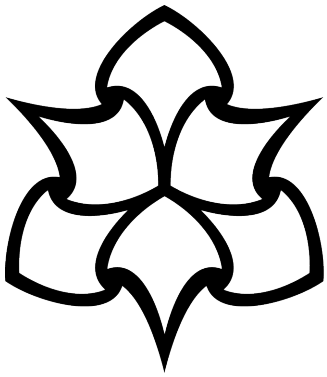


Gamification in a Living Lab: Energy saving challenges in student halls

Regine Sønderland Saga and **Rachel Dunk** look at the potential use of current information and communication technologies in the management of energy in student multi-occupancy housing.

ANALYSIS

In recent years, the concept of the 'Smart City' has emerged as a central theme in the sustainable urbanism discourse. Though the concept is somewhat ambiguous, there is a general agreement that Smart Cities address urban challenges by engaging citizens in the use of information and communication technologies (ICTs)[1]. In order to facilitate user-centric innovation processes, some Smart City research adopts a 'Living Lab' approach. In this context a Living Lab approach:

"Offers a collaborative platform where professionals from different disciplines work together with future users and public and private stakeholders to generate solutions that are rooted in the dynamics of daily life practices"[2].

As large institutions, which can in and of themselves be considered analogous to small cities, universities are playing an increasingly important role in the urban sustainability debate, where some university campuses are emerging as Living Labs to address challenges such as energy saving measures in buildings. Financial savings are a key driver for reducing energy use in buildings, while occupant behaviour is a key determinant of energy use. In student residences, the landlord–tenant relationship between a university and its students, where utility costs are typically included within an overall charge for accommodation, eliminates the financial driver for students to engage in energy saving behaviours. Student residences thus present a prime example of a landlord–tenant 'split-incentive' scenario – a well-known barrier to reducing energy use in buildings. In addition to this, student residences are also an example of multi-occupancy housing (MOH), where differing attitudes and preferences amongst occupants may limit the potential for behavioural change to deliver energy savings.

Manchester Metropolitan University (Manchester Met) is participating in the European Union Horizon 2020 funded Triangulum project which aims to demonstrate Smart City solutions and facilitate their replication with a strong focus on the co-creation of solutions with citizens. Here we present an overview of a Living Lab case study at Manchester

Met that aims to address the split-incentive barrier to energy saving behaviour in student residences through the development and implementation of smart solutions.

THE CASE STUDY

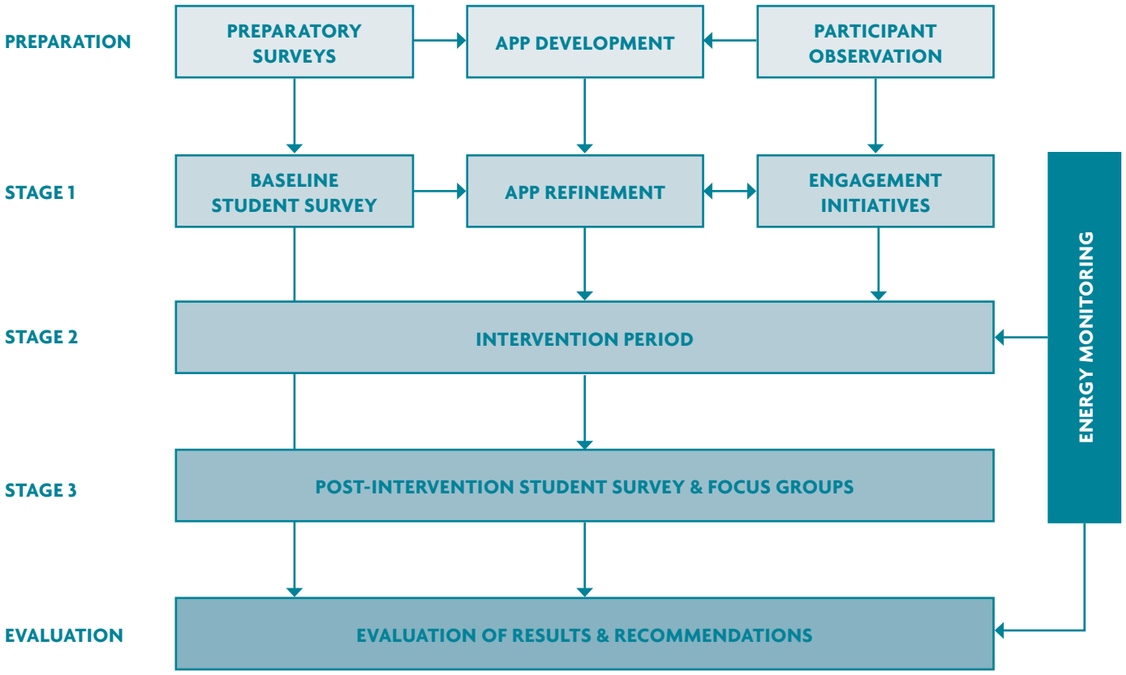
Opened in 2014, Manchester Met Birley campus includes student accommodation in the form of two blocks of halls comprising 37 flats, housing eight students per flat (all rooms are en-suite) and three blocks of townhouses comprising 56 flats housing 12 students per flat (one bathroom shared between two rooms). The student residences were built to high energy-efficiency standards and with real-time energy monitoring at both the flat and block level. Based on building design performance, the accommodation therefore, offers multiple replicates of flats with identical energy demand, where the only variable in determining actual energy use will be occupant behaviour.

This study adopts a user-centric, cross-sectional, collaborative Living Lab approach to co-create and test the success of behaviour change initiatives, including application (app) based gamification, in order to deliver energy savings and thereby reduce carbon emissions in a split-incentive scenario in MOHs. A schematic showing the study stages is presented in **Figure 1**, while **Table 1** presents a summary of the stakeholders and their roles.

The study involves collaboration between academic researchers and a range of stakeholders, including Manchester Met's Services Group, students, Clicks+Links[3] (a small to medium sized enterprise partner in the Triangulum project with expertise in smart solutions) and Manchester Student Homes (a housing service for students owned and managed by all of the Manchester universities).

The initial preparation phase focused on gathering data to inform and shape the implementation phase. Key activities included two questionnaire based stakeholder surveys, participant observation, and app development.

The first survey targeted all Manchester Met students and collected data about their self-reported environmental and technological attitudes, perceptions and behaviours; this survey also served as the pilot for the student baseline survey. The second survey targeted Manchester Student Homes landlords who provide university approved accommodation. While students not residing in university accommodation and private



▲ **Figure 1. The stages in the Living Lab study.**

▼ **Table 1. Internal and external stakeholders and their roles in the Living Lab study.**

	Internal		External	
Stakeholders	**Students**	**Services Group: Student Living & Environment Team**	**Clicks+Links**	**Manchester Student Homes Landlords**
Roles	Attitudes & perceptions	Advise on challenges & barriers		Attitudes & perceptions
	Energy behaviours	Energy behaviours		Advise on student energy
		Advise on app development	Lead app development	
	Participate in initiatives, including app gamification	Lead initiatives, including app gamification	Monitor app usage	
	Participate in evaluation of initiatives, including app gamification	Participate in evaluation of initiatives, including app gamification	Participate in evaluation of app gamification	

sector landlords were not active participants in the implementation phase of this study, it was considered important to collect data regarding their attitudes and perceptions in order to place this study in a wider context, and thereby help ensure that the findings were more broadly applicable. Participant observation was carried out over a one year period where a researcher was embedded in the university's Environment Team for one day per week to identify and address potential challenges to implementation. App development was led by Clicks+Links in collaboration with the Environment Team and researchers at Manchester Met.

Through the app, students will be able to see their real-time energy consumption and compete against other flats in 'energy saving missions'. The missions will be sent as notifications and students will be able to accept the missions or decline to participate.

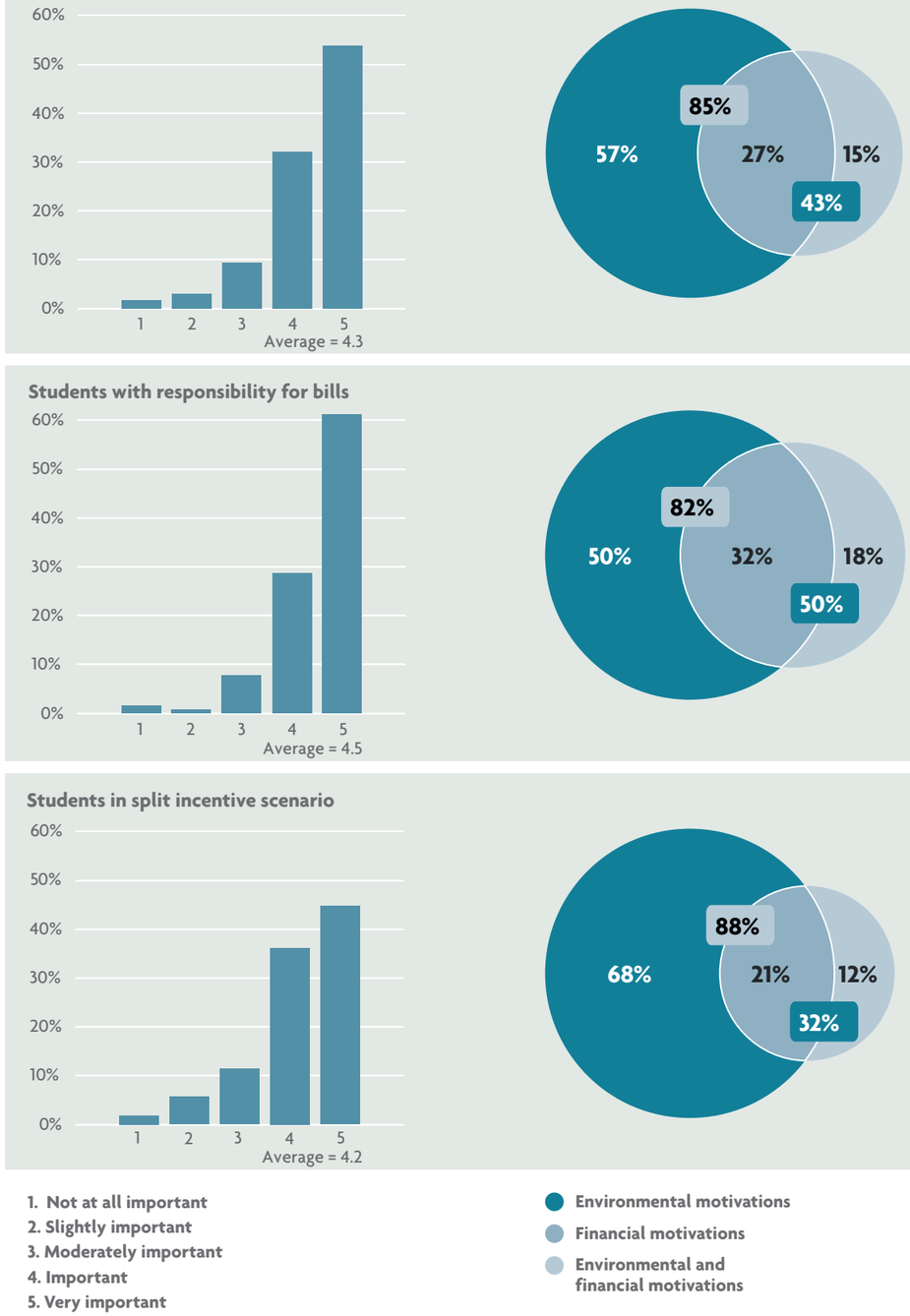
The implementation phase started in September 2017, when students moved into their university accommodation, and will end in June 2018 when they move out. Baseline data will be collected during Stage 1. Stage 2 is the active intervention period, during which engagement initiatives, including app based gamification, will be trialled. Continual monitoring of energy consumption data throughout the implementation phase will allow the comparison of energy usage before, during and after engagement initiatives, and will enable an impartial assessment of their success and longevity in terms of reducing energy demand. Post-intervention student surveys and focus group discussions will feed into an evaluation of the engagement initiatives, which will also include a comparison of students' self-reported attitudes, perceptions and behaviours together with their level of engagement during the intervention period (e.g. active engagement with app missions) as well as actual energy usage.

PRELIMINARY FINDINGS FROM PREPARATORY SURVEYS

Responses from both the student and landlord surveys indicated that around half of Manchester Met students living in rented accommodation are in a split-incentive scenario where energy bills are included in their rent. Preliminary results suggest that there is a gap between students' and landlords' perceptions regarding student energy behaviours and the potential impact of students being able to see their real-time energy consumption. Overall, of the 234 students surveyed living in rented

Student views on energy conservation

Left: Student perceptions of the importance of energy conservation ranked on a scale from not at all important (1) to very important (5). Right: Students' stated motivations for energy conservation.



▲ **Figure 2. Student's perceptions of the importance of and motivations for energy conservation.**

Seeing my real-time energy use would encourage me to conserve energy because...	Having a smart meter or monitor didn't encourage me to conserve energy because...	Having a smart meter or monitor did encourage me to conserve energy because...
"...if I had a little progress bar that told me how much i was using I'd be much more aware of and able to prevent my energy wastage."	"...[it only showed] numbers I don't understand and didn't really have a severity level (showing what's good, bad and average)."	"...[it displayed a] smiley face and a green background when we used little energy."
"...if I knew the average amount that a person was using and I was using more, I would want to cut down."	"...it tell [sic] me what it's currently using however it should also come up with [a] message [...] warning when I'm using more than average amount daily or weekly. Just because it displays numbers doesn't mean anything."	"...it would show how much energy is being used in the household at that time represented by colours; green, orange and red. When it is red or a large amount of orange it encourages us to use less energy, by switching things off or using them for a short amount of time."
"...I'm quite competitive so I'd probably be trying to beat my daily best for less consumption."		"...it reminded me of how much energy I have used and how much I have saved from previous day or week."
"...gamification [...] would make it easy to turn the abstract concept of saving energy into a tangible concept and remind you how much you should/shouldn't be using."		

▲ **Figure 3. Quotes illustrating the importance of cues, context and challenge setting when providing energy consumption information in order to motivate energy conservation.**

accommodation, 98 per cent placed some degree of importance on reducing their energy consumption, although the level of importance was somewhat lower for students in a split-incentive scenario compared to those with responsibility for paying their own bills (**Figure 2**). Explanatory comments were provided by 188 of the respondents, all of whom placed some importance on conserving energy. The two principal motivations that emerged were the environmental and financial benefits, with a number of students also referring to issues relating to security of supply. Interestingly, environmental motivations were identified by a higher proportion of students than financial savings, even amongst those with responsibility for their energy costs (**Figure 2**). Conversely, and of interest to the study, some students in a split-incentive scenario identified financial savings as a motivating factor (**Figure 2**).

Of those students with some experience of smart energy meters, monitors, or thermostats (112 students), only two-thirds reported that having these devices had encouraged them to conserve energy. Associated comments (64 students) revealed that the way in which information was presented was an important factor in effecting energy efficient behaviour, particularly the use of intuitive easy to interpret visual cues and the provision of context (**Figure 3**). However, when all students were asked how useful it would be to know their real-time energy consumption, 97 per cent thought it would be useful to a greater or lesser extent, with a broadly similar response from students with responsibility for paying their bills and those in a split-incentive scenario (**Figure 4**). In the associated comments (182 students), respondents noted that "Seeing the information makes it real", with many comments (of direct relevance to the design of a smart energy conservation initiative) reiterating the importance of cues and context, and highlighting the motivating force of setting challenges (**Figure 3**).

In comparison, 44 landlords thought that real-time energy information would be of less use to students, particularly when bills are included in rental charges (**Figure 4**). In the associated comments, around a quarter of the landlords expressed the viewpoint that students are not interested in their energy consumption. For those landlords who thought it would be useful, 25 cited financial reasons, with only seven citing environmental reasons. These results suggest that landlords hold a misconception regarding students (self-reported) attitudes towards energy saving. Interestingly, the survey also revealed that around a third of landlords wished to

▲ **Figure 4. Perspectives on how useful it would be for students to see their real-time energy consumption.**

improve the communication between themselves and students regarding energy usage and billing, noting that if the students knew their real-time consumption they could better advise them on energy conservation.

As noted previously, these preliminary results will inform the design of engagement initiatives and app based challenges to be employed during the project implementation stage, where there are encouraging indications that provision of contextualised information using intuitive visual cues and app gamification could change student energy behaviours. Furthermore, this study has identified that landlords hold misconceptions about students' attitudes and perceptions regarding energy conservation. This study will seek to bridge this gap during the implementation and evaluation phases by actively engaging all stakeholders in the innovation process, thereby boosting cross-sectional communication, increasing engagement with energy related ICTs, and ensuring the design of energy related ICTs are fit for purpose. If app based gamification is proven to encourage energy conservation in this case study, then replication in other split-incentive scenarios could contribute further to addressing this urban sustainability challenge. **ES**

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