eTEACHER Questionnaire 7 / 8

32. Which of the following methods is likely to catch your attention about a new energy saving scheme in this building?

Posters around the building		Word of mouth	
Email direct to you		Presentation/assembly	
Leaflet/Newsletter		Announcement on TV/screens in building	
Dedicated website		A short video	

33. Which of the following would encourage you to take part more, select all that apply?

Personalised energy use information		If the scheme improved the image of the building	
Monetary rewards		If it was encouraged by others	
Competitions		Recognition for taking part	
Regular updates to the scheme		If it has significant environmental impact	

Importance of others & you

34. How important to you is what other building users do regarding energy use?

Very important	Somewhat important	Neither	Not important	Not important at all

35. Please indicate your interest, from extremely interested to not at all interested, to the following statements.

	Extremely interested	Very Interested	Somewhat interested	Slightly interested	Not at all interested
Tool which allows you to report issues in the building					
Tool which allows you to share energy knowledge with others					
Tool which allows you to learn energy saving advice via playing a game					
Tool which allows you to compete against other building users related to energy use					

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eTEACHER Questionnaire 8/8

36. If a tool was developed which allowed information to be shared with all building users, what information would you want to know? (Select all that apply)

Energy bills		Temperatures/humidity levels	
Itemised energy consumption		Tips & advice on energy saving	
Suggestions for energy improvements		Suggestions for building improvements	
Consumption of appliances		Schedules for heating/cooling	

37. What information of yours would you be happy to share with other building users? (Select all that apply)

Your energy bill		Your comfort level	
Separate gas/electricity consumption		Tips & advice on energy savings	
Whether you have carried out any energy improvements		Your suggestions for the building	
Your use of appliances		Heating/cooling schedules	

Thank you for completing this questionnaire, your responses are extremely valuable to the project.

Future eTEACHER events/engagement

We are really keen to design a tool that works for this building and for you! If you would like to take part in any future events, please let us know which type of events you are interested in and the best way of getting in touch with you about those events.

Interactive workshops		Focus groups	
Online Questionnaire/survey		Paper Questionnaire/survey	
Interactive online calls		Face to Face Interview	
Interactive ICT trials		eTEACHER prototype trial	

Best contact method:

Email: _____

Phone number: _____

Address:

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9.11 eTEACHER Design brief incorporating D1.1, D1.2, D1.3 & D1.4

eTEACHER Design Brief

This design brief collates recommendations and requirements from D1.1, recommendations from Task 1.2, the Ask/Bridge workshops held as part of Task 1.3 and our socio-technical workshop in Dresden.

Aim of the eTEACHER app.

To design an app to empower building users to engage with the energy consumption in their buildings.

General Principles

(1) **Deliverable 1.1** noted four recommendations for designing behaviour change interventions. Table 1 maps these onto specific design requirements for the eTEACHER app.

D1.1 recommendations (abridged)	Design Principle for eTEACHER
Behaviour change literature emphasises the need to design interventions around specific behaviours undertaken by specific actors in a given context.	The app needs to be **adaptable to different building types** (notably workplace/domestic). For example, to be able to state, "I work here" or "I live here". It should also locate the user in their building.
The Enabling Change approach recommends that at both Programme and Project level, proposals are discussed and co-developed with a sounding board to "reality check" the viability of the ideas. For eTEACHER we recommend setting up a "Feedback Forum" for each case study building.	The app will not be designed in a vacuum but, utilising the 'enabling change' framework will be underpinned by **meaningful engagement** with 'the brain's trust' – that is a user-group consisting of relevant stakeholders in each building.
User-engagement is key to behaviour change. eTEACHER can create the possibility for deeper change through enabling community building between building users/stakeholders.	**The app will encourage and enable engagement between building users**, for example sharing information on their energy consumption, asking for/sharing advice on behaviours and encouraging competition and collaboration.
Evaluation of behaviour change projects should gather data on and test a clearly articulated "Theory of Change", which links specific behavioural interventions to predicted changes in behaviour. Baseline data for energy use is a key requirement.	**Selection of building type will determine a list of behaviours the user can undertake.** These will have an associated monitoring and measurement (energy consumption per building + qualitative survey). Nb. The app should support the evaluation through gathering data on the behaviours undertaken.

(2) These 4 recommendations and principles are supported by the eTEACHER **ICT engagement Requirements** from the Bridge workshop which noted that:

- eTEACHER should be an app with all full functions available on a smartphone.
- 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.
- Consider alternative hardware relating to specific pilot building to ensure engagement with all key building users.
- Smart watches should no longer be considered as a target device.
- 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).
- Ensure inclusion of most popular functions: alarm, dashboard, advisor, reward, feedback.
- Incorporate gamification but avoid serious games.
- Make app adaptable in terms of basic functions through manual customisation or automatic filtering according to user or building type.
- Make app settings (e.g. alarm, advice frequency) adjustable through one or both of: Manual customisation / user schedule input/ automatic settings according to user interaction
- Consider layers: headlines giving key info which can be expanded for extra detail if user has interest /time.

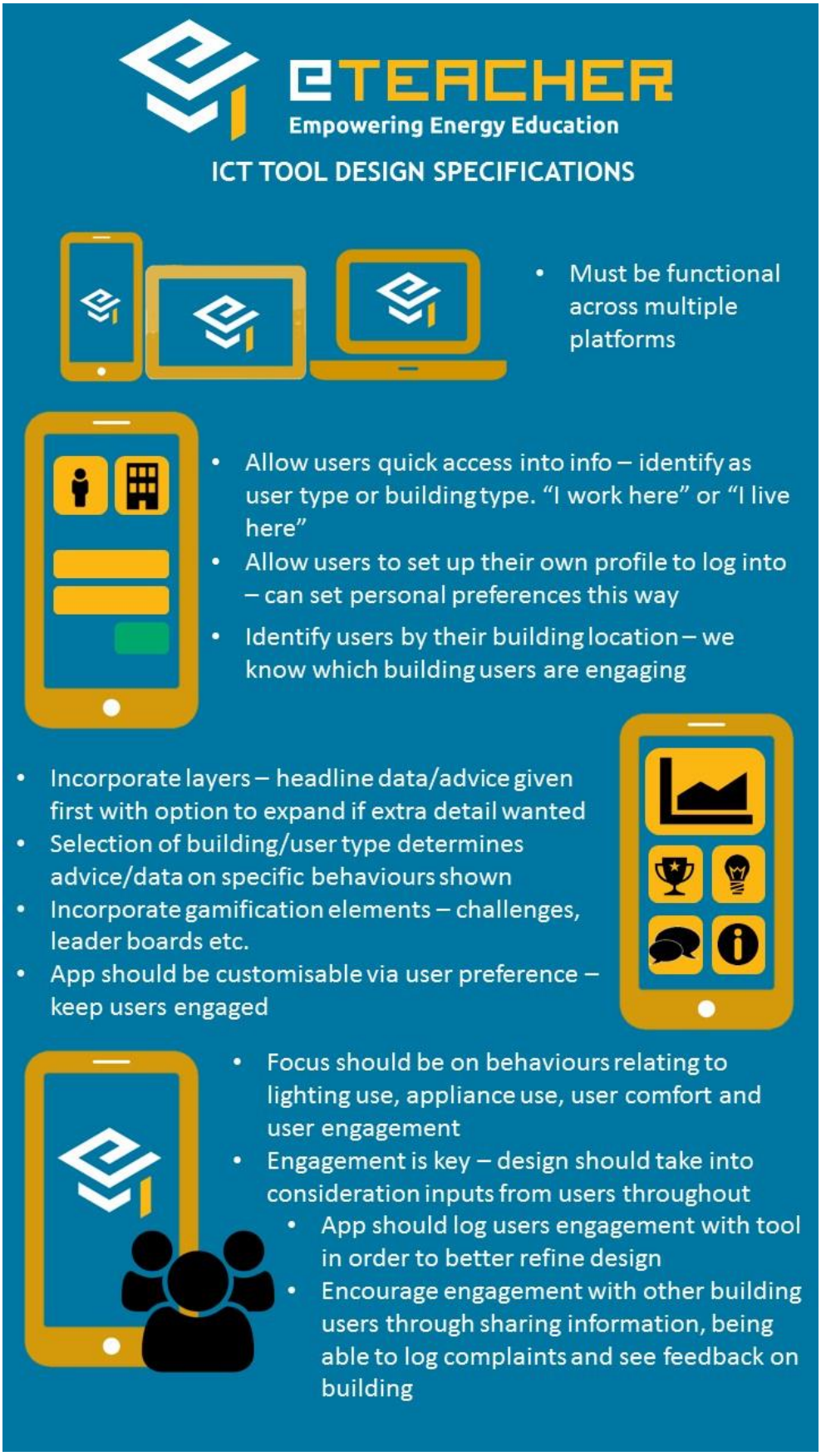
(3) The socio-technical workshop held in Dresden noted the following **behaviours to be targeted:**

Principle	[Building User] behaviour	[Building Manager] behaviour
User behaviours aimed at reducing electricity & gas consumption, notably lighting and appliance usage	Use of lighting; leaving lights on choice of efficient lighting; choice of controls, inc. possible automation, Use of computers, ICT, etc. Leaving on when not in use	Procurement, control settings, replacement
User behaviours aimed at enhancing comfort (temp/air quality/outdoor temp/solar gain) and improving engagement (via feedback loop & system)	Use of heating & cooling systems to achieve thermal comfort. Choice of systems and controls; interactions with users. Use of windows and doors to alter thermal environment etc. Incorrect usage causing draughts etc.	Choice of windows/doors and replacement
User behaviours aimed at improving engagement	Interactions around energy (inc. eTEACHER once live); reporting issues/discomfort; helpful reminders/prompts; building community with other building users.	Dialogue with building users; interaction with users around energy issues; notifications of problems/issues and resource for reporting back

(4) The recommendations following Task 1.2, presented in Deliverable 1.2, which **MUST** be included in the design of the eTEACHER tool are:

Issue	MoSCoW Recommendation(s)
Mixture of building types and user types	• (M) be one app, as discussed and decided by project partners. • (M) be able to identify which building the users are from, and which rooms they use.
Range of user ages	• (M) use language and terminology that is accessible to all building users – therefore cannot be overly complex.
App to be used across multiple countries	• (M) Include options for English, Romanian and Spanish languages to be selected by users.
Capability of users	• (M) be accessible across multiple platforms – smartphone, tablet, laptop and desktop computer. • (M) Factor different understandings of energy into the design. Show savings and consumption data in cost and kWh consumption, using intuitive visual methods, to ensure comprehension for all users.
Opportunities for users	• (M) consider the opportunity available in each building.
Motivations of users	• (M) emphasise to users the environmental impact, cost savings and potential benefits to personal comfort when using eTEACHER.
User behaviour – lighting	• (M) sub-meter lighting energy at a whole building level at the very least.
User behaviour – appliances	• (M) sub-meter appliance use, at the very least on whole building level but ideally at appliance level.
User behaviour – comfort	• (M) sub-meter HVAC consumption on whole building level.
User behaviour - engagement	• (M) record users' engagement with eTEACHER tool in order to analyse how they use the tool, how prolonged their use is and what features they respond best to.

The key requirements identified through WP1 are summarised in the following figure:


eTEACHER
Empowering Energy Education
ICT TOOL DESIGN SPECIFICATIONS
• Must be functional across multiple platforms
• Allow users quick access into info – identify as user type or building type. "I work here" or "I live here"
• Allow users to set up their own profile to log into – can set personal preferences this way
• Identify users by their building location – we know which building users are engaging
• Incorporate layers – headline data/advice given first with option to expand if extra detail wanted
• Selection of building/user type determines advice/data on specific behaviours shown
• Incorporate gamification elements – challenges, leader boards etc.
• App should be customisable via user preference – keep users engaged
• Focus should be on behaviours relating to lighting use, appliance use, user comfort and user engagement
• Engagement is key – design should take into consideration inputs from users throughout
• App should log users engagement with tool in order to better refine design
• Encourage engagement with other building users through sharing information, being able to log complaints and see feedback on building