Energize Worcester: Smart Heating Controls in Student HMOs

An Interactive Qualifying Project Submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE In partial fulfillment of the requirements for the Degree of Bachelor of Science

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Abstract

This project partnered with the University of Worcester to examine the possible social implications and effects of implementing smart heating controls in student-rented houses in multiple occupation (HMOs). Through the use of surveys, our team evaluated student attitudes towards sustainability as well as the potential acceptance and effectiveness that smart heating controls could have in student off-campus housing. Our survey results identified three areas that may complicate the implementation of smart heating controls: insufficient levels of student motivation to improve energy efficiency, the apparent absence of fuel poverty in the population studied, and concerns regarding privacy. We recommend that students be educated on energy expenditure and sustainable practices.

Acknowledgements

We would like to express our gratitude towards the University of Worcester for its hospitality and our project sponsors Director Katy Boom and Professor Carolyn Roberts for their guidance. We would also like to thank our site advisor, Professor Rob Krueger, and our ID2050 advisor, James Chiarelli. In addition, we would like to thank Martyn Bridges and Richard Forrester at Worcester Bosch. Finally, a special thanks to Professor Ruth Smith who advised us every step of the way, and without whom the project would not be where it is now.

Executive Summary

Homes in the United Kingdom are among the least thermally efficient in Western Europe. A survey conducted by the National Union of Students (NUS) found that 78% of students in houses in multiple occupation (or HMOs) felt uncomfortably cold at home in the winter season and 79% of students were hesitant to use the heat in their homes due to expense. Half of the students surveyed felt that their home experienced condensation, mold, and/or dampness (Bouzarovsky et al., 2012). One factor that differs student-rented HMOs from other housing is the presence of a dynamic known as the 'split incentive', which creates different complications depending on who is paying for the utilities. If the tenants are paying, they tend to conserve energy, but properties may have fewer energy efficient improvements because the landlord isn't motivated to improve the efficiency of the property. If the landlord is paying, the properties tend to be more energy efficient, but the tenants may not be mindful of their spending and are may be likely to overuse energy. The existence of this social dynamic makes improving the thermal efficiency of the properties involved challenging.

Through an initiative called Energize Worcester, the University of Worcester has been working with local students, landlords, and local boiler manufacturer Worcester Bosch in an effort to improve living conditions and reduce energy use in student-rented HMOs. Energize Worcester has done this by educating and incentivizing landlords and occupants to adopt energy saving technologies and behaviors. It was the primary goal of our project, as a part of the Energize Worcester initiative, to explore the possibility of implementing new smart heating controls in these student houses in multiple occupation while being mindful of social factors that may complicate the usefulness and acceptance of the smart controls. In order to explore this, we asked four primary questions:

- What are the existing attitudes of student tenants toward the subject of heat system management?
- Would student tenants be interested in new smart heating control systems?
- Would smart heating controls be effective in student-rented HMOs?
- Do students have concerns about privacy involving smart heating controls?

Methodology

To answer these questions we formulated the following objectives:

- Evaluate student energy attitudes and behaviors in student-rented HMOs
- Evaluate potential acceptance and effectiveness of smart heating technologies in student-rented HMOs

To evaluate the student's energy attitudes and behaviors in student-rented HMOs we used an in-home student survey. this survey was conducted by going door to door to student-rented HMOs in our sponsor's database (collected from previous sustainability research). The surveys generally

lasted 20 to 40 minutes. Our team developed guidelines to ensure uniformity. This in-home student survey sought to:

- Ascertain how temperature set points are managed in student-rented HMOs
- Evaluate how responsibility for energy consumption and conservation is shared between occupants and landlords (according to student assessment)

In order to evaluate the acceptance, effectiveness, and social implications of smart heating technologies in student-rented HMOs created a short, smart technology survey. This was a 5-minutes survey conducted on the University of Worcester campus in the dining hall, as well as around other housing when convenient. Its goals were to:

- Identified attitudes towards adopting smart heating technologies
- Evaluated the potential/effectiveness of adopting a smart heating control in a student-rented HMO

Findings

Through the close analysis of our survey responses and an interview at Worcester Bosch, we made the following observations pertaining to the attitudes and behaviors of students, as well as the functionality of smart heating controls.

1. **Fuel poverty was not apparent among the students surveyed** Our team found that fuel poverty was not apparent among the students we surveyed. The majority of students surveyed did not find the cost of their energy bills expensive. However this may have been a result of students not seeing their energy bills. 36 of the 39 students had gas and electricity included and many expressed not seeing their bills as a result. Generally students felt comfortable with the temperature in their homes and had no issues turning up the heating if they were cold. From this data, we concluded that students surveyed are not concerned with cost when heating their homes and do not appear to be living in fuel poverty.

2. **Communication between students and landlords on energy issues appears incomplete.** Based on responses from the students that we surveyed and the landlords that Carolyn Roberts surveyed, it appeared that communication between student-tenants and landlords was incomplete. We found it common for the students surveyed to either not know or not be confident in how to use their heating system, and more than a quarter of students surveyed said their landlord had not explained the heating system arrangements to them either verbally or in writing. From this, we concluded that insufficient communication between student-tenants and their landlord may affect the potential adoption of a smart heating control in a student rented property.

3. **Students are not sufficiently motivated to reduce heat consumption.** The idea of managing the heating system as a means to save energy was not common amongst the surveyed tenants. Of the 39 surveyed, only 87% reported not knowing their monthly expenditure on heat. When asked what the most challenging aspect of energy management was, only 30% of surveyed tenants responded with anything heating related. We observed that the other tenants in the

home were often blamed for the energy waste. This suggests that students are often not willing to take responsibility for their own energy waste. When asked if they (the respondent) felt that they needed more information or training on managing energy in their homes only half said yes, yet when asked if they felt their fellow tenants needed more information 68% of students responded yes. Most of the tenants reported having the ability and permission to adjust their thermostat. Despite this 18 students responded that they made no conscious attempts to be more sustainable and students who did not turn their heating down or off when they left for extended periods of time were very common.

4. **Some features offered by smart heating controls may not be useful in student rented HMOs.** Smart heating controls offer a variety of features that companies promise will reduce energy waste and save money. However from our data collection we found that many of these features would be less effective in student rented HMOs. This is due to the large number of tenants in each home with schedules that change frequently as well as the lack of motivation found among students. The devices do not understand the motivation behind why a person is altering the heat, and as a result they take every temperature change into consideration when generating a schedule. With so many tenants altering the temperature frequently the device may create a schedule that is not useful to tenants and may not save energy. If students are not willing to be more sustainable they may not use features offered by the devices other than being able to control it from their phone which can increase energy usage. From this our team concluded that these devices may not aid in reducing energy waste in student HMOs. Our team suggests that the University of Worcester start initiatives to better educate students on sustainability and monitoring energy costs in their homes.

5. **Students appear to like the concept of smart heating technologies; however, they may not know enough to have strong opinions about them. Additionally, privacy appears to not be a large concern of students regarding smart heating controls.** Our smart technology survey produced two main findings. The first was that students believe the features could be useful but may not know enough to have a strong opinion. The second finding from our survey is that students are not concerned with privacy but rather not having control over their heat. It is also important to note here that communications between landlords and students are incomplete. From this we concluded that students are not opposed to the idea of smart heating controls, however they may not know or care enough for them to necessarily be effective. Our research also brought into question who would have control of the thermostats. Due to the current lack of communication between landlords and students this question will need to be carefully answered, bearing in mind students' reluctance to relinquish control of the heat. We recommend that future Energize Worcester projects look into improving the relationships among tenants and landlords to overcome this hurdle.

Recommendations

Our survey results identified three areas that may complicate the implementation of smart heating controls: insufficient levels of student motivation to improve energy efficiency, the apparent absence of fuel poverty in the population studied, and concerns regarding privacy. Although the issues involved are far more complex than the following can resolve, we hope that the following recommendations aid students in improving their own sustainability.

1. **Recommendations for student behavioral changes:** Based on the results of our surveys, we have concluded that students are not sufficiently motivated to reduce their energy consumption. We therefore recommend additional research be conducted to determine what would motivate students to make changes to reduce energy use. Ideas to consider include adding financial incentives and social comparisons. Additionally, we recommend that students be informed of their energy usage in context, perhaps by being shown the bill every month. It will likely be difficult for students to find the motivation to make changes without seeing the actual impact of their efforts.

2. **Recommendations for student education:** We found that among the surveyed students knowledge of heating system management was incomplete. Based on the information and comments gathered from our survey, we recommend that future efforts focus on student education. Students should be taught how to properly and effectively manage the heating systems present in their accommodation. We also recommend that landlords meet with students in person in order to inform and discuss with students their energy usage. It may also be beneficial for students to be given access to their monthly utility bill so that they can see how much energy they are using. Installing a smart meter with an in-home display may also be beneficial in educating students, as it would allow students to have an easy-to-read breakdown of how much energy they were using throughout the month.

3. **Recommendation for future research:** We recommend that future Energize Worcester teams study and research what could motivate students to change their attitudes and behaviors. Further research into energy saving motivators may help better establish what actions could be taken to encourage students to reduce energy consumption in their rented homes. Additionally, we recommend future Energize Worcester projects look into conducting focus groups where both landlords and students can share their attitudes and behaviors towards heat consumption. Since we did not gather students' opinions on security, we recommend that future teams evaluate students' knowledge on security in smart heating controls and their opinions on security concerns. Finally, we recommend that future teams follow-up with the Worcester Bosch case study and continue to evaluate the acceptance and effectiveness of smart heating controls in student-rented HMOs.

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1 Introduction

In the United Kingdom, many buildings have not yet been modernized to improved thermal efficiency. Inefficient properties are responsible for 30% of the UK's annual CO_2 emissions (Department of Energy & Climate Change, 2015). Fuel poverty, a term specific to the region, is when a home cannot be heated to a sufficient temperature for a reasonable cost, a problem the UK has been trying to improve since the year 2000. A survey conducted by the National Union of Students (NUS) found that 78% of students in houses with multiple tenants felt uncomfortably cold at home in the winter season and 79% of students are hesitant to use the heat in their homes due to expense. Half of the students felt that their home experienced condensation, mold, and/or dampness (Bouzarovsky et al., 2012). Energy management and efficiency can have a large impact on the quality of life of people living in fuel poverty homes.

Students often live with numerous other tenants in a building managed by a landlord. This type of residence is known as a 'house in multiple occupation', or HMO. One factor that makes student-rented HMOs different from other housing is the presence of a dynamic known as the 'split incentive', which creates different complications depending on who is paying for the utilities. If the tenants are paying, they tend to conserve energy, but properties may have fewer energy efficient improvements because the landlord isn't motivated to improve the efficiency of the property. If the landlord is paying, the properties tend to be more energy efficient, but the tenants aren't mindful of their spending and are more likely to overuse energy. The existence of this social dynamic makes improving the thermal efficiency of the properties involved challenging.

Energize Worcester is a sustainability initiative, funded in part by the NUS. It was created to educate the University of Worcester community on sustainability while simultaneously improving the overall condition of student living. Phase II of Energize Worcester was created to evaluate student and landlord attitudes and behaviors towards heat use in HMOs. In 2016,the Energize Worcester team focused on collecting data from students and landlords in the local area. This was done to better understand how the temperature and conditions of student-rented HMOs were affecting the quality of life of the students at the University of Worcester, as well as how these factors contributed to energy waste (Ruiz-Cadalso, Puckett, Goddard, Braconnier, & Golding, 2016).

The 2016 Energize Worcester team made the recommendations for the University of Worcester to educate students on how to manage energy and for landlords to provide their student tenants with more information on the heating system in the home. The team's final recommendation was to explore new technologies, such as smart meters and thermostats, in order to better control and monitor energy use in HMOs (Ruiz-Cadalso et al., 2016). We believed smart heating controls had the potential to increase sustainability and comfort in off-campus student housing. This raised some

interesting questions, such as:

- What are the existing attitudes of student tenants toward the subject of heat system management?
- Would the student tenants be interested in new smart heating control systems?
- Would smart heating controls be effective in student HMOs?
- Are there student concerns over privacy involving smart heating controls?

Because of issues such as privacy and security, smart domestic technologies have the potential to be dangerous if not carefully considered and researched before being implemented on any sort of scale.

The main goal of this project was to investigate how complicated social and technical factors may affect the implementation of smart technology to reduce heat consumption in student-rented houses in multiple occupation at the University of Worcester. We surveyed students to understand their attitudes and behaviors toward both sustainability and smart temperature controls. We aimed to identify what student tenant attitudes towards smart heating controls were, and to evaluate the potential effectiveness of adopting a smart heating control in a student-rented HMO. We hope that this research will fill a gap in the available literature, and aid in determining if smart thermostats are the next step in improving energy efficiency in student-rented HMOs.

2 Literature Review

Inefficient United Kingdom (UK) properties contribute to 30% of CO_2 emission in the UK (Department of Energy & Climate Change, 2015). These homes are among the least thermally efficient creating a demand for more sustainable heating systems. More efficient heating systems may also result in a reduction in fuel poverty which the UK has made efforts to reduce since the year 2000. This project specifically deals with heating and sustainability among students in off campus housing. In this chapter, we introduce the broad topic of energy conservation in the UK, leading into sustainability at the University of Worcester as well as how the Energize Worcester initiative began. We describe student and landlord attitudes towards sustainability before moving into attitudes surrounding smart technologies, specifically to do with heat control, as well as any issues associated with these smart heating devices. This chapter illustrates many social aspects surrounding the implementation of smart heating controls, taking into account this project's four key stakeholders: The University of Worcester, Worcester Bosch, students, and landlords.

2.1 Energy Consumption in the United Kingdom

The Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change reported that in 2014 the burning of coal, natural gas, and oil for electricity and heat was the largest single source of global greenhouse gas emissions. In 2010, electricity and heat production were responsible for 25% of global greenhouse gas emissions and was the sector that made the largest impact. A graph of the percentage each sector contributed can be seen in Figure 2.1 (Edenhofer et al., 2014). In the UK specifically, properties are among the least thermally efficient in Western Europe, and in 2011 were responsible for 30% of CO_2 emissions (Department of Energy & Climate Change, 2015). According to the Department for Business, Energy, & Industrial Strategy, energy consumption has increased in the domestic sector by 3.6% from 2014 to 2015. This increase is due to the following factors:

- Weather
- Number of households
- Household characteristics
- Disposable income and energy prices
- Efficiency measures

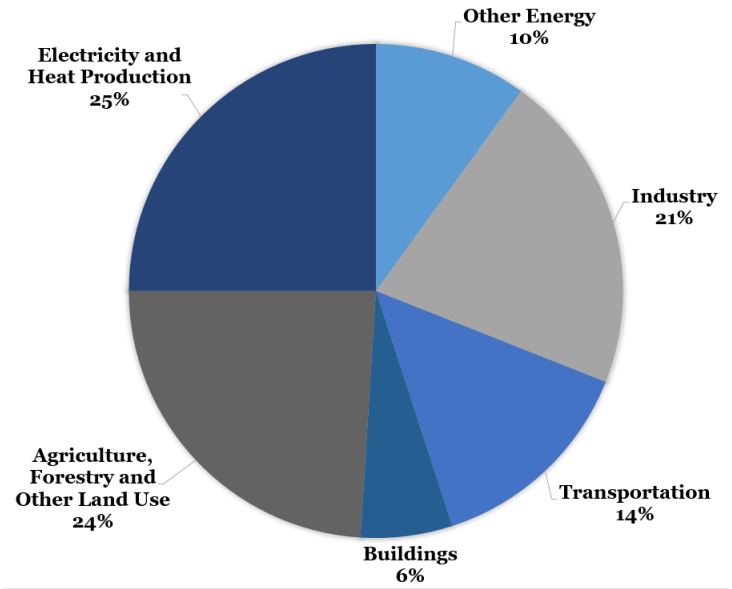

Figure 2.1: *Global Greenhouse Gas Emissions by Sector*

The first factor affecting emissions is a simple change in weather. In 2015, the average air temperature was 0.6 degrees Celsius lower than the previous year. Additionally, the domestic sector was responsible for 29% of total final energy consumption, and gas consumption increased by 4.5%. Between 2014 and 2015, consumption per household increased by 2.6% and consumption per person increased by 2.8% (Department for Business, Energy & Industrial Strategy, 2016).

Changing household characteristics also contribute to changing energy demand. The number of households in the UK has grown from 18.8 million in 1970 to 27.5 million in 2015–an increase of 46%. In this same time, the population has increased by 17%, which suggests there are now fewer residents per household. An increase in the number of households increased consumption as a whole, but having fewer occupants per household has decreased the average household's energy use. Additionally, level of comfort, or what is considered to be a reasonable level of warmth, is a factor that affects heat consumption. It varies over time, but has increased in recent years. This increase has resulted in a greater demand for energy (Department for Business, Energy & Industrial Strategy, 2016).

Natural gas prices have more than doubled since 2002, which has made consumers more aware of their consumption in an effort to save money. A graph of how fuel prices have increased over time can be seen in Figure 2.2 (Department for Business, Energy & Industrial Strategy, 2017). According to Wave 17 of the Public Attitudes Tracker, 28% of 2,105 UK households surveyed were worried or very worried about paying for their energy bills. The level of worry was highest among households with incomes under £16,000, social renters, 35-44 year olds, and private renters. The increase in households worried about energy bills has been a factor in the decrease of consumption per household (Department of Energy & Climate Change, 2016).

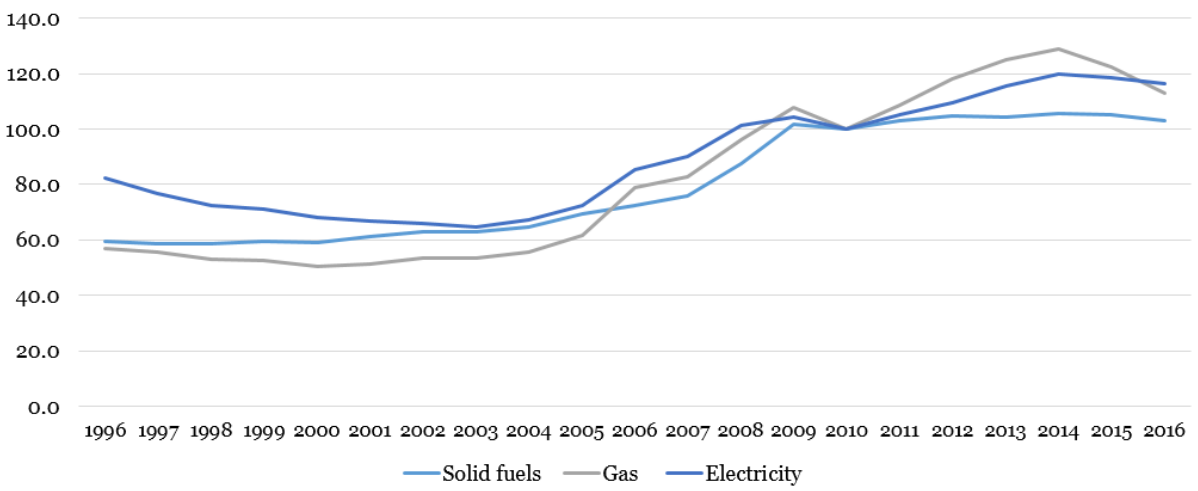

Figure 2.2: *Fuel Price Index Numbers Relative to the GDP Deflator*
This graph was produced using data from Domestic Energy Price Indices, published by the UK's Department for Business, Energy & Industrial Strategy (Department for Business, Energy & Industrial Strategy, 2017) We were able to use the UK government's data to produce this graph under the Open Government Licence (Appendix I)

New efficiency measures taken also have an impact on emissions. Many houses in the UK have poor insulation because much of the housing dates back to the Victorian era. Poor insulation results in increased consumption to maintain a comfortable temperature. As older homes are gradually replaced with more energy efficient homes, consumption will tend to decrease. In 1970, 25% of UK housing stock was built prior to 1918, but that percentage decreased to 16% in 2014. This is a long-term trend that makes a significant impact. Measures that homeowners and landlords can make to improve home efficiency include installing a condensing boiler, double glazing windows, cavity wall insulation, solid wall insulation, and loft insulation (Department for Business, Energy & Industrial Strategy, 2016).

Normalizing for temperature fluctuations, final energy consumption fell 19% from 2002 to 2015. This can be attributed to a combination of the factors explained above. A graph of how each factor has impacted domestic consumption can be seen in Figure 2.3.

Energy consumption in the UK decreased with temperature corrections, but without temperature corrections energy consumption increased. Since the UK's average air temperature is getting colder, more fuel is being used to maintain a comfortable temperature in homes. The increased use of fuel results in increased greenhouse gas emissions. Catherine Mitchell, author of *The Political Economy of Sustainable Energy*, believes there are three efforts humans need to focus on in order to reduce greenhouse gas emissions produced by domestic energy consumption. First, there needs to be a reduction in demand for energy through lifestyle choice changes. Second, there needs to be increased efficiency in the production and consumption of energy. Third, energy supply should be supplied by non-fossil sources, such as renewable energy and nuclear power (Mitchell, 2010). The

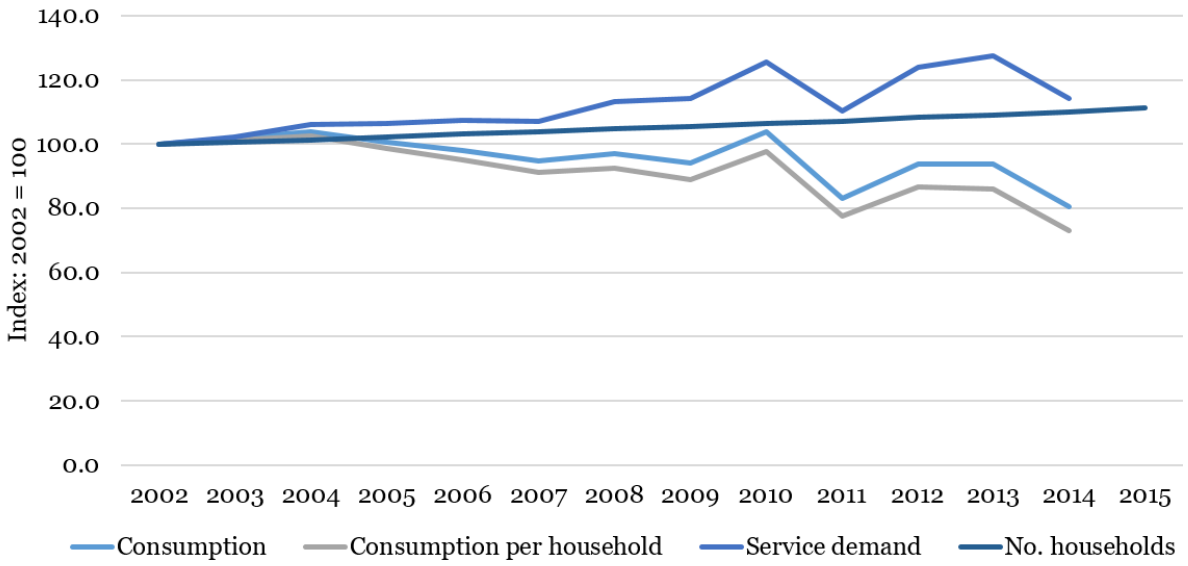

Figure 2.3: *Factors Impacting on Domestic Consumption*
This graph was made using data tables from Energy Consumption in the UK, a government report that provides data on overall energy consumption as well as data from each energy sector. (Department for Business, Energy & Industrial Strategy, 2016). We were able to use the UK government's data to produce this graph under the Open Government Licence (Appendix I)

focus of our research will be on the first two efforts.

2.2 United Kingdom Government Actions to Reduce Greenhouse Gas Emissions

The United Kingdom government recognizes the effect that their country's energy consumption and greenhouse gas emissions has on the environment. It has taken efforts to reduce greenhouse gas emissions from the transportation, domestic, industry, and service sectors. For the sake of this project, we focused our research on the domestic sector. Through various policies, the UK government has taken action to help make homes more energy efficient. Such policies include the 2008 Climate Change Act, The Green Deal, and the Smart Metering Implementation Programme.

2.2.1 2008 Climate Change Act

The 2008 Climate Change Act set legally binding targets to reduce greenhouse gas emissions. The UK aims to reduce greenhouse gas emissions by at least 80% by 2050 from baselines that were established in 1990. The government plans to do this through moving towards an energy efficient, low-carbon economy (Committee on Climate Change, 2015). Actions the government has taken since the act was passed are:

- Setting a national policy and strategy for reducing energy consumption

- Reducing the demand for energy
- Aiding people and businesses to use energy more efficiently
- Investing in low-carbon technologies
- Publicly reporting carbon emissions from the business and public sector of the UK (Committee on Climate Change, 2015)

In 2015, greenhouse gas emissions had been reduced by 38% from the 1990 levels. Most of this energy saving was in the power sector due to a reduced use of coal and an increased generation of electricity from renewables. The UK government recognized that emissions reduction in the power sector alone is not enough to meet the 2050 target. There has not been a significant emissions reduction in the domestic, transportation, buildings, industry, and agriculture sectors (Gummer et al., 2016).

2.2.2 The Green Deal

The Green Deal was created in 2012 to reduce energy consumption in the UK. It provides guidance to householders, tenants, and landlords on what energy-saving home improvements can make properties more comfortable and energy-efficient. At the request of the householder, a Green Deal Assessor comes to the home to learn about the residents energy use and establishes if they could benefit from energy efficiency improvements. The Assessor recommends energy improvements that are appropriate for the home. Green Deal Providers assess whether a Green Deal Plan will benefit the home, and if they deem it useful they provide a quote for the improvements. A Green Deal Provider creates a Green Deal Plan, which is a contract between the householder/tenant/landlord and the Green Deal provider. If the contract is agreed upon, improvements are made to the home (Department of Energy and Climate Change, 2014).

Examples of improvements the Green Deal covers are:

- Installation of loft insulation
- Technologies like wind turbines and solar panels
- Installation of secondary, double, or triple glazing windows
- Drought proofing by sealing gaps around doors, windows, loft hatches, fittings, and pipework
- Installation of cavity walls insulation
- Installation of internal and external solid wall insulation
- Replacement of old boilers

Green Deal improvements are expected to reduce the residents' heating bill since their homes should be using less electricity, gas, or oil. Repayments for some or all of the improvements are made over time through the electricity bill. Repayments are not meant to be more than what a typical household should save in energy costs. A landlord can initiate the Green Deal program on behalf of the tenants if the landlord includes gas, electricity, or oil in the rent. If the tenant pays for the gas, electricity, or oil themselves, then the tenant can set up a Green Deal assessment with the permission of the landlord (Department of Energy and Climate Change, 2014).

2.2.3 Smart Metering Implementation Programme

In 2013, the UK government started requiring energy companies to replace gas and electricity meters with smart meters at 30 million properties. Smart meters send digital meter readings to energy suppliers. They will be standard in the country by 2019; however, there is no legal obligation for individuals to have one for domestic use. These new meters may give consumers and energy companies more accurate information on energy use and should bring an end to estimated billing. Meters are usually read by energy suppliers. However, if the meter reader is unable to take a reading, the consumer can take their own reading and provide it to the supplier. This may prevent customers from receiving an estimated bill, which is when suppliers use an algorithm that takes into consideration usage history to estimate how much energy was used in a given time period. Bills are adjusted over time once meter readings for the estimated time period are reported (Regulatory Delivery, 2014). With smart meters, consumers will no longer need to send meter readings manually to a provider or have the meter read by a provider's meter reader. Through an optional In-Home Display that is linked to the meter, customers will be able to see real time information on their energy use. Customers will be better able to manage their home's energy use to monitor spending and reduce emissions (Department of Energy & Climate Change, 2013).

2.3 Sustainability at the University of Worcester

In addition to, and alongside governmental efforts, the University of Worcester has made its own efforts to be sustainable. The University of Worcester was ranked fifth out of 150 other universities by the 2016 People and Planet University League for green schools. They were also the first English University to achieve EcoCampus Platinum Status, which recognizes the work the school has done in aiding the planet by reducing energy waste. The university has been recognized by many other organizations such as the National Union of Students, FairTrade, and Green Gown because of their efforts (What We Do, 2016).

According to the University of Worcester's Annual Sustainability Report, emissions intensity with corrections for an increased number of students and staff decreased by 7% between 2014 and 2015. The University was ranked 34 out of 120 universities in percent change in emissions intensity per square meter since 2008. This emission metric is based on floor space (Brite Green, 2016). Despite

their efforts, there was an 11% increase in gas emission, even though Worcester had a mild winter. However, they did achieve a slight reduction of 0.16 MWh at the St John's Campus due to energy saving initiatives (University of Worcester, 2016).

In February of 2008, the university created a sustainability policy to promote sustainability in the community through teaching, research and knowledge. They encourage active engagement of students in helping to reduce the impact they have on the environment (Green, 2008). The school has an environmental management system as well as performance indicators, which assess current and future levels of sustainability. Each year the policy is reviewed and objectives are generated to reduce overall negative impact the University of Worcester has on the environment (University of Worcester, 2016). The current objectives include:

- Recognize the potential impact of climate change and the strategic and operational need to control, manage and reduce carbon dioxide and other GHG emissions
- Fulfill all the institution's legal and other compliance obligations
- Encourage sustainable procurement and employ whole-life costing and environmental performance criteria for selection
- Provide appropriate sustainability and environmental training for all our staff and students and encourage them to support this program (The Strategy and Private Housing Sector Team, 2015)

2.4 History of the 'Energize Worcester' Initiative

The National Union of Students (NUS) was founded in 1922 as an outcome of the desire for peace after the destruction of the first World War. It was started with the intent to promote, defend, and extend the quality of student living. The union has a large focus on promoting and aiding strong student unions throughout the United Kingdom and consists of over six hundred of these unions (NUS, 'Our History'). Energize Worcester was funded in part by the NUS to promote overall awareness of energy and the damaging effects on the environment as a result of heating emissions. Energize Worcester Phase II focused singularly on landlord and tenant relations within student housing due to heat management and the impact it can have on quality of living.

The WPI Global Project Program first partnered with the University of Worcester in 2014. Since then, WPI IQP teams have been completing projects with the Energize Worcester student group. The 2016 WPI IQP project assisted Energize Worcester in determining student tenants' and landlords' attitudes and behaviors regarding thermostatic and boiler systems in student-rented homes. This project recommended that the University of Worcester and landlords use various education techniques to teach student tenants how to be more aware of their energy consumption (Ruiz-Cadalso et al., 2016). These recommendations included:

- The University of Worcester and the NUS develop educational materials about how to better manage energy use
- The University of Worcester and NUS develop materials and advice for negotiating energy consumption and bills with roommates
- Landlord associations work with landlords to develop materials that explain the thermostatic controls and boilers
- Landlords include details about heating caps in rental agreements
- Landlords meet with student tenants periodically to review the heating system and utility payments (Ruiz-Cadalso et al., 2016)

Their final recommendation was to explore the use of smart technologies, which was the purpose of our 2017 Energize Worcester project. Through these recommendations they hoped to increase knowledge and awareness of energy efficiency in order to affect student opinions and attitudes. The overall goal was to decrease heat consumption, lower energy costs for students and landlords, improve student comfort, and reduce environmental impacts (Ruiz-Cadalso et al., 2016). One of our project sponsors and principle investigator for the full student-landlord research grant, Professor Carolyn Roberts, did research concurrently with our project. She evaluated landlord attitudes and behaviors towards energy consumption through a long-form interview that we include with her permission in Appendix H. Roberts is an Environmental Consultant specializing in environmental and water management and allied sectors. Roberts' findings are not featured in our paper as her work was ongoing and unpublished at the time of our research.

2.5 HMOs and Student Accommodations

The Worcester City Council defines a house in multiple occupation (HMO) as, "a house (or flat) with 3 or more tenants, forming 2 or more households," (The Strategy and Private Sector Housing Team, 2015). Two different types of HMO licensing exist: mandatory licensing and additional licensing. Mandatory licensing is required for any HMO which has three or more stories, and five or more occupants. Additional licensing covers any other HMOs. Before September 1, 2015, mandatory licenses were only required for these HMOs (The Strategy and Private Sector Housing Team, 2015). The additional licensing encompasses homes that house two households in one residency. The purpose of the additional licensing is to ensure that tenants receive the fundamental basic standards of accommodations. This includes:

- Safe gas and electric
- Fire safety precautions

- Suitable room sizes
- Adequate kitchens and bathrooms for the number of occupants

The policy also aims to improve the overall atmosphere of neighborhoods. Prior to the additional licensing going into effect, a landlord accreditation scheme was in use that recognized landlords who were committed to offering good quality, properly managed rentals (The Strategy and Private Sector Housing Team, 2015). Due to the new law in 2015, accreditation no longer applies.

Due to a demand for first year housing, around 2009, the university started leasing off campus properties from local landlords. Prior to the 2015 act, the University of Worcester only leased properties that had been accredited. As a result not enough of these homes were available resulting in inflated rent. After The Housing Act 2004 Section 56 was added in 2015, there was an excess of properties available, decreasing rent prices (Participation, 2004). A landlord who wants to lease to the university must agree and sign the Agreement for Letting Furnished Houses (attached in Appendix G). This document defines the expectation the university requires of the properties before the school then rents them to students.

Prior to 2009, a first year student was expected to deal directly with the landlord when renting a property off campus. (Second year and above students are expected to rent properties on their own, whether from university-approved houses or other means.) However due to the university now leasing some properties, the relationship between students and the university is often viewed as the tenant-landlord relationship. The Licensed Agreement for University Managed Accommodation (also in Appendix G) is signed by the student agreeing to the terms the university has for renting these properties. Due to the fact that the first years do not deal directly with a landlord, they may not have had any discussion about energy on the property and may be unaware of their usage.

Two of the major stakeholders in the Energize Worcester project are the students in these HMOs and the landlords who own the actual property. As a result, a central focus of this project is the relationship between the two, specifically the concept known as the 'split incentive'. The split incentive was defined by the state of California as "a circumstance in which the flow of investments and benefits are not properly rationed among the parties to a transaction, impairing investment decisions." (California Sustainability Alliance, 2011). This idea is one of the main reasons why sustainability is not implemented more often. Specifically in student rented HMOs, the split incentive relates to how utilities are managed in the household. If a tenant has the utilities included in their rent fee, they are less likely to be conscious about how much energy they are saving. Since the landlord will then be paying the utilities, he/she may see more of the advantage in saving energy. The same principle occurs in the reverse. If the student pays for utilities separately, energy saving methods may be more appealing to them than it would be to the landlord.

2.6 Fuel Poverty in Student Housing

The Energize Worcester project has had a strong focus on the overall quality of student life making the NUS a key resource. A study conducted by the NUS in the winter of 2015 examined fuel poverty and energy efficiency for student housing. Fuel poverty, as defined by The Warm Homes and Energy Conservation Act, is when a household with a relatively low income cannot be kept warm for a reasonable amount of money. The act was created in 2001 and demands the government do what it can to reduce the fuel poverty of its citizens. A home is considered to be in fuel poverty if more than ten percent of a person's income after housing expenses is put towards heating the home to an adequate standard of warmth. The temperature of the living room must be at least twenty-one degrees Celsius and all other rooms must be eighteen degrees Celsius or above in order to meet the these standards (Boardman, 2004).

The NUS survey showed that 78% of students were uncomfortably cold and 64% did not think their homes were adequately insulated to retain heat. Almost 80% of students chose not to heat their home or hesitated to heat their homes because of the cost. 82% wore multiple layers while they slept in order to remain warm and 62% have worn winter accessories such as gloves or scarves to keep warm when in their homes. Energy management and efficiency can have a large impact on the quality of life of people living in fuel poor homes (Bouzarovsky et al., 2012). These statistics are one of the reasons the NUS gave the original grant to Energize Worcester at the university.

2.7 Student Behaviors and Attitudes Towards Sustainability

A study done at Sheffield Hallam University surveyed students living in residence halls managed by The UNITE Group Plc. in order to gauge what students understand about the concept of sustainability. Of the 396 students surveyed, 73% believed they had a strong understanding of the term sustainability. Of that group, only 6% provided a satisfactory definition. This suggests that the students surveyed misunderstood what sustainability is. Additionally, students tended to displace responsibility for sustainability issues onto others, such as government, businesses, or their social group. The survey showed that 75% of students felt that sustainability issues did need to be addressed, but felt it was not their responsibility to deal with it. This is known as the displacement theory and it is due to the perception students have that they do not have the time or resources to act sustainably (Chaplin & Wyton, 2014).

There is also evidence that students cite their flat mates' behavior as something that prevents them from being sustainable. Some respondents didn't understand the point of acting sustainably, such as through recycling and energy conservation, if their flatmates were not making an effort. The following statements from the surveyed students give evidence to displacement theory (Chaplin & Wyton, 2014):

- "Not everyone in my flat will contribute and consistently make sure the sustainable (sic)

practices would be carried out"

- "living in a shared living environment means you can't always operate as you would do if you were living as a non-student"
- "I would like to do it but my flat mates do not really care about it" (Chaplin & Wyton, 2014)

Fumiyo Kagawa, Research Director of Sustainability Frontiers, suggests that there is limited benefit in people believing a concept is important if they don't fully understand what it is and how they can get involved (Kagawa, 2007). This suggestion could be applied to student sustainability because a majority of the students surveyed thought sustainability was an important enough issue to be addressed, but didn't think they were responsible for getting involved.

The 2016 Energize Worcester IQP team found that if students were conscious of their energy consumption, it often wasn't because they were concerned about sustainability or the environment. The surveys they conducted showed that students' primary motivation for reducing heat consumption was to save money. Of the 40 students surveyed, 29 believed they consciously controlled the heat. When those 29 were asked what their motivation was to keep the heat down, 66% wanted to save money, 24% wanted to protect the environment, and 10% wanted to save money and protect the environment (Ruiz-Cadalso et al., 2016).

The IQP team also found that 87.5% (35/40) students surveyed did not have a methodical way of controlling the temperature in the house, with one student saying that they "just don't talk about it ever." It's notable that of those 35 students surveyed, 6 had noninclusive rent, 14 had inclusive rent with a heat cap, and 15 had inclusive rent without a heat cap (Ruiz-Cadalso et al., 2016). Thus, 20 of them appear to have a monetary incentive for having a methodical way of controlling the heat, yet they don't discuss it.

2.8 Landlord Behaviors and Attitudes Towards Sustainability

According to the UK Department for Communities and Local Government, social renters and private renters accounted for 17% and 20% of housing stock respectively in 2016. The remaining 63% was made of up homeowners. Privately rented homes, which are defined as all rented homes not owned by local authorities or housing associations, are the only part of the housing stock that is continuously expanding due to an increased number of people aged 25-34 preferring renting over home owning (Department for Communities and Local Government, 2016). When homes are sold or rented an Energy Performance Certificate is required. The basis for this certificate is a Standard Assessment Procedure (SAP) system that provides a rating for a home's energy efficiency. The rating is placed on an A–G scale with A being the most energy efficient. Social renting has the best energy performance with 48% of homes rated from A–C. Only 24% of owned homes and 26% of privately rented homes are rated in these high bands (Department for Communities and Local Government, 2016).

A Private Landlord Survey conducted by the UK government in 2010 showed that 38% of private landlords do not have an Energy Performance Certificate for their property and do not plan to get one. Of the landlords that did have a certificate, 70% did not have plans to make any changes to their property to improve energy efficiency (Department for Communities and Local Government, 2011). A study done at Northumbria University asked landlords to explain their reason for obtaining or not obtaining an Energy Performance Certificate. Notably, none of the landlords obtained it to learn about the energy efficiency of their home or about how they could improve their home. The landlords surveyed either chose not to acquire a certificate, or acquired one simply because they were required to. A graph of how the landlords responded can be seen in Figure 2.4 (Hope & Booth, 2014).

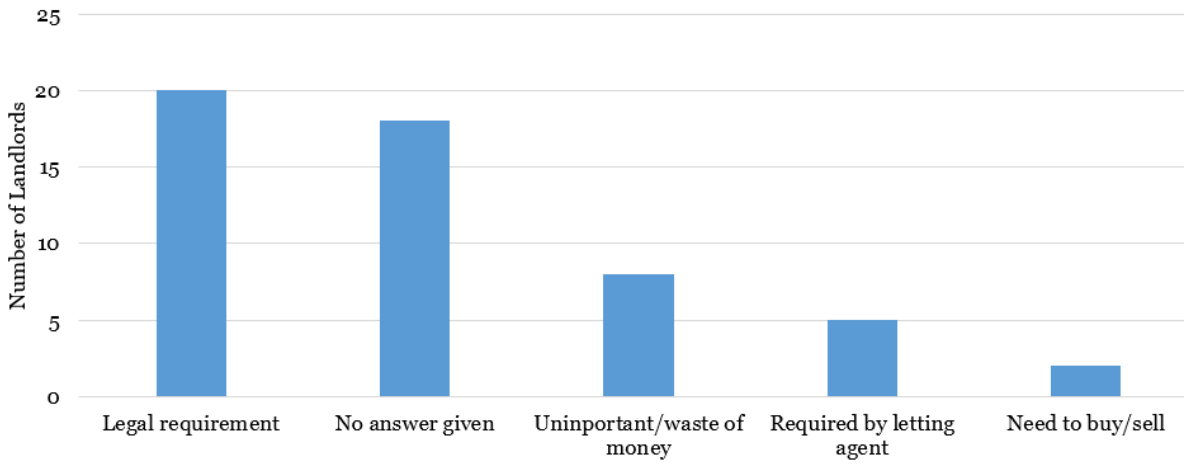

Figure 2.4: *Landlords Reasons for Obtaining or not Obtaining an Energy Performance Certificate This graph was reproduced with permission from publisher Elsevier (Appendix J).*

The study done at Northumbria University by Alexander John Hope (Faculty of Business and Law) and Alexander Booth (Faculty of Engineering and Environment) surveyed 53 private sector landlords. Of those landlords, 28 let their properties to students. When landlords were asked how much influence they believed household energy consumption had on UK carbon emissions, 48% believed they had either a minor influence or no influence. A chart of how the landlords responded can be see in Figure 2.5 (Hope & Booth, 2014).

As of 2015, 78% of the 573,162 homes that utilized a Green Deal assessment were owner-occupied properties. The remaining 12% and 10% of homes that utilized it were privately rented and socially rented respectively (Department of Energy & Climate Change, 2016). Of the 53 landlords surveyed in the Northumbria University study, 67% had never used government schemes to improve the energy efficiency of the homes they let. None stated that they used the Green Deal. Of the respondents, 47% had never heard of the Green Deal, 70% had no understanding of how it worked, and almost a third of respondents had not intention of using the scheme. When landlords were asked why they haven't used the Green Deal, some were quoted as saying (Hope & Booth, 2014):

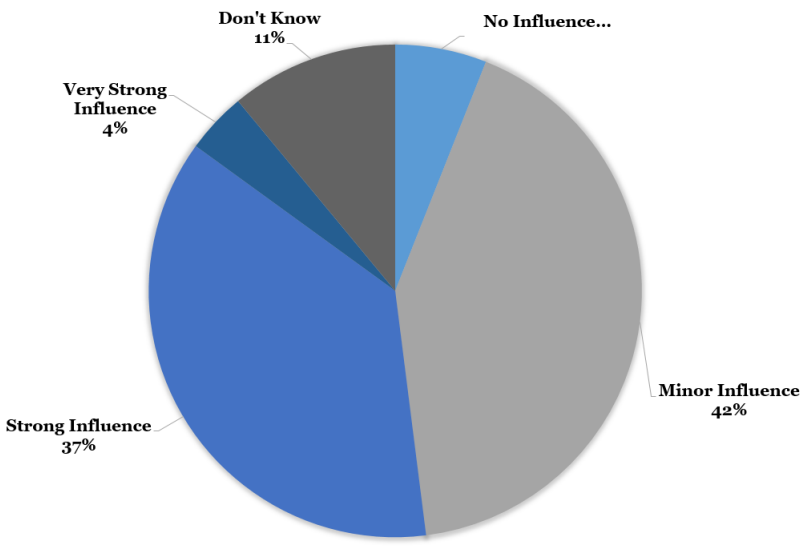

Figure 2.5: *Influence Landlords Believe Household Energy Consumption Has on UK Carbon Emissions*
This chart was reproduced with permission from publisher Elsevier (Appendix J).

- "The Green Deal is too complicated..."
- "Landlords require simple language. Simple schemes"
- "Many landlords are working and do not have time to wade through paperwork to see if they qualify"

Of the 53 landlords surveyed in the Northumbria study, 28% have never made energy improvements to their home and have no intention to improve them in the near future. Additionally, 32% have made only minor improvements that cost under £100. When landlords were asked what deters them from making improvements, most landlords claimed it was high upfront costs. Figure 2.6 shows the response rate for deterrents to energy improvements (Hope & Booth, 2014).

There were 14 landlords of the 53 who did make substantial energy efficient improvements in their homes that cost over £100, and 15 of the landlords had made no improvements yet, but were planning to in the near future. When asked what their primary reasons for making improvements were, many of the landlords wanted to increase thermal comfort for tenants. The bar graph in Figure 2.7 shows landlords' drivers for making energy efficient improvements in the homes they let (Hope & Booth, 2014).

It appears that the landlords surveyed in the Private Landlord Survey conducted by the UK government and the 53 respondents in the study done at Northumbria University are not making significant efforts to improve the energy efficiency of the homes they let.

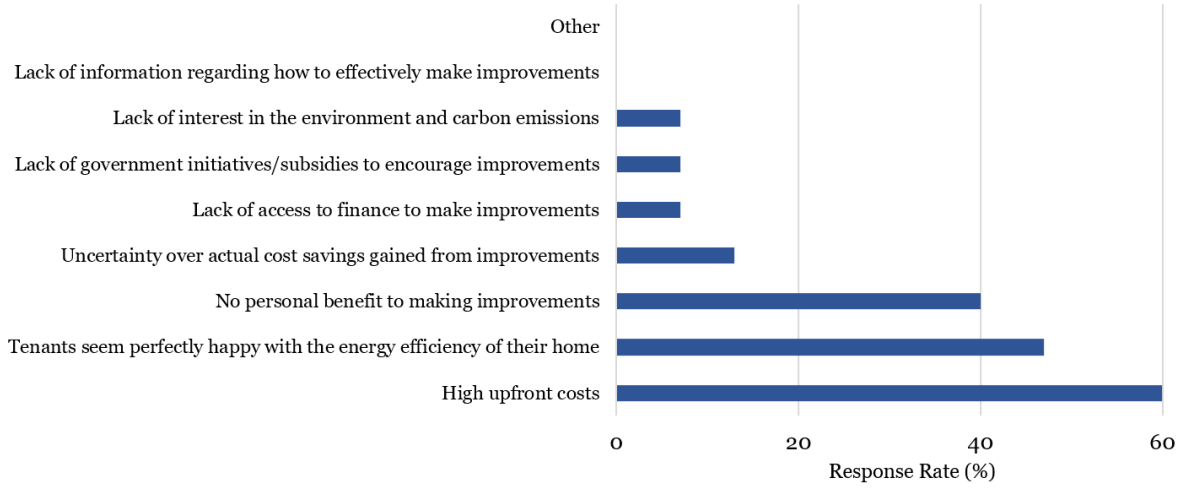

Figure 2.6: *Landlords' Deterrents for Making Energy Efficient Improvements in the Homes They Let This figure was produced using data tables from Hope and Booth's journal article Attitudes and behaviors of private sector landlords towards the energy efficiency of tenanted homes (Hope & Booth, 2014).*

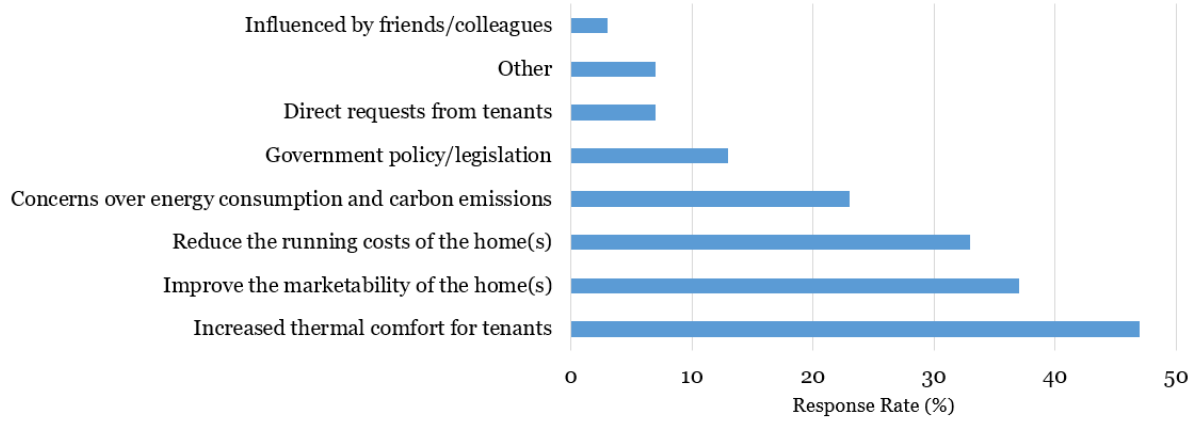

Figure 2.7: *Landlords' Drivers for Making Energy Efficient Improvements in the Homes They Let This figure was produced using data tables from Hope and Booth's journal article (Hope & Booth, 2014).*

2.9 The Rise of Smart Technologies, and the Internet of Things

Smart heating technology is often associated with the Internet of Things. The International Telecommunication Union, an agency of the United Nations, defines the Internet of Things as:

> "A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies." (Recommendation ITU-T Y.2060: Overview of the internet of thing, 2012)

To simplify, the Internet of Things is the group of connected smart devices working as a whole. For our purposes, we may consider a smart thermostat, smartphone, smart CO_2 and smoke detector, and a smart security system acting in tandem to be part of the IoT.

Smart technologies are even less clearly defined than the Internet of Things. However, they often tend to share a few characteristics with exceptions. These are:

- Connected: Smart devices can generally be accessed remotely via the internet.
- Interactive: Smart devices can adjust their behavior based on direct human input.
- Autonomous: Smart devices can collect information and make decisions to adjust their performance without human input.
- Predictive: Smart devices can use models and previously gathered information to predict future conditions and act accordingly.

The definitions given here are somewhat vague. This an unfortunate byproduct of the explosive growth of these type of devices. No governing body has set a clear definition for "smart" in this context, so any company developing a product with even slightly more features than the average competitor may find it beneficial to attach "smart" to the name. The end result is a lack of complete clarity for these definitions.

2.10 An Introduction to Smart Temperature Controls and Their Features

A variety of smart heating controls are available for purchase, offering a wide array of features for a range of prices. The purpose of this section is not to give a recommendation for a particular unit, but rather to explore features offered by different smart controls. It is important to note that some of the features were designed with single-family homes in mind, so their use may differ if implemented in an HMO (Davidoff, Kyung Lee, Zimmerman, & Dey, 2006). Charts comparing the features of popular smart temperature controls can be found in Appendix A.

2.10.1 Multi-Zonal Heating

Multi-zonal heating is not offered by every smart temperature control. However, it could be especially useful in homes that have multiple occupants. Multi-zonal heating is the ability to heat specific rooms or zones of a house to a desired temperature at different times during the day. For example, if a occupant returns home from work to cook dinner everyday, the kitchen will be warmed by the time they arrive without having to waste energy heating up other rooms in the house. Zonal heating is a relatively new feature and sometimes requires multiple devices to equip a home. It originally was a separate heating control method but was recognized as a main source of competition so companies worked to include the option with their thermostats. (Wood, 2015).

2.10.2 Learning

One of the most advertised features of smart heating controls, especially thermostats, is its adaptive technology and ability to learn the habits and schedules of the occupants of a home. This feature is what defines a thermostat as 'smart' and separates it from more basic controls, for example timing thermostats. By the term 'learning' companies mean that the device is able to understand the when occupants are home and generate a heating schedule in order to improve comfort and reduce energy waste. However, this feature has proven to be one of the most difficult for consumers to use and adjust to. A study conducted by the university of Michigan involving the Nest found that the device would take into account every temperature change made. This created a problem because some situations called for a specific temperature that didn't follow the household's normal schedule but the device would include it in the daily schedule it generated. Subjects of the study found that they would end up overriding the feature and not using it in their homes to avoid this. However sometimes the device would ignore the manual temperature change and set the temperature based off the schedule anyways (Yang & Newman, 2013).

2.10.3 Motion Detection

Motion detection is a trait that belongs typically to the most expensive heating controls on the market. It is also one of the least common features among the available devices. Temperature controls with this feature have sensors embedded in the unit that can detect the presence of an occupant within a certain range. If no person is detected within a time range, the device will turn down the heat. A problem encountered with this feature is that often, single thermostats are used to heat entires homes. If an occupant is in a separate part of the house, the motion sensor will not detect them and as a result it will reduce the heat even though a person is present (Yang & Newman, 2013).

2.10.4 Geo-Tracking

Geo-tracking is when a device logs a person's current, physical location using GPS data from their smart phone or other smart device, such as a tablet. A feature offered on a few smart heating controls, it allows the thermostat to track when an occupant is home or will be home and heat the house accordingly. The goal of this feature is to save energy by not heating a home when no one is present. It also allows for the temperature in a home to warm up when the occupant is on their way home. A problem encountered with this feature is that often devices struggle to track a phone when it is not on Wi-Fi and do not recognize a person until they are already in the home (Lu, 2010).

2.10.5 Weather Responsive

Temperature controls that are weather responsive take into account the temperature outside and heat the house accordingly. If a day is warmer than expected the devices take that into account

before heating the home. Weather responsive controls can be installed as a separate system that sends information using sensors directly to the boiler. However, many devices now connect to the Wi-Fi directly and use the internet to look up the local weather. Although this may not be as accurate as actual sensors on the location, it is more efficient and much cheaper than installing the entire weather sensor system. A downside of this option is that if the device has trouble connecting to Wi-Fi it can no longer take the temperature into account (Weather-responsive controls (outdoor reset controls), 2017).

2.10.6 Hot Water Control

Hot water control is a newer feature offered by some smart heating controls. Devices that include this feature connect directly to the boiler and can turn the boiler on or off to adjust the water in the hot water tank. These controls allow the hot water to be on a schedule so that energy is not wasted keeping water warm when it is not in use. For example if an occupant comes home after work to shower every day at a specific time, the water can begin heating before they arrive. A problem with this feature is that devices do not work with every type of boiler so hot water control may not be useful in some homes (The 3rd-generation nest thermostat's domestic hot water control, 2016).

2.10.7 Mobile Control of Device

Mobile control of a device is a feature offered by every smart heating control on the market. It allows a user to control their thermostat or boiler through an app on a smartphone or tablet even when the occupant is not home. The University of Michigan found that it was actually the most useful feature to the subject studied and was the main selling point of the devices. They found that often users would ignore other features offered by the smart thermostat and use it simply as a mobile way to adjust their heat. However, consumers have had occasional issues with the application connecting to the smart control, not allowing them to adjust the heat. Most smart heating controls allow for a manual override but as a result some people end up using the smart control as a normal thermostat (Yang & Newman, 2013). Additionally, some smart heating control users have experienced issues connecting to their thermostat via mobile data. Customers were still able to control their heating control by connecting the phone to a Wi-Fi network (Bosch Group, 2017). An alternative problem is if the smart thermostat is operating perfectly, but the Wi-Fi in the home is turned off or stops working. The same issues arise where users could not control their thermostats through the applications on their phone.

2.10.8 Cost of Systems

Smart devices span a large price range. The diverse range in price is owed in part to the varying levels of 'smart' of the systems available. Less expensive devices typically meet only the minimum requirement to be considered 'smart'. This usually means that they can be connected to a

smartphone or tablet wirelessly and then controlled through an application. The most expensive smart devices, such as the Nest, offer sensors that make the smart technology adaptive to the occupants of the home. It is also important to consider that many companies, such as the Z-Wave, require a hub to be purchased along with the thermostat or valve in order for it to be connected to a smartphone or tablet which will increase the overall amount spent in updating a home. The tables in Appendix A illustrate the prices of various smart thermostats as well as the features each device offers.

2.11 Do Smart Heating Technologies Actually Save Money/Energy?

A main selling point of a smart heating control is its supposed ability to save energy and by consequence money. However sometimes human and device error inhibit this from happening.

A study conducted by The School of Information at the University of Michigan found that the Nest did not clearly lead to energy savings. A number of participants found that they may have been paying excess energy costs due to the easy accessibility of the thermostat as well as the time it actually took to learn to control the smart thermostat. The Nest thermostat is primarily controlled from an application on a smartphone. Subjects reported that they were much more likely to adjust their heat because of this. For example, one respondent reported that he would turn the heat up before he left his bed in the morning. As a result of this, some people's energy expenditure went up. Another human error was brought into focus when five of the ten participants explicitly said that they would choose comfort over energy savings and that they did not change their behavior to be more energy conscious after getting the Nest. They were reported to change the temperature for comfort often which lead to no decrease in energy consumption(Lu et al., 2010).

Within this study, error within the actual device also resulted in a problem. Five subjects found that the Nest was not learning an energy efficient schedule but was rather just memorizing numbers they inputted themselves. Participants found that due to this their homes were often heated higher than necessary. The Nest device offers a feature called auto-away which is supposed to reduce energy waste when a person is not home. Participants found that the feature was relatively useless and often the heat would be turned on when they were away (Lu et al., 2010).

The study concluded that even though the Nest offered a variety of energy 'saving' methods, the most successful way to improve sustainability in these homes had to do with how involved the participants were. Subjects who actively monitored their heat and energy expenditure while making conscious choices to be more sustainable saved the most money. Even though the Nest advertised energy savings, it was unclear exactly how much savings the device was responsible for (Lu et al., 2010).

Another study conducted by the University of Warwick drew a similar conclusion: energy savings depends on the participants more than the device. Every smart heating control device promises to save the consumer energy. Often companies claim up to approximately 30% energy savings when in

actuality it has been reported to be around 10% overall energy savings (Dimitrokali et al., 2015). The study conducted by the University of Warwick consisted of 12 participants. Subjects were asked what they consider a smart heating system should consist of. The top three answers were intelligent temperature control, remote control, and smart learning. More than fifty percent of people who responded to the survey expected less than 15% energy savings. The most important finding of the study was that the smart heating control changed the participants behavior and that was what reduced energy usage. It was reported that being able to see the temperature display clearly motivated participants to be more conscious of energy usage (Dimitrokali et al., 2015).

Smart heating controls come with a variety of energy saving options. However research has found that the most important contribution to reducing energy use relies on the consumer. If a person is unwilling or uninterested in changing their habits to be more energy conscious the chances of a smart device having a significant effect is small. A willing participant combined with a smart heating device ends up being much more successful in improving sustainability (Yang & Newman, 2013).

2.12 Security Concerns with Smart Thermostats

Smart thermostats give rise to a number of security and privacy concerns. Huichen Lin and Neil W. Bergmann of the University of Queensland pointed out a couple of characteristics that make these technologies unique with regards to security. It is likely that smart technologies are installed individually into a home, instead of all at once as a cohesive system. Additionally, the homeowner is unlikely to have any significant security training or knowledge. This makes security and privacy difficult to maintain (Lin & Bergmann, 2016). Even if the manufacturers are aware of a security issue, and release a security patch, smart devices often cannot be easily updated. As Alex Chiu of Cisco's Talos Intelligence points out: "The unfortunate truth is that few people think 'Hey! It's the first Monday of the month! I should check and see if my TV needs to be patched!'" (Chiu, 2016). If security patches are not installed in a timely fashion, devices are vulnerable to attacks.

2.12.1 Examples of Security Concerns

In 2014, researchers from the University of Central Florida demonstrated a hack of the Nest smart thermostat, one of the most popular smart thermostats on the market. The exploit required physical access to the Nest, but left no trace and only took 10 seconds with a USB flash drive to carry out. A thermostat could be compromised any time before being mounted in the home, and the owner would never know. With full control of the Nest, an attacker could not only have control over the heat, and occupancy data the Nest collects, but they could also gain access to any device on the network (Hernandez, Arias, Buentello, & Jin, 2014).

In an incredibly concerning example detailed in the Talos Intelligence blog, the Trane ComfortLink II smart thermostat was found to have some security vulnerabilities. Engineers at Cisco Talos found 3 different flaws, all of which allowed for remote attacks on the smart thermostat, and

gave an attacker the ability to run any lines of code they desire on the machine. The vulnerabilities were discovered and disclosed in early 2014, and Trane did not respond to the disclosure. Software to fix two of the vulnerabilities was released a year later in 2015, without mentioning to any of the users the importance of installing the new software. A solution for the final (and most critical) vulnerability was not released until 2016, nearly 2 years after the initial disclosure. And of course, the issues still persist on the many devices that have not been updated (Chiu, 2016).

It seems unfair to lump all of these smart devices together, but security is something that is difficult to measure, and attention to it appears to have been inadequate.

2.12.2 Dangers of Compromised Smart Technologies

There are many dangers associated with security of smart technologies in general, and smart thermostats in particular. One concern with smart technology security is a malicious individual gaining control over the device. For something like a smart lock, the dangers are obvious. For a smart thermostat, the concerns are subtler, but it is not too difficult to concoct a scenario where control over a smart thermostat could prove disastrous. For example, Ronnie Richardson and Max North of Kennesaw State University warn of the dangers of ransomware. They have "no doubt" it will move to the Internet of Things (Richardson & North, 2017). In the case of smart thermostats, a cybercriminal could lock in the heat either too high, or too low, and hold the thermostat hostage until a ransom has been paid. Lin and Bergmann allude to a more physical concern. A criminal could access the data logs of a smart thermostat and use those to determine when to best schedule a burglary (Lin & Bergmann, 2016).

There are other dangers associated with security as well. James Jerkins of the University of North Alabama warns that insecure IoT devices can easily be hacked and used in a botnet, a collection of computers hijacked to perform illegal activities without their owner's knowledge. In 2016, such a botnet composed primarily of DVRs and webcameras supported a massive attack on important servers (Jerkins, January 2017). While not exactly a report of smart heating controls, this example shows a real-world attack on similar systems. Multi-stage malware that gets onto one device could spread to others, like from a smart thermostat to a security camera or computer on the same network (Storm, 2013). Having access to a device on the network could allow an attacker to easily monitor traffic to snag personal information, and would create a 'backdoor' for easier attacks in the future. Furthermore, a consumer would have nearly no way of knowing their devices has been affected. As the University of Queensland team points out: if a smart technology is not both secure and trusted, any theoretical benefits from the system will be lost (Lin & Bergmann, 2016).

2.12.3 Social Aspects of Security

Professor Mikko T. Siponen, of the University of Oulu, Finland, discussed the topic of information security and society's attitudes towards it in his article *Five Dimensions of Information Security Awareness*. Siponen believes that the general public should have a basic level of knowledge

of IT security and safety issues. He considers this knowledge no less valuable or important than traditional security and safety issues, comparing the severity to knowing not to use electrical devices while showering (Siponen, 2001). He warns that technology is so much a part of everyday lives it tends to get forgotten. Especially the aspects of security are rarely considered. Furthermore, Siponen says that in a rush to adopt new technologies, people often fail to look with a critical lens, or to consider if non-technical solutions would serve better (Siponen, 2001).

Debi Ashenden and Darren Lawrence of Cranfield University discuss that when nothing has gone wrong, the idea of security is not at the forefront of people's minds. Furthermore, they point out that there is a critical difference between awareness and behavior change. As with many behavioral changes (smoking, for example), informing people of dangers is not enough to create change (Ashenden & Lawrence, 2013).

Searching for why these concerns have not been addressed more strongly, Siponen suggests that owing to its existence outside of 'hard' engineering and computer science, the topic of security awareness is relegated to a part of society's collective thinking which is not often visited. Cultural and societal awareness of informational security concerns are likely to remain low until we, as a society, have a strong reason to revisit it (Siponen, 2001).

2.13 Privacy and Technology

In his 1996 paper, "Privacy and Technology", Gary Marx raises the issue that society is becoming transparent. Information is leaked everywhere. Barriers protecting an individual's privacy are crumbling. A person's personal attitudes and history are being made available with or without their consent or knowledge. Marx illustrates that with the advancement of technology, the gap between what is public information and what is private is disappearing. He states society is under constant observation. Everything individuals say, feel, or do is being monitored by unknown figures. Marx demonstrates companies are selling data to marketing researchers to analyze to better sell their products citing the Lotus Corporation which created a database containing consumers personal information such as names and addresses as well as buying habits. He argues that with privacy there are numerous issues, the central concern being the control of personal information. He concludes that technology may reduce "the power of the individual relative to large organizations and the state." Marx summarizes that society as a whole must better understand the potential and limits of technology. There should be truth behind what information is being displayed for the world to see. (Marx, 1996).

In another one of his publications, "Surveys and Surveillance", Gary Marx illustrates the issues with organizations misleading individuals about what their information is being used for. He states that often companies encourage people to respond by making them feel important and bringing forth the idea of an "equal voice". Often this is misleading and not the goal of the survey being conducted. Organizations present themselves as serving the public interest when in reality they are

pursuing the company's own interests. Marx raises significant concerns with this issue of data gathering without the respondent being informed of the true intentions behind the survey. Another important issue he argues is that people do not know where their data is being stored. Companies don't often explain where the data is being held and what will happen to it once the study is complete. The article outlines the power imbalance created between organizations and individuals in society in regards to control of privacy. With this sort of data collection, privacy becomes a concerplays a role in what may be considered the violation of an individual's right to know what is being done with personal information (Marx, 2008).

A research team from Stanford University released an article titled "Privacy and Information Technology". They define information technology as a device that stores, processes, and distributes information. As technology advances, the capability of what these devices can store grows (Van den Hoven et. al., 2016). In close association with information technology is information privacy. Information privacy is a relatively new term that is defined as when a person's information is readily available for anyone else to access. This stems from the ability to observe people indirectly using information technology. As modern technology is advancing privacy is becoming harder to maintain. However many people do not view the decreasing level of privacy as a bad thing. Information can be more honest this way, preventing people from releasing inaccurate information. This idea brings forth the concept of privacy as property. There is a concern with smart thermostat companies gathering information and selling the data to marketing firms to make a profit. If privacy were a person property, companies would lack the right to do that (Friedman, 2000). A study done by the University of Central Florida titled "Smart Nest Thermostat: A Smart Spy in Your Home" focused on privacy and security concerns involving the Nest smart thermostat. The device collects user statistics, which are uploaded to the Nest Cloud. Reports show that the company who owns the device plans on sharing the information gathered by the Nest thermostats with energy providers. This may appear harmless, however, the Nest collects a lot of personal data. Privacy is a large concern with smart technologies and the rights a company has to consumer data is being questioned (Hernandez, Arias, Buentello, & Jin, 2014).

2.14 Attitudes Surrounding Sustainability Innovation in the United Kingdom

The application of smart heating controls in homes of multiple occupancy (HMOs) is a topic that has potential, however, there are many socio-economic and social factors involved. Patrick Devine-Wright, a research fellow in Environmental Psychology, published an article titled "Local aspects of UK Renewable Energy development: exploring public beliefs and policy implications (2005)". He found that the attitudes of participants in community programs dealing with the development of local energy were influenced by the respondent's age, gender, and status of employment (Devine-Wright, 2005). He suggests that the attitudes of students may differ from those

of older generations. It should be noted that the article published by Devine-Wright was about the reactions of participants in a program concerning the development of local wind farms not heating systems but it is probable that the same social dynamics and motivations exist with the issue of new energy development as with new heating methods. His study found that the population of males aged 30 years or younger were less likely to respond favorably for local ownership of local wind farms (Devine-Wright, 2005). In fact 37% of surveyed males under the age of 30 supported local ownership while 53% of men between the ages of 30 and 50 and 63.5% over 50 (Devine-Wright, 2005). This is suggestive of the extent to which different factors such as age and gender influence people's attitudes.

Another research team from the Mixed Reality Laboratory at the University of Nottingham found that while initially participants were wary of new software systems and while they might come to accept them with time, many still saw the new systems as a tool of the utility companies to learn more about household's usage in order to be able to maximize profits. Participants also brought up concerns of the increased complexity of the possible future energy systems which the newer software agents made possible. Issues ranging from coding bugs which cause the participant to be charged more to calling the trustworthiness of the companies which many saw as exploitative were raised. The team found that participants in their study thought that any future software or hardware systems should function not only as a tool for the utility companies but also as a tool for the homeowner to keep the utility company honest in matters of usage and accountability (Rodden, Fischer, Pantidi, Bachour, & Moran, 2013).

The University of Nottingham team found that, concerning the issue of privacy and data collection, participants in their focus groups were less concerned with the collection of the actual data, which many saw as no different than what they already do online. They were much more concerned with how the companies that collect the data might sell that data and to whom. Governmental regulation was seen as the participants' answer to this issue of privacy and data collection. They felt that there should be informed how their data is used (Rodden et al., 2013).

There are broad social and personal implications of the implementation of sustainable innovations ranging from data collection to personal comfort and ease of use. The attitudes of the people possibly play a larger role than the technology itself.

2.15 Attitudes Toward Smart Technologies

Attitudes towards smart technologies in general, and smart thermostats in particular are complex. They include both concerns and considerations of benefits.

2.15.1 Concerns Involving Smart Technologies

The topic of smart technology applied to heating carries with it concerns. Aside from the possible security concerns previously mentioned, the implementation of smart thermostats and

smart energy management systems introduce privacy and social strains that are unique to new heat management systems.

One study conducted by a group looking to improve home heating by automating the thermostat programming process found that even though many of the newer thermostats with programable features are being underutilized. The article goes on to state that, according to the US Environmental Protection Agency, residents with programmable thermostats are not using the programmable features in 30% or more of the US households with such devices installed (Scott et al., 2011). This brings to light one important concern to be addressed; though the technology exists and may be deployed in different households there is a difference between *installing* the hardware and *using* the hardware. Landlords or tenants may install a smart boiler control but if they do not program it properly then they may never see a reduction in either heating cost or CO_2 emissions.

A study from Carnegie Mellon University concerning smart grids and smart electrical metering hardware, brought to light the difference between consumer perception and designed product functionality. The study found that most of their respondents were in favor of installing smart meters. However, this desire tended to be based on erroneous beliefs about the features of these smart meters. For example, it found that people thought smart meters were designed to control energy use, when in fact, they simply monitor that use (Krishnamurti et al., 2012). This type of misconception about the exact purpose of various smart technologies could then lead to dissatisfaction when the devices do not function as the consumer anticipates.

In the modern era privacy is a key topic of discussion. More importantly the thoughts and feelings of people regarding the interrelation of the topics of privacy, smart technology, and sensors involved is a complex and critical point of conversation. An illustration of this is a technology, currently under development, that utilizes five bi-directional air pressure sensors to determine the different pressure changes in the houseto identify where and when occupants are moving around the space (Ding, Cooper, Pasquina, & Fici-Pasquina, 2011). This level of possible monitoring has the potential to influence consumers' views of smart technology and the issues it presents concerning privacy.

With any smart technology the device observes the environment and reacts as it is programmed to react. While this has the potential to develop into efficient and sustainable heating systems, it also carries with it a sense of being watched. Having a home that is monitoring and learning residents' behaviors is beneficial from a sustainability standpoint, due to the potential for an increase in efficiency and the ability to micromanage the system. However to many residents, the loss of privacy in one's own home may not outweigh the benefits.

2.15.2 Benefits Involving Smart Technologies

One study, done specifically with the Nest, found that participants found the Nest to be "more enjoyable to use" when compared to the preexisting thermostat which it replaced (Yang & Newman, 2013). The team, from the University of Michigan, proposed that this was largely derived from the

industrial looking design and the thermostat's interactive nature as well as the ability to use a web-based application to control it. Subjects enjoyed the device's ability to interact with them when they walked past. It acted as a reminder which kept the participants engaged and actively thinking about their energy use (Yang & Newman, 2013).

The team conducting the study also found that participants in their study enjoyed using the Energy History feature of the Nest because it helped them to "remain engaged and make informed decisions" (Yang & Newman, 2013). One of the participants in Yang and Newman's study stated that:

> "It kind of keeps me engaged on it. I think the engaging process of the machine is probably part of the reason why the energy savings come in because you pay more attention to it and you make sure it's running properly." (Yang & Newman, 2013).

The level of interaction that these devices provide helps to keep the homeowner mindful of their managing their heat.

3 Methodology

Our team sought to investigate how the complicated social and technical factors may affect the implementation of smart technology to reduce heat consumption in student-rented houses in multiple occupation, at the University of Worcester. We surveyed students to evaluate:

- Student energy attitudes and behaviors in student-rented HMOs
- The potential acceptance and effectiveness of smart heating technologies in student-rented HMOs

In this chapter we describe the approach we developed to gather and analyze input from student tenants to examine the possible impacts of the implementation of smart technology.

3.1 Evaluate Student Energy Attitudes and Behaviors in Student-Rented HMOs

We set out to learn about students' current attitudes and behaviors regarding heat consumption in their off-campus housing. Our background research indicated that student-rented HMOs have complications regarding how heat is consumed. These complications included the 'split incentive', fuel poverty, and the displacement theory. It was important for us to establish how these dynamics affected students living in off-campus properties around the University of Worcester. This was in order to gain a better understanding of how useful smart heating controls could be at improving sustainability in student-rented HMOs. The goal was to learn how students share responsibility for energy consumption. In order to assess what motivated student behaviors towards energy we had to understand how students felt about general heat use in their homes. We used the following research questions to establish our information needs:

- How do students control their heat?
- Do student tenants minimize their energy use?
- Do student tenants track the energy consumption of their rented home?
- Do student tenants communicate with their landlord about the energy consumption of the home?
- How useful would a smart domestic control system be to a student tenant in regards to sharing responsibility for energy consumption and conservation?

Through our data collection of student accounts, we were able to evaluate how student tenants may share responsibility for heat consumption with their landlords. The data collected provided insight into how helpful smart technology may be in reducing energy consumption in student-rented HMOs.

A survey provided by our project sponsors, Director of Sustainability Katy Boom and Professor Carolyn Roberts, was used to help answer our research questions. Prior to surveying, our team signed survey safety guidelines (Appendix E) to comply with the Ethics and Research Governance Committee of the University of Worcester. The survey (Appendix B) was conducted by going door-to-door to student HMOs in groups of either two or three. We were given a sub-set of student properties from a master list that the University of Worcester compiled.

The surveys were conducted long-form interview style and generally lasted 20 to 40 minutes depending on the student's willingness to elaborate and level of interest in the subject matter. Survey Guidelines (Appendix D) were developed to ensure that the surveys were delivered in a manner that was as uniform as possible. In total we visited 131 homes around the University of Worcester St John's and City campuses and received at least one response from 32 of the homes visited. A map of the area we surveyed can be seen in Figure 3.1. Before conducing the survey, students were asked to sign a consent form (Appendix F). The student and interviewer (a member of our team) signed two copies of the form. One copy was left with the participant, and the other was collected as a record of the participant's consent. Signed forms were given to Director Boom.

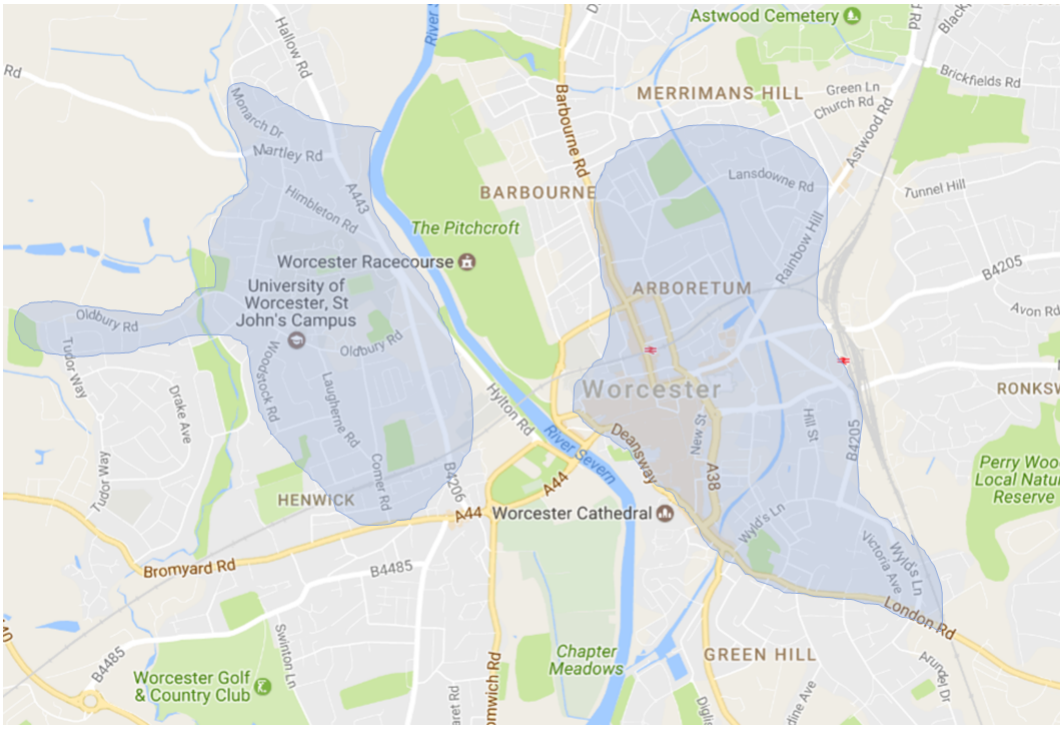

Figure 3.1: *Map of Area Surveyed*

From those 32 properties, our team conducted 39 in-home surveys. A group of University of Worcester students were conducting the same survey in conjunction with us. They conducted 80 additional surveys by the date of this publication, which will be analyzed by the UK Energize Worcester team after the completion of this project.

A major challenge our team encountered was getting students to participate in the survey. During the period in which we conducted our survey, many students were doing final assignments for classes and were unwilling unable to devote any time to a survey. Of the 64 properties where a student answered the door, 32 of them were unwilling to devote the necessary 30 minutes to the survey. Sometimes people agreed to take the survey until they were told the time it would take which led them to decline. We also encountered the issue that a lot of students were not interested at all in the survey and immediately declined. This situation created a voluntary response bias. Students who were willing to take a survey about energy attitudes might have been more sustainability-minded than students who were unwilling to take the survey. Because of this factor, our results could be less representative of the student population than they would be otherwise. Additionally, the list of student homes was, in some cases, outdated and we had a few interactions with tenants who were not students. A breakdown of responses we received from the 131 homes visited can be seen in Figure 3.2

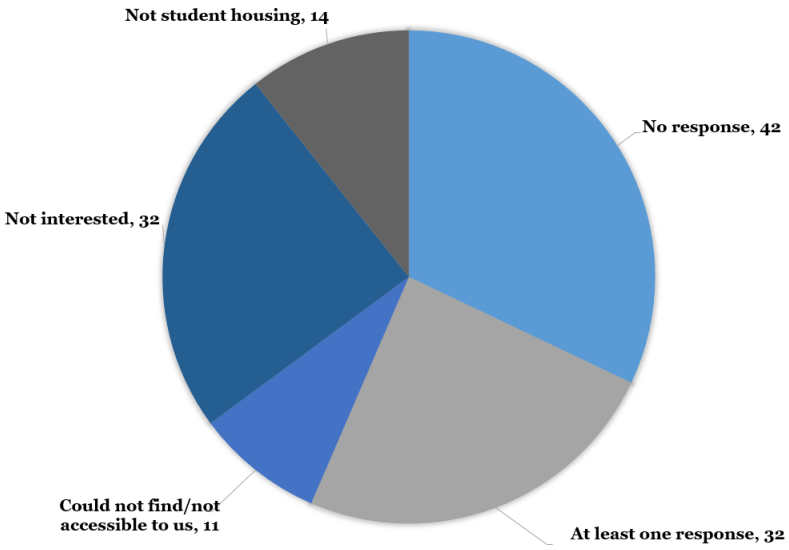

Figure 3.2: *Responses Received from In-Home Student Survey*

In addition to student nonresponse, our survey was limited because the list of properties in our sponsor's database did not include all off-campus student housing. Furthermore, we had no way of knowing what student properties were excluded from the list. While we were surveying, we were asked to look for obvious signs of shared student living (e.g. ground floor bedrooms, stacks of beer cans in the windows, etc...) to help add known student properties to the database.

Not being able to survey every tenant in the home was another limitation we encountered.

Generally we tried to interview as many tenants in the house as possible. Often though, only one tenant was available at the time. If one response was given, we generally did not return to the property, which eliminated possible respondents, and important points of view from other tenants. Since we went in pairs only two surveys could be conducted at a time.

3.2 Evaluate Acceptance and Effectiveness of Smart Heating Technologies in Student Rented HMOs

An important idea we needed to consider in order to move forward with our project was the effect a smart thermostat or other heating device could have if they were to be implemented in a student-rented HMO. Our team needed to assess the level of acceptance by students of these devices. We then needed to understand how effective these devices would be if they were implemented in a student HMO. From our background research, studies found these devices could often increase the amount of energy used. We needed to evaluate whether or not this would be the case for off-campus student housing. Our research questions were as follows:

- Would smart heating controls be accepted in student rented HMOs?
- Would smart heating control features be utilized in student rented HMOs?
- Who would have control of the smart thermostat in a student HMO?
- Would students be concerned about privacy?

To help answer these research questions, we conducted a survey on the University of Worcester campus in the dining hall, as well as around other housing when convenient. Additionally, if the 20-40 minutes in-home survey was too long for students, some agreed to take the shorter smart technology survey. Survey guidelines (Appendix D) were developed to ensure that the surveys were delivered in a manner that was as uniform as possible. In total, we conducted 52 surveys.

A discussion with the accommodations department allowed us to better understand the involvement of the university in certain tenant/landlord relationships. We also conducted an interview with Richard Forrester, an engineer at Worcester Bosch, to understand how their device functions and learn more about the case study they have partnered with Energize Worcester to complete.

Our research prior to our data collection revealed that people had many reservations about smart heating controls. Issues with the functionality as well privacy concerns were brought to our attention. We quickly realized that many students were uninformed about smart heating controls so our team needed to be careful to not lead them in a specific direction with our questions. We had to make sure that the focus of our smart technology survey was not on just the negatives and concerns of these devices but also what had the potential to be useful to these students.

The primary limitation of this smart technology survey was the sample. We did not have the resources to survey a random sample of the desired population (the entire University of Worcester student body). The sample surveyed was ultimately a convenience sample, constructed from the students found in the canteen, and other nearby students. The lack of a random sample is apparent in that first-year students were overrepresented in this survey. With the information available to us, it is difficult to speculate further on any effects of this besides simply noting it reduces validity.

4 Findings

By analyzing the data gathered from the student surveys in conjunction with our background research and interviews, we observed the following findings regarding smart heating controls in student-rented apartments and the attitudes surrounding their implementation.

4.1 Fuel Poverty is not apparent among students surveyed at the University of Worcester

Of the 39 student surveys we conducted, 36 had gas and electricity included. This typically correlated with the students not knowing their monthly expenditure on energy. Only two students surveyed gave a definitive quantitative answer for this question. The large majority of students questioned did not find the energy cost of their home expensive. However it is important to note that the possible reason behind this statistic is that students were unaware of how much they were spending on gas and energy bills. We concluded from the surveys conducted that students who did not know how much they spent on heat generally assumed it was not expensive revealing a gap in education and communication.

A majority of students (24 of 39 surveyed) were sufficiently warm in common living areas. However, 22 respondents reported that they were not comfortably warm in their individual bedrooms. When a student felt uncomfortably cold in their home a common solution found was to turn the heat up. 54% of students surveyed revealed that they simply turned up the heat where only 15% chose to either go to another place or ignore it and suffer in silence. Furthermore, we found that of the students who would not turn up the heat, many did not even know how to adjust their thermostat.

Fuel poverty was defined in our our literature review as a relatively low income home that can not be heated to a comfortable temperature for a reasonable cost. Because these concerns about cost and comfort were not present in most students, we found that fuel poverty is not apparent among the surveyed students

The previous year's Energize Worcester team produced different results, stating that they found fuel poverty to be present among students surveyed. Of the students who could control their thermostat, 66% monitored the heat for the sole purpose of saving money and at least 60% of the 40 respondents could identify one or more cold zone in their homes. It is important to also note that 20% of those students paid for their own utilities. As mentioned earlier, the ability to see their energy bills may have made the students more conscious of how much energy they were using. Our team has found a link between fuel poverty presence and whether or not utilities are included. If students

are paying for their own utilities, there is a higher likelihood that their home can be identified to be in fuel poverty. Students who are not paying for their bills separately, may be unaware that their energy is expensive and therefore not consider themselves in fuel poverty. During an informal interview with the University of Worcester accommodations department, they revealed a probable reason behind this. There is an excess of properties available for students to rent. As a result, within recent years, landlords have had to include utilities to make their properties competitive. There was a significant decrease in students paying separately for utilities from last year to the present, possibly due to this change in the housing market. In conclusion, among students surveyed, we found fuel poverty was not apparent. However, this does not mean it does not exist and should not be considered for future work.

4.2 Communication between students and landlords on energy issues appears incomplete

All ten landlords interviewed by Carolyn Roberts said they explained the heating system to their student tenants. However, as can be seen in Figure 4.1, 28% of the students we surveyed (a different population) said the landlord had not explained the heating system arrangements to them either verbally or in writing. As we found it common for students to either not know or not be confident in how to use their heating system, it is especially important that the information be expressed to them. As the person who owns the system, the landlord is perfectly positioned to express this information. The students' perspective indicates a lack of communication with their landlords.

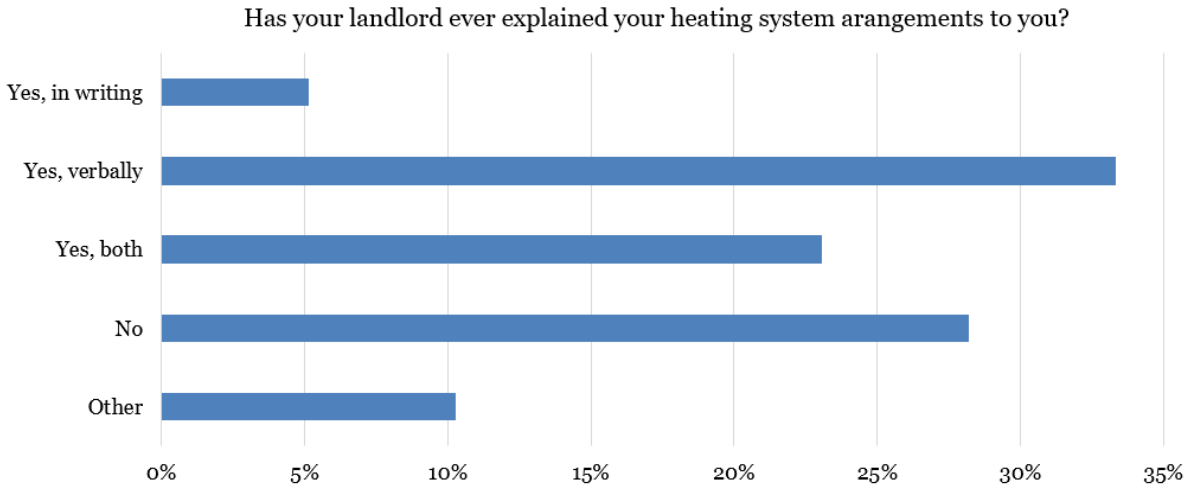

Figure 4.1: *Responses to the question: "Has your landlord ever explained your heating system arrangements to you?"*

When students were asked to rate where they obtained a current, trusted understanding of energy issues from 1-10 (where 10 is a major source of information), 60% of students rated their

landlord either 1 or 2. This low ranking demonstrates that from their perspective students in general feel disconnected from their landlords with regards to energy issues. Because of the 'split incentive' the landlord-student dynamic may play a critical role in making these student-rented HMOs more sustainable. Insufficient communication between student-tenants and their landlord may affect the potential adoption of a smart heating control in a student rented property.

One of the students we met while doing in-home surveys gave a particularly illustrative example of the importance of student-landlord communication. He mentioned he was vegan for the sake of the environment, and tried to be energy conscious by adopting behaviors such as turning off unused lights. However, when asked what the most challenging aspect of managing his house's energy use, he commented that the heating system seems to come on and off at random times. Sometimes it is too hot, sometimes too cold, making a poor arrangement for both heating and comfort. The student further explained that he thought the thermostat was on a timer, but wasn't certain. When asked about his control over the thermostat, he responded that he thinks he can change it but never tried. In his case, the landlord explained the heating system arrangements verbally, but was not particularly clear. This example demonstrates a student who would like to be more energy efficient, but is missing critical information and so is being neither efficient, nor even comfortable. With improved communication, the landlord may be able to provide this information.

4.3 Students appear to not be sufficiently motivated to reduce energy consumption

Based on the in-home student survey conducted, we found that students are not sufficiently motivated by environmental impact or cost to reduce their energy consumption, even though they have the opportunity and capability to adjust their heat. Students often instead placed the responsibilty on others, which is indicative of the displacement theory we considered in our literature review.

Of the 39 students surveyed, 51.3% did not make any conscious attempts to reduce energy consumption in their homes since they began the tenancy. Of the 20 students who did make conscious attempts to reduce their energy consumption, only 8 mentioned heating as a way they try to reduce energy. These results suggest that reducing their impact on the environment (particularly through changing heat consumption behaviors) is not a major focus for many students. Of the 39 students surveyed, 41% had not had any discussions among the house's tenants about the controls of the heating in their home. Additionally, 38.5% of students rarely or never turn the heating down or off if they leave the property for several days. Many landlords from the interviews conducted by Professor Carolyn Roberts reported that heat management among tenants was one of the more difficult aspects to manage in their homes. Furthermore, they reported that students were often forgetful, or did not care to turn down heat. From these landlords perspective, few students think consciously about the impact their heat consumption has on environment.

The students surveyed did not find the energy cost of their house expensive, so it appears that they do not have monetary motivation to reduce their energy consumption. Of the respondents, 38.5% do not have a ceiling charge on the utility bills, or do not know if there is a ceiling charge on the utility bills. Of the 61.5% that do have a ceiling charge, none of them have ever reached it. Since most students who have utilities included don't see the bill, the split incentive becomes challenging. Students may lack sufficient motivation because they are not responsible for paying the heating bills, especially in first year student homes leased by the university. The University, as mentioned in Appendix G, pays £10 a week for electric and gas to landlords to cover energy charges of students and will go no higher. This could mean that if students are using excess energy there is often little repercussions for exceeding energy use and therefore a lack of motivation to make conscious attempts to reduce it.

Students' apparent unwillingness to alter the temperature in their homes appears to not be due to accessibility or restrictions of the actual thermostats. Of the 39 respondents, 37 (94.9%) reported that their thermostat was easily visible. Of these 37, 31 reported not adjusting their thermostat, adjusting it rarely, or were unsure of how often it was adjusted. Most respondents reported that the tenants were in control of the heating in their house. Despite this level of control, 17 people responded that they did not make conscious attempts to be more sustainable. We found that 47.5 % of respondents reported never turning the heating off or down when leaving for extended periods of time. These statistics suggest that there may be a lack of motivation among many students to physically adjust their heat. In general, students are not limited by their device nor their landlord so more factors must be at play.

When asked what their typical response would be when a student was cold in their house, 21 out of 39 respondents said that they would turn up the heating. Through conversation and questions about how the students decide on a temperature to keep the house at, we found that the majority of students surveyed just go by feeling, turning the temperature up when they are cold and down when they are hot. These results suggest that even though students have the ability to control the heat, they will routinely choose comfort over energy conservation. Comfort may be one of the primary reasons students lack the motivation to be more energy conscious. This could possibly stem from the lack of information available to the students regarding their energy use, because the majority of students reported not looking at their energy use on a monthly or more frequent basis.

Displacement theory in regards to sustainability, as mentioned in our literature review, is present when a student does not believe that it is their responsibility to fix sustainability issues and that someone else should be held accountable for it. When asked what the most difficult part of managing energy in their home was, a number of respondents said getting their roommates to turn down heat or turn off the lights. When asked if they personally needed more information on managing energy in their homes, only 51.3% responded affirmatively. However when asked if their fellow tenants needed more training, 66.6% of students responded yes. These results suggest evidence of the displacement theory since the students surveyed often placed responsibility on other

occupants. Students may not be motivated to reduce energy waste if they do not view the responsibility as their own.

A number of factors may contribute to why students appear to lack the motivation to reduce their energy use. From our research, we concluded that it does not appear to be due to monetary or environmental factors. It instead may be a result of students' lack of education on the subject and the choice of comfort over the environment. some students surveyed appear more willing to place responsibility on others instead of making more choices to be energy conscious. Whatever the reason, a motivator for students to be more sustainable is lacking from the situation.

4.4 Some features offered by smart heating controls may not be useful in student rented HMOs

Smart heating controls offer a wide variety of features that propose to improve sustainability in homes. However, from our research and data collection, we have concluded that these smart controls may not improve sustainability in student-rented HMOs. When our team interviewed Worcester Bosch they informed us that their device, the Wave, was not designed for use in HMOs, but rather for single family homes. A reason we have concluded these devices do not meet their full potential is that multiple student schedules in a single home strain the device's ability to interpret the data and function appropriately.

Multi-zonal heating may be one of the more useful features of smart heating controls since it allows for rooms of a home to be heated individually. Looking at the data collected from the in-home student survey, the majority of homes had around 4 or 5 bedrooms in the property, and only 1 or 2 other public spaces. In a discussion with Professor Roberts, she indicated that the reason may be that many public rooms were converted into bedrooms in order for landlords to house more students (and thus increase profit). However, this creates a problem because these rooms may not be insulated as well as normal bedrooms and therefore can lose heat more quickly. When interviewing students using the in-home student survey, some respondents expressed that some bedrooms were either much colder or much warmer than others due to location or lack of insulation. For example, one student expressed that because her room had a large window, it was often colder than the rest of the home. Although zonal heating may be a useful feature to have in student HMOs, many of these homes already have radiator valves which allow for rooms to be heated individually. At least 63% of respondents had multiple radiator valves along with a single central thermostat in their homes. Multi-zonal heating would be one of the more useful features in student HMOs. However, many of their homes already have a system in place.

What makes a smart thermostat 'smart' is its adaptive technology, which generates a schedule based on when occupants are adjusting their heat. This feature is often the main selling point of many devices; however, our team found that it may not be useful in student HMOs. These households usually have upwards of four or five tenants, all on varying schedules that change

biannually. From our research we concluded that this could create possible problems for a smart heating device. In the case studies mentioned in the background, the devices often took every adjustment on the thermostat into account when generating a schedule, even if the change was not part of the occupant's ordinary daily routine. This may cause a problem among tenants because there could be more than six people altering the device. The device does not understand the motivation behind temperature inputs making it highly probable that the schedule generated for students would be suboptimal. While conducting our survey, we learned that many students did not adjust their heat because someone was always home. One respondent said that he was unsure when people were going to bed so he chose not to turn down the heat in case someone was still awake. Even if the smart thermostat were to generate a schedule for the household, there is a chance that it would make no difference since someone is always home so the heat would need to be on.

Geo-tracking is when a smart heating control tracks the occupants of a household using the GPS on their phones. The feature enables the home to begin heating when it detects a person's location within a specific range. Because of the various schedules among student tenants, this feature may be useful in HMOs, since the device can read exactly when occupants are in the house. From our interview with Worcester Bosch we learned that their device, the Wave, does not detect a phone when an inhabitant is beyond 50 meters of the house. By the time a person is typically in range, the home does not have enough time to heat up. As a result, this feature is often ignored. From the behavioral trends observed in our survey results, it is possible that students would also ignore this feature.

From studies mentioned in the literature review, the ability to control the device using an app on a smartphone or tablet was found to be most useful. However in our interview with Bosch, Richard Forrester confirmed that this feature may cause even more energy to be wasted, especially in homes with many tenants since the heat is so accessible to everyone. The few respondents to our in-home student survey who already had a smart heating thermostat in their homes reported having connectivity issues with the devices. One student reported that their Nest kept disconnecting from the Wi-Fi. Typically the landlord controlled the heat at this property, but because the device was not working, the students were put in charge. The respondent explained that this created a problem, since no one in the house was trained in using a smart thermostat.

Smart heating controls offer a variety of features aimed at reducing energy waste. Our study found that these features may not be as useful in student rented homes in multiple occupation. Student schedules as well as the number of students in a household may severely affect how these devices perform and may end up using more energy than intended.

4.5 Students appear to like the concept of smart heating technologies; however, they may not know enough to have strong opinions about them.

From the in-home student survey, as well as our smart tech survey, we set out to determine student attitudes towards smart technology in general. Of the 39 respondents to the in-home survey, every single student ranked their attitudes towards information and communication technology a five or above (scale of 1-10, 10 being I am a keen adopter of new technology). This suggests they would most likely be willing to adopt and learn the features of a smart thermostat. However, there appeared to be a general lack of knowledge expressed by students when the survey was conducted.

One of the primary focuses of our smart technology survey was to determine how students felt about individual features a smart heating control could offer. As expected from our background research, students were most keen on being able to control the device from an app on their phone. The feature students found the least useful was geo-tracking, which received the most low number responses (we asked students to rank usefulness on a scale of 1-5, 5 being highly useful). Despite this, it still received more high rankings than low ones. This shows that among the students we surveyed, the general feelings towards smart thermostat features were positive. When talking with students, many expressed that they knew nothing about the technology. 18 of the 52 surveyed said that a smart thermostat would not affect their decision to rent a property in any way. Students expressed that these devices seem useful to them however they do not have enough information to have a strong feeling. One student expressed that smart thermostats seemed beneficial but they were not a necessity. From our survey we saw that students generally don't feel strongly about these devices but do see the potential with adopting one in their homes.

4.6 Privacy appears not to be a large concern of students regarding smart heating controls

Based on the results of our shorter survey, what we designated the "Smart Tech" survey, it appears that students are not incredibly concerned about privacy violation in relation to smart heating controls. Of the 52 students surveyed 100% responded that they would be okay with their landlord seeing the temperature they have their heat set at. Most of the comments made by respondents were that it did not seem like a big deal. Notably, one student said that it was "a bit weird" but that they ultimately would be fine with it.

When asked if they would be okay with the landlord seeing when they had been 66.67% of students responded in the affirmative. The general consensus of the group that said they would be okay with it was that they saw no issue and thought that it should be fine. The comments from the students that replied no felt that the landlord did not need to know that level of information. Many stated that they felt that it was an invasion of privacy.

The students were then asked if they felt that it was okay for the landlords to remotely set the temperature in the houses. Only 18.37% of students responded with a yes. The students that said yes all shared similar comments that dealt with the fact that the house did belong to the landlord and that their landlord would either not care or was a friendly person. Among the majority of students who replied that they were not okay with their landlord remotely, many felt that since the landlord did not live at the property they should not have a voice in the temperature of the house.

When the topic of complete landlord control was discussed 91.67% reported that they would not be okay with their landlord having complete control over the heating of their apartment. Only 3 students responded that they would be okay with it. Of those 3; one said that "at the end of the day it was still the [landlord's] house", one stated that they did not have a preference, and one said that they (the student) currently did not have much control anyway so it would not be much different. Those that reported not being okay with complete landlord control cited reasons ranging from"just no" to "because I am paying the bill". Students explained that, again, their major concern was that the landlords did not live at the property and therefore should not have a say in what the temperature is set at.

As we found from our short Smart Tech survey, privacy appears to not be an issue that is on the minds of many students. Students appear not to be bothered by the possibility of smart heating controls invading their privacy. However many students expressed discomfort with the geo-tracking feature some thermostats offer. Even though students did not express major concerns with privacy, it may be that they are unsure of what falls under the scope of privacy. This is seen in their discomfort with the device tracking them even though the majority were okay with their landlord tracking when they're home through the device.

5 Conclusion and Recommendations

5.1 Summary of Key Findings

Our team found that current smart heating controls may not be developed enough to improve sustainability in student rented houses in multiple occupation. From our two surveys as well as an interview conducted at Worcester Bosch we have come to understand that student attitudes and behaviors as well as limitations of the devices in question prevent smart heating controls from being the most effective in reducing energy waste in student off-campus housing. The key findings from our research are as follows:

- Fuel poverty is not apparent among students surveyed at the University of Worcester
- Communication between students and landlords on energy issues appears to be incomplete
- Students appear to not be sufficiently motivated to reduce energy consumption
- Some features offered by smart heating controls may not be useful in student rented HMOs
- Students appear to like the concept of smart heating technologies; however, they may not know enough to have a strong opinion about them.
- Privacy appears not to be a large concern of students regarding smart heating controls

Our team found that fuel poverty was not apparent among the students we surveyed. The majority of students surveyed did not find the cost of their energy bills expensive. However this may have been a result of students not seeing their energy bills. 36 of the 39 students had gas and electricity included and many expressed not seeing their bills as a result. Generally students felt comfortable with the temperature in their homes and had no issues turning up the heating if they were cold. From this data, we concluded that students surveyed are not concerned with cost when heating their homes and do not appear to be living in fuel poverty. We recommend that students energy bills be made available for them to view.

Based on responses from the students that we surveyed and the landlords that Carolyn Roberts surveyed, it appeared that communication between student-tenants and landlords was incomplete. We found it common for the students surveyed to either not know or not be confident in how to use their heating system, and more than a quarter of students surveyed said their landlord had not explained the heating system arrangements to them either verbally or in writing. From this, we concluded that insufficient communication between student-tenants and their landlord may affect

the potential adoption of a smart heating control in a student rented property. We recommend that future projects focus on bettering communication between student-tenants and landlords.

One important finding from our research was that students lack the motivation to improve sustainability in their homes and everyday lives. From case studies brought up in our background, we learned that devices are most effective in reducing energy when a person is willing to change other aspects of their lives to be more sustainable. Often when occupants chose comfort over reducing energy waste they ended up spending more energy than they did before they had a smart thermostat. We know from our research that students primarily adjusted their heat based on comfort and were not particularly inclined to alter it to reduce energy waste. As a result we can conclude that there is a possibility that students with smart heating controls end up using more energy. We recommend looking into a way to motivate students to change their sustainability behaviors.

Smart heating controls offer a variety of features that companies promise will reduce energy waste and save money. However from our data collection we found that many of these features would be less effective in student rented HMOs. This is due to the large number of tenants in each home with schedules that change frequently as well as the lack of motivation found among students. The devices do not understand the motivation behind why a person is altering the heat, and as a result they take every temperature change into consideration when generating a schedule. With so many tenants altering the temperature frequently the device may create a schedule that is not useful to tenants and may not save energy. If students are not willing to be more sustainable they may not use features offered by the devices other than being able to control it from their phone which can increase energy usage. From this our team concluded that these devices may not aid in reducing energy waste in student HMOs. Our team suggests that the University of Worcester start initiatives to better educate students on sustainability and monitoring energy costs in their homes.

Our smart technology survey produced two main findings. The first was that students believe the features could be useful but may not know enough to have a strong opinion. The second finding from our survey is that students are not concerned with privacy but rather not having control over their heat. It is also important to note here that communications between landlords and students are incomplete. From this we concluded that students are not opposed to the idea of smart heating controls, however they may not know or care enough for them to necessarily be effective. Our research also brought into question who would have control of the thermostats. Due to the current lack of communication between landlords and students this question will need to be carefully answered, bearing in mind students' reluctance to relinquish control of the heat. We recommend that future Energize Worcester projects look into improving the relationships among tenants and landlords to overcome this hurdle.

5.2 Recommendations for Student Behavioral Change

Based on the results of our surveys, we have concluded that students are not sufficiently motivated to reduce their energy consumption. An important factor is that most students' energy bills are included with their rent, and additional usage does not increase the students' costs. Because of this, one of the largest motivators driving sustainability changes is absent.

We therefore recommend additional research be conducted to determine what would motivate students to make changes to reduce energy use. Ideas to consider include adding financial incentives and social comparisons. Additionally, we recommend that students be informed of their energy usage in context, perhaps by being shown the bill every month. It will likely be difficult for students to find the motivation to make changes without seeing the actual impact of their efforts.

5.3 Recommendations for Student Education

We found that among the surveyed students knowledge of heating system management was incomplete. Based on the information and comments gathered from our survey, we recommend that future efforts focus on student education.

Students should be taught how to properly and effectively manage the heating systems present in their accommodation. Perhaps this could be done by a discussion with their landlord, in a pamphlet provided to students moving off campus, or possibly in a set of written directions posted by the landlord near the thermostat or boiler. We also recommend that landlords meet with students in person in order to inform and discuss with students their energy usage. Different strategies to lower their consumption may also be touched upon in these meetings. Taking one or a few of these steps may help combat the lack of student understanding in the areas of heat management and system control.

It may also be beneficial for students to be given access to their monthly utility bill so that they can see how much energy they are using. This will allow students to have insight into the effectiveness of their conservation efforts. It could be effective for the university to give a presentation at the beginning of the year outlining ways to manage energy bills. We further recommend that the university look into creating a program to prepare students, while they are still living on campus, so they are ready to move off campus in the following year.

Installing a smart meter with an in-home display may also be beneficial in educating students, as it would allow students to have an easy-to-read breakdown of how much energy they were using throughout the month.

5.4 Recommendations for Future Research

We recommend that future Energize Worcester teams study and research what could motivate students to change their attitudes and behaviors. Our findings showed that students do not currently

appear to be sufficiently motivated to decrease their heat consumption. Further research into energy saving motivators may help better establish what actions could be taken to encourage students to reduce energy consumption in their rented homes.

Additionally, we recommend future Energize Worcester projects look into conducting focus groups where both landlords and students can share their attitudes and behaviors towards heat consumption. Our research and findings showed that there is incomplete communication between students and landlords, so using focus groups to study why that is may provide insight into how both parties could communicate better in order to conserve energy. Focus groups could also be used to further evaluate student and landlord opinions on smart heating controls.

Since we did not gather students' opinions on security, we recommend that future teams evaluate students' knowledge on security in smart heating controls and their opinions on security concerns.

Finally, we recommend that future teams follow-up with the Worcester Bosch case study and continue to evaluate the acceptance and effectiveness of smart heating controls in student-rented HMOs. Our research was not able to study an example of smart controls being in student homes, so the Worcester Bosch case study may provide insight into how students use the smart heating controls in practice rather than in theory.

5.5 Conclusion

Fuel poverty was not apparent among the students we surveyed. The majority of students surveyed did not find the cost of their energy bills expensive. Generally, students felt comfortable with the temperature in their rented homes and were not hesitant to turn up the heating in their homes. From this data we concluded that students are not concerned with the energy costs of their homes and do not appear to be living in fuel poverty.

We found that it was common for students to either not know or to not be confident in the use of their heating system. It is especially important that the information be made available to them. As the person who owns the system, the landlord is well positioned to express this information.

The surveyed students at the University of Worcester did not appear to be significantly motivated by either environmental concerns or cost to reduce their energy consumption. This is despite the fact that they generally have the opportunity and capability to alter their heat. Students instead often placed the responsibility onto others. From our study we concluded that this is not due to monetary or environmental factors. It may instead be a result of the students' lack of education on the subject and the priority of personal comfort.

Our research suggested that these smart controls may not improve sustainability in student-rented HMOs. Smart heating controls offer a variety of features aimed at reducing energy waste. Our study found that some of these features may not be useful in student accommodations. Student schedules, as well as the number of students in a home, may severely affect the performance of these devices, which were designed for single-family households. The reduced performance may

result in the system using more energy than intended.

We looked to determine student attitudes towards smart technology in general. Students appear to be open to learning how to use a new device such as a smart thermostat, suggesting they would most likely be willing to adopt and learn the features of such a device. From our survey we saw that students generally do not feel strongly about these devices but do see the potential of adopting one in their homes.

We found from our smart technology survey that privacy was not an issue with the students we surveyed. However it should be noted that many students were not well informed on the topic or had not thought about it before.

To address these points we suggest work be done in persuading students to change their behaviors regarding sustainable heating and in educating students about their energy use.

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Appendices

Appendix A: Smart Heating Control Comparison Tables

The following tables compare information about smart heating controls. It is meant to provide a basic understanding of the variety of options available and their features

Table A.1: *Smart Temperature Control Logistical Information*

Device	Cost	Compatibility	Installation	Historical Issues
Nest	£199	Gas, Electric, oil boilers (no radiator valves)	£249 (Thermostat + Installation)	Going offline. Not sensing people in the house
Wave	£240	Variety of Bosch Boilers	Varies based on installer	Issues connecting to Wave via mobile
Hive	£199	Gas, LPG, some electric	£249 (Thermostats + installation)	Software glitch which increased temperature in homes
Climote	£299 (£3.20 monthly after first year)	Oil and gas boilers	Includes installation	Service issues across network
Honeywell Evohome	£202	Any wet central heating system	Depends on installer	Won't turn on
Netatmo	£199 (installation included)	Gas, fuel, and wood boiler	Included	Connection problems, stop reporting
Tado	£239 (or £2.82 monthly for the first year £6.99/month thereafter)	Gas and oil boilers, heat pumps	£50	Problems connecting to app
Heat Genius	£249	Gas, oil, biomass boilers, heat pumps	Varies	
Heatmiser Neo	£199 , £265 with heating control	Most boilers		Clock won't show correct time

Data compiled from: "App control for your heating and hot water." 2016, Heatmiser; "Smart thermostats explained: We turn up the heat on nest, hive, tado° and the best of the rest" by Chris Haslam, 2016, Trusted Reviews; "Climote - total control of your home heating." 2016, Climote; "Evohome - Honeywell UK heating controls." 2016, Honeywell heating Controls; "Genius: Remote heating control - heating app." 2016, Genius; "Smart thermostats in the UK: Which one should you pick?" by C. Haslam, 2016; "Nest Learning Thermostat." 2016, Nest; "The Hive." 2017, Hive; "Smart

Table A.2: *Smart Temperature Control Features Comparison*

Device	Multi-zonal	Learning	Motion Detection	Geo-tracking
Nest	Yes - max 10	Yes	Yes	Yes
Wave	No	Yes	No	Yes
Hive	No	No	No	Yes
Climote	Yes - max 3	No	No	No
Honeywell Evohome	Yes - max 12	No	No	No
Netatmo	No	Yes	No	No
Tado	No	Yes	No	Yes
Heat Genius	Yes - Max 30	Yes	Yes	No
Heatmiser Neo	Yes - max 32	Yes	No	No

Device	Weather Responsive	Hot Water Control	App/Web Control	Manual Control
Nest	No	Yes (Heat Link)	Both	Yes
Wave	Yes	Yes	Both	Yes
Hive	No	Yes	Both	Yes
Climote	No	Yes	Both	Yes
Honeywell Evohome	No	Yes	App	Yes
Netatmo	Yes	No	Both	Yes
Tado	Yes	Yes	Yes	Yes
Heat Genius	Yes	No	Yes	Yes
Heatmiser Neo	No	Yes	App	Yes

heating control - tado°.” 2016, tado°.

Appendix B: Questions of the In-home Student Survey - Developed by Project Sponsors Katy Boom and Carolyn Roberts for Energize Worcester

1. Address
2. Number of bedrooms in the property:
3. Number of other rooms (including kitchen, but not bathrooms, hallways and landings, or conservatory)
4. Does the property have double glazing or secondary glazing?
    - Yes
    - No
    - Partial Double or Secondary Glazing
5. General state of repair of the property, excluding decoration (1 very poor- 10 excellent)
6. Has your landlord ever explained your heating system arrangements to you and your housemates verbally or in writing (for example when you moved into the property)?
    - Yes, both verbally and in writing
    - Yes, in writing only
    - Yes, verbally only
    - No
    - Other
7. Does the heating system include:
    - Gas boiler and central heating
    - Electric central heating
    - Other
    - I don't know
    - Other

a. If you selected Other, please specify:

8. Is there a single thermostat, or several?
    - Single
    - Several
    - Other
9. In which room is the thermostat located?
10. Is the thermostat easily visible?
    - Yes
    - No
    - Other
11. Do you personally have the ability to control the temperature set on the thermostat?
    - Yes
    - No
    - I don't know
    - Other
12. If your house has a thermostat, who actually controls the timing and temperature of the heating?
    - You, on behalf of the group of tenants
    - Another of the tenants, on behalf of the group of tenants
    - The Landlord
    - Some or all of the above
    - No one really controls the heating
    - I don't know
    - Other
13. If your house has a thermostat, does someone regularly or frequently adjust the thermostat (say daily, or several times a week) to alter the set temperature?
    - Yes, daily
    - Yes, weekly
    - No

- Other

14. Has your household made any conscious attempts to reduce its energy consumption in the house since you began the tenancy? Say a little more...

15. Does your house have any form of 'smart control' or 'remote control' on the timing and temperature of the heating system? What type of system is it, and how does it work?

16. If you have smart controls, who can theoretically control the heating?

    - You, on behalf of the group of tenants
    - Another of the tenants on behalf of the group of tenants
    - The landlord
    - Some or all of the above
    - I don't know
    - Other

17. If you have smart controls, who actually controls the timing and temperature of the heating?

    - You, on behalf of the group of tenants
    - Another of the tenants on behalf of the group of tenants
    - The landlord
    - Some or all of the above
    - No one really controls the heating
    - I don't know
    - Other

18. In colder months of the year, do you personally find the temperature in your room generally too warm, sufficiently warm, tolerably cold or too cold?

    - Too warm
    - Sufficiently warm
    - Tolerably cold
    - Too cold

19. In colder months of the year, do you personally find the temperature in common living areas generally too warm, sufficiently warm, tolerably cold or too cold?

    - Too warm

- Sufficiently warm
- Tolerably cold
- Too cold

20. Have you ever experienced significant dampness in your house, for example as mould growth on bathroom or kitchen walls?

    - Yes, in bathroom
    - Yes, in kitchen
    - Yes, in my room
    - Yes, in common living areas
    - No

21. Have you had discussions amongst your house's tenants about the control of the heating in your house? Say a little more about this...

22. How do you decide what temperature is appropriate in your house? Say a little more about this...

23. If you personally feel uncomfortably cold in the house, what would your typical response be?

    - Turn up the heating
    - Put on more clothing
    - Go to another place to study or relax (bed, library, gym, pub....)
    - Ignore it, and suffer in silence
    - Other

    a. If you selected Other, please specify:

24. Does your group of tenants turn down the heating, or turn it off if you leave the property for several days, or during a longer holiday?

    - Always
    - Almost always
    - Sometimes
    - Rarely
    - Never

25. Do you find the energy costs of your house expensive? Yes/No

26. Do you usually look at your energy use on a monthly (or more frequent) basis, for example through the meter, or through looking at the bill?

27. What is the most challenging aspect of managing your house's energy use? Please explain. . . ..

28. Have you had any arguments with your landlord about energy use in your house? Say a little more about this. . . .

29. Do you feel that you personally need more information or training about managing energy in your house? Yes/No

30. Do you feel that the other tenants in your house need more information or training about managing energy? Yes/No

31. Have you studied environmental or sustainability issues as part of a school, Further or Higher Education (College or University) course? Please say a little more. . . .

32. How would you rank your own understanding of domestic energy management?

    - 1 – I feel that I know a lot
    - 2 - I know quite a bit
    - 3 - I know a medium amount and am somewhat informed
    - 4 - I don't know much about it
    - 5 - I know nothing about it

    This part of the survey uses a table of questions, viewed here as separate questions?

33. Rank each item in the following list in terms of where you obtain most of your current, trusted understanding of environmental issues, from 1 – nothing, to 10 -major source
    Please don't select more than 1 answer(s) per row.

    - Formal course teaching, including textbooks
    - Friends (face to face)
    - Parents (face to face)
    - Friends or parents online
    - Websites
    - TV and radio
    - Reading books
    - Reading national newspapers (hard copy or online)
    - Reading local newspapers (hard copy or online)

- Landlord (face to face, messages or online)
- By observing University housekeeping practices on campus
- From communications from the NUS
- A workplace or employer
- Other (please specify)

34. Rank each item in the following list in terms of where you obtain most of your current, trusted understanding of energy issues, from 1 – nothing, to 10 -major source
Please don't select more than 1 answer(s) per row.

    - Formal course teaching, including textbooks
    - Friends (face to face)
    - Parents (face to face)
    - Friends or parents online
    - Websites
    - TV and radio
    - Reading books
    - Reading national newspapers (hard copy or online)
    - Reading local newspapers (hard copy or online)
    - Landlord (face to face, messages or online)
    - By observing University housekeeping practices on campus
    - From communications from the NUS
    - A workplace or employer
    - Other (please specify)

35. If you have significant concerns about future sustainability, what is the most important element that you think you personally could influence? Please say a little more...

36. To what extent do you think technological developments may provide some solutions to environmental challenges? (1 – almost none, to 10 – almost complete solutions)?

37. Name of respondent

38. Gender

    - Male
    - Female

- Prefer not to say

39. Email address of respondent
40. Age of respondent
41. Course being followed by respondent
42. Full time or Part time
43. Level of study of respondent
    - Undergraduate I
    - Undergraduate II
    - Undergraduate III
    - Postgraduate taught
    - Research Student
44. Are you a UK national, an EU national, or an overseas student?
45. If you have further relevant information to add please use this box. . . ..
46. How would you describe your attitudes to information and communications technology?
    - 1 – I am uncomfortable or hopeless with new technology
    - 2
    - 3
    - 4
    - 5 - Indifferent
    - 6
    - 7
    - 8
    - 9
    - 10 – I am a keen adopter of new technology
47. Total monthly rental for the whole property
48. Does the rental you personally pay include part or all of utility bills, including:
    - Gas
    - Electricity

- Other fuels
- Water
- Telephone
- Broadband/WiFi
- I don't know

49. If the rental includes only part of the utility bills, or has a ceiling charge on utility bills (e.g. beyond £10 per month, then the tenants must pay excess charges), explain this....

50. What do you estimate is your household's typical monthly expenditure on gas? (If you do not know, please say so)

51. What do you estimate is your household's typical monthly expenditure on electricity? (If you do not know, please say so)

52. During your tenancy, have you ever paid excess energy charges to the landlord?

53. How would you describe your working relationship with your landlord? (1 – Poor, to 10 – excellent)?

54. Please say a little more about your landlord's relationship with your group of tenants....

55. Would the respondent be willing to be interviewed again, in a few month's time? Yes/No

56. Date of interview

    Dates need to be in the format 'DD/MM/YYYY', for example 27/03/1980.

57. Time of completion of interview

    Times need to be in the format 'HH:MM', for example 15:43.

58. Interviewer please use this box to note observations (eg. cold outside, heating at 30, wearing t-shirts & flip flops)

59. Name of interviewer:

Appendix C: Smart Technology Survey - Developed by the Project Team

Energize Worcester: Smart Technology

Q1 Do you live on or off campus?
- ❍ On Campus (1)
- ❍ Off Campus (2)

Q2 What year are you in?
- ❍ Undergraduate I (1)
- ❍ Undergraduate II (2)
- ❍ Undergraduate III (3)
- ❍ Postgraduate Taught (4)
- ❍ Research Student (5)

Q3 For our project, we are defining smart thermostats (heating controls) as technologies that can monitor and adjust the temperature in a house. They tend to be able to be controlled remotely (for example from an app), and can adjust temperatures as needed with and without human input.

Q4 How would the presence of a smart thermostat influence your decision on choosing an apartment to rent? Could you rank your thoughts on a scale (-5 much less likely to rent, 0 no effect, 5 much more likely to rent)?
_____ -5 much less likely, 0 neutral, 5 much more likely. Could you say a little bit more? (1)

Q5 Please rank these features in terms of usefulness to you (1 being not useful 5 being useful):
_____ Ability to heat individual 'zones' of your house (1)
_____ Ability to predict people's behaviors and adapt to them to heat the house accordingly (2)
_____ Ability to detect when people are in the house and heat accordingly (3)
_____ Ability to track individual members using GPS and only heat the house when occupants are home (or heading home) (4)
_____ Ability to monitor the weather outside to adjust inside temperature accordingly (5)
_____ Ability to control the hot water (6)
_____ Ability to control the thermostat from an app (7)

Q6 If additional information about features is given, note it here:

Display This Question:
If Do you live on or off campus? Off Campus Is Selected

Q7 Do you monitor your heating costs/usage?
- ❍ Yes (1)
- ❍ No (2)

Display This Question:
If Do you monitor your heating costs/usage? No Is Selected

Q8 Would you be interested in monitoring your heating cost and/or usage?
- ❍ Yes (1)
- ❍ No (2)

Display This Question:
If Do you live on or off campus? Off Campus Is Selected

Q9 Who pays your heating bill?
- ❍ You or your parents (even if you just pay a portion of the bill) (1)
- ❍ Landlord (rent includes utilities) (2)
- ❍ University (rent is paid to the university) (3)
- ❍ Other occupants (you personally pay nothing for heating) (4)
- ❍ Other (5) _____

Display This Question:
If Do you live on or off campus? Off Campus Is Selected

Q10 How much control do you have over your heat?
- ❍ I can set it however I want (1)
- ❍ I could set it however I want, but I don't know how (2)
- ❍ I can set it, but my landlord has placed physical restrictions on it (3)
- ❍ I can set it, but my landlord has placed contractual restrictions on it (4)
- ❍ I can set it, but I need permission from my landlord (5)
- ❍ I cannot adjust the heat (6)

Display This Question:
If How much control do you have over your heat? I cannot adjust the heat Is Not Selected

Q11 How often does your household adjust the heat?
- ❍ Daily (1)
- ❍ 2-3 Times a week (2)
- ❍ Once a week (3)
- ❍ Never (4)
- ❍ Seasonally (5)
- ❍ Other (6) _____

Q12 Would you be okay with your landlord seeing your thermostat information? (temperature)
- ❍ Yes (1) _____
- ❍ No (4) _____
- ❍ Other (3) _____

Q13 Would you be okay with your landlord being able to see when you have been in the house?
- ❍ Yes (1) _____
- ❍ No (2) _____
- ❍ Other (3) _____

Q14 Would you be okay with your landlord being able to remotely set the temperature in your apartment?
- ❍ Yes (1) _____
- ❍ No (2) _____
- ❍ Other (3) _____

Q15 Would you be okay with your landlord having complete control of the heating?
- ❍ Yes (1) _____
- ❍ No (2) _____
- ❍ Other (3) _____

Q16 Do you have any additional comments on anything we have talked about?

Q17 Interviewer notes:

Appendix D: Survey Guidelines - Developed by the Project Team

This appendix contains two sets of guidelines for surveying. The first set is for the in-home student surveys, and the second is for the smart technology surveys.

Introduction

UK Students:
Hello my name is <name> and this is my partner <name>.We are students from the University of Worcester <show ID> working with the Energize Worcester group. We are conducting a survey to better understand sustainability in off campus student housing. The survey is confidential and will take approximately 30 minutes (If wifi is needed, add: “We are using an online survey that requires internet access. Would you be comfortable entering in your wifi password?”). We would really appreciate it if you and your flatmates would take the time to speak with us.

WPI Students:
Hello my name is <name> and this is my partner <name>. We are american engineering students from Worcester Polytechnic Institute and have partnered up with the Worcester University to better understand sustainability in student housing. The survey is confidential and will take approximately 30 minutes (If wifi is needed, add: “We are using an online survey that requires internet access. Would you be comfortable entering in your wifi password?”). We would really appreciate it if you and your flatmates would take the time to speak with us.

Important Notes:

- Make sure Katy Boom and Mihaela have been emailed before setting out (k.boom@worc.ac.uk, getm_13@uni.worc.ac.uk)
- Do not plan to be out past 7:30 p.m.
- A mobile phone must be carried by at least one partner with Katy Boom’s number (07976932089).
- We can walk around with paper or offline versions of the survey in case students are unwilling/unable to let us use their wifi. The data would then be entered manually into BOS at our earliest convenience
- If you are made uncomfortable by the tenants or do not feel safe, **do not enter the property**
- Be alert in the house - take note of exits, stay in communal areas
- **You may leave the property at any time** if you are uncomfortable.
- Do not make a point of informing the students that they do not have to take the survey if they are not inclined to
    - This creates a voluntary response bias and will skew the data

If response is in the positive:

- Make sure both partners enter the house
- Stay in public rooms (living room, kitchen)
- **First, make sure that two consent forms have be signed by each person interviewed**
    - They keep one copy and the university keeps one copy
    - Explain any questions they may have regarding the form

If response is in the negative:

- Politely request if there is a more convenient time for the tenant(s) (take note if yes) or if there is anyone in the property available
- Kindly thank them for their time and leave - do not be forceful/pushy

When Interviewing:

- Only interview one person at a time each with separate/private conversations to avoid third party input
    - Recommend multiple tablets or computers so that multiple tenants can be interviewed at once
- Casual but professional - avoid personal opinions on the subject
- Do not give details of WPI project before the survey is completed - do not want to influence opinions
- Sit across from the respondent if possible
- Ask the questions as closely as possible to how they were written unless further clarification is requested/needed
- **Do not lead responses** - if a student does not know the answer do not suggest a reasonable one or provide possible examples
    - 'I do not know' or 'I am unsure' are useful and credible responses
    - If the ask for an example, inform them it is okay to be unsure or no know
- **Make sure all questions are filled in** (time and date are important)
    - Every question should be asked

Directions for specific questions where clarification might be needed:

1. Address
    - The entire address should be written, including the postal code

5. General state of repair of the property, excluding decoration (1 very poor- 10 excellent)
    - Is there anything broken that hasn't been fixed?
    - Do things on the property break often?
    - How often does your landlord do repairs?

8. Is there a single thermostat or several?
    - "Do you have radiator controls? How many?"
    - Be specific in what you write down - "They have one central thermostat but at least one radiator control in each bedroom"

11. Do you personally have the ability to control the temperature set on the thermostat?
    - If they need clarification we can ask:
        - "Is it in a cage?"
        - "Is it locked?"

    - “Do you need permission to change the temperature ?”

14. Has your household made any conscious attempts to reduce its energy consumption in the house since you began the tenancy? Say a little more…
- Re-word if necessary ‘Do you do anything to be more green in your home?’

15. Does your house have any form of ‘smart control’ or ‘remote control’ on the timing and temperature of the heating system? What type of system is it, and how does it work?
- If they need clarification you can ask:
    - “Can you control your heating system with an app?”
    - If they don’t know, write “Doesn’t know”

27. What is the most challenging aspect of managing your house's energy?
- Is there anything to do with heating/electricity that you do because you need to, but it gives you trouble every time
- Possible responses
    - drafty/damp house
    - Prices
    - old/faulty devices
    - Tough to deal with landlord
    - Energy cap
    - Multiple tenants fighting over heat

33. Rank each item in the following list in terms of where you obtain most of your current, trusted understanding of environmental issues, from 1 – nothing, to 10 -major source
- It is important to keep this question and its answers different from #34

34. Rank each item in the following list in terms of where you obtain most of your current, trusted understanding of energy issues, from 1 – nothing, to 10 -major source
- It is important to keep this question and its answers different from #33

35. If you have significant concerns about future sustainability, what is the most important element that you think you personally could influence? Please say a little more…
- If they need clarification we can ask:
    - “How can *you* be more green?”

37. Name of respondent
- “Like we talked about when you signed the consent form, your responses will be completely anonymous, and your name will not be used in any of our work.”
- We are asking for this information so that we can contact you again to see if you are willing to partake in the survey again.

47. Total monthly rental for the whole property

- If the respondent does not know, we should put “Doesn’t know” in the text box
- If the respondent makes a guess, we should put “Not sure, guesses <£XX>”

50. What do you estimate is your household’s typical monthly expenditure on gas? (If you do not know, please say so)
- If the respondent does not know, we should put “Doesn’t know” in the text box
- If the respondent makes a guess, we should put “Not sure, guesses <£XX>”

51. What do you estimate is your household’s typical monthly expenditure on electricity? (If you do not know, please say so)
- If the respondent does not know, we should put “Doesn’t know” in the text box
- If the respondent makes a guess, we should put “Not sure, guesses <£XX>”

54. Please say a little more about your landlord’s relationship with your group of tenants….
- Try to probe specifically for any information related to energy use. For example, have the landlords sent them any information, had any meetings with them, etc.
- To coax them, we can use questions such as:
    - “Do you have regular contact with them about energy?”
    - “Do they reach out to you or do you reach out to them?”
    - “How often do they visit?”

55. Would the respondent be willing to be interviewed again, in a few month’s time?
- “This is for future surveying because future Energize Worcester groups would like to see how things change over time.”

<u>When the survey is completed</u>
- Make sure all questions are completed and filled in
- Fill in observations at the end of the survey
- Make sure survey is submitted before exiting so data is not lost
- Make sure to thank the respondent(s) for their time
- Politely exit the house, do not stay longer than necessary

Smart Thermostat Survey Guidelines

Introduction

WPI Students:
Hello my name is <name>, and I am an American engineering student from Worcester Polytechnic Institute, and I have partnered up with the University of Worcester to study smart technologies in student accommodations. Could you spare 5 minutes to fill out a confidential survey?

Important Notes:

- Do not make a point of informing the students that they do not have to take the survey if they are not inclined to
    - This creates a voluntary response bias and will skew the data

When Interviewing:

- Only interview one person at a time each with separate/private conversations to avoid third party input
    - Recommend multiple tablets or computers so that multiple tenants can be interviewed at once
- Casual but professional - avoid personal opinions on the subject
- Ask the questions as closely as possible to how they were written unless further clarification is requested/needed
- **Do not lead responses** - if a student does not know the answer do not suggest a reasonable one or provide possible examples
    - ‘I do not know’ or ‘I am unsure’ are useful and credible responses
    - If the ask for an example, inform them it is okay to be unsure or no know
- Every question should be asked

Directions for specific questions where clarification might be needed:

- Do you monitor your heating costs/usage?
    - Do you look at a bill, or at the meter, or get an email.
- Would you be okay with your landlord seeing your thermostat information? (temperature)
    - Like being able to look on his computer and see what your thermostat is set at, and what it was set at in the past
- Would you be okay with your landlord being able to see when you have been in the house?
    - Like being able to look on his computer and see a graph of times that people are and aren’t home
- Would you be okay with your landlord having complete control of the heating?
    - Like he controls it from an app on his phone, and you can’t turn it up or down if you want to.

When the survey is completed

- Fill in interviewer notes at the end of the survey
- Make sure to thank the respondent(s) for their time
- If you feel that a long-form survey with this individual mi

Appendix E: University of Worcester Survey Safety Guidelines

To comply with the Ethics and Research Governance Committee of the University of Worcester, our team agreed to follow the guidelines as set out in the following document.

Health and Safety for house visits –

Energize Worcester

Before setting off

- **Always go in pairs**
- Make sure you have emailed Katy (k.boom@worc.ac.uk) and Mihaela getm1_13@uni.worc.ac.uk to let us know the time you are setting out, how long you propose to make visits, and which streets you intend to visit. You could also let friends or housemates know where you intend to go.
- **Do not plan to be on visit's after 7:30pm –** However after 5.00 is good time to catch people in.
- Carry a mobile phone and make sure Katy's phone numbers (07976932089) is saved. Ensure your mobile phone is charged, on and accessible. If you are out longer than an hour text or email in to let Katy or Mihaela to know your location.

Visiting student houses

- **NEVER call at a house on your own.** Always **stay together when** in a property.
- If you have any concerns about entering the house, for example, if the occupant appears under the influence of alcoholic or drug or is aggressive, **don't enter the property**. If you suspect the property is not a student house do not enter the property.
- Be alert when entering a strangers' house, make sure you are fully aware of the exits and floor plan and stay in the communal areas of the building. Don't let the client come between you and your exit route if possible.
- If during the meeting the occupant starts to display agitated or aggressive behaviour make excuses and leave.
- Be aware of any potential hazards such as a slip or trip and take action accordingly.
- Get in touch again with either Katy or Matt when you return. Ideally if it's during working hours by calling back into the Sustainability Office to report any findings/debrief.

Instructions for visiting houses

Before setting off

- Ensure you have letter of introduction/authority from University of Worcester
  Carry with you your WPI student ID.
- Ensure you've signed out a tablet, it's got enough charge and it's switched on so your location can be tracked.
- Get student house locations (from Mihaela) you will be visiting and tablet.
- Check the map to give you sufficient time to travel from address to address.

The visit:

- Introduce yourself at very beginning of your conversation: name, course, WPI and that you are volunteering through the project.
- Show Consent Form and get this signed before you start
- Explain the purpose of the calling at the address
- Use tablet to record results of the questionnaire.
- Do note the correct address, street number. It is important for us to verify which student houses are. Look for obvious signs of shared student living, e.g. ground floor bedrooms, stacks of beer cans in the windows.

Appendix F: In-home Student Survey Consent Form

In order to inform participants of the in-home student surveys exactly how the collected data would be used, we employed this form. For each survey participant, two identical forms were signed by both the student and the interviewer. A copy was left with the participant, and the other was collected as a record of the participant's consent. Completed forms were collected by Katy Boom.

Energize Worcester – Phase 2

Researchers – Professor Carolyn Roberts, Gresham Professor of Environment; Katy Boom, Director of Sustainability, University of Worcester, Henwick Grove, Worcester WR2 2AJ. k.boom@worc.ac.uk 01905 855243. This study follows the principles of the University of Worcester ethical guidelines, but is being undertaken by Worcester Students' Union.

Information to potential participants of this study

You are being invited to take part in a research study, which will help you to manage your expenditure on domestic energy, and be more comfortable in your rented accommodation. Your participation will also assist the researchers, and help the University to maintain its position is a leader in sustainable practice in the UK. We would be very grateful for your assistance, but before you decide whether to help, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

This research is being undertaken to understand the role of technological innovation (smart boiler controls, other apps) to manage and control domestic heating, by developing new opportunities for energy management. The study involves both young people living in shared rental property, and the landlords of these homes. Pilot work has already been undertaken in 2015 and 2016. This new phase of the study will be conducted in semesters 1 and 2 this academic year, and most work will be complete by June 2017. Participation would not be time consuming for you. Focus group and short interviews, or on-line surveys, often undertaken by other students, will be arranged at convenient times. The research is being undertaken in conjunction with a group of landlords in Worcester, and with Worcester Bosch, who make boilers and control systems. A small number of student rental properties will also have new boilers and state-of-the art remote control systems installed this winter, which will offer tenants additional controls on comfort and expenditure.

Your participation in this study will help us examine how temperatures are set in houses, what arrangements are considered optimal by groups of tenants, and how responsibility for energy consumption and conservation is shared between occupants and landlords. Information from this research, anonymised, may be used in conference presentations and/or in publicised research papers. *It is up to you to decide whether or not to take part.* If you do decide to take part you will be asked to sign the consent form on the reverse of this information. You would still be free to withdraw at any time and without giving a reason. Choosing either to take part or not take part in the study will have no impact on your housing arrangements or your university studies.

All information collected about you will be kept strictly confidential. The information is not highly sensitive however, data on line will be stored in a password protected UW server, and hard copies kept securely in a locked office. Data will be destroyed after 3 years. A random generated code will be used, quotes will be anonymized.

Thank you for taking the time to read this information, and the questions overleaf.

Energize Worcester – Phase 2

		Please Initial Box
1.	I confirm that I have read and understand the information for the above study and have had the opportunity to ask questions.	☐
2.	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.	☐
3.	I agree to take part in the above study.	☐
4.	I agree to the interview / focus group / consultation being audio recorded	☐
5.	I agree to the use of anonymised quotes in publications	☐

Name of Participant	Date	Signature
Researcher	Date	Signature

Appendix G: Contracts for University Managed Houses

This appendix contains two contracts. The first, Agreement for Letting Furnished Houses, is between the University of Worcester and the landlord of the property. The second contract, Licensed Agreement for University Managed Accommodation, is between the University of Worcester and the student renting the property.

University of Worcester

Agreement for Letting Furnished Houses

Date: 13th February 2017

Landlord's Name:

Landlord's Address:

Tenant: **UNIVERSITY OF WORCESTER** (the University)

Tenants Address: Henwick Grove, Worcester. WR2 6AJ

Premises Let:

("Premises") together with the fixtures fittings and contents as set out in the Inventory which will be provided to the University by the Landlord prior to the Term Commencement Date ("Contents") which shall include such fixtures fittings and contents as are set out in the Furnishings List (attached).

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Term means the period of weeks from the Term Commencement Date to the expiry of this Agreement

Term Commencement Date: 9th September 2017

Term Expiry Date: 13th July 2018

Occupiers Students of the University duly selected by the University to occupy the Premises subject to the terms of this Agreement

Termination rights: As set out at clause 4(a)

The University's acceptance of the terms of this Agreement is conditional on the following

Property	Room No	Weekly Rent per room*	Weekly Rent (minus 10%)	Income (per room, over 44 wks)
Total (over 44 weeks)				

The University will reimburse you for the payment of gas and electricity on the basis of £10.00 per week per student, for the duration of the Term. This is a flat rate and no adjustments will be made. The University will consider (in its reasonable discretion) reimbursing for exceptional levels of gas or electricity consumption where you can provide evidence to our reasonable satisfaction that this consumption exceeds the weekly cost of £10.00 per student and that it is caused by the actions of the student not the condition of your property.

The above is payable in three equal instalments, by BAC's transfer with the first payment being received by the end of October. Payments will be made into your nominated bank account, and each payment will comprise Rent and utilities.

1. The Landlord agrees to let to the University the Premises at the Rent and for the period stated above

2. The University agrees
   a) to pay the Rent as stated above. If the payment is late, the Landlord is entitled to claim the relevant interest at 4% above the Bank of England base rate.
   b) To collect a deposit from each student to hold as security against damage for the duration of the term. The University agrees to hold these deposits in accordance with current legislation.
   c) not to use the Premises except as a residential dwelling house to be occupied by existing or prospective full time students of the University, and not to exceed the maximum number of occupants permitted to live in the Premises by the Landlords insurance and/or HMO Licence.
   d) not to assign this tenancy, sub-let or part with possession of all or any part of the Premises except to existing or prospective students of the University who shall be the "Occupiers" for the purposes of this Agreement
   e) not to allow anyone else to live at the Premises except for the Occupiers,
   f) to return the Premises at the end of the term in as good a condition as at the Term Commencement Date, as evidenced by the attached Schedule of Condition, and subject to fair wear and tear. The majority of keys will be available to the Landlord by 12 noon on the final day of the tenancy, however the University may need to retain 1 set of keys beyond the expiry of the Term to carry out a deep clean of the Premises and to fulfil its obligations under this Agreement and in such circumstances the Landlords gives the University a licence to this effect.
   g) not to intentionally cause damage to the Premises or its Contents
   h) not to make any additions or alterations to the Premises or its Contents without the Landlord's prior consent in writing, which should not be reasonably withheld or delayed.
   i) not to remove any of the Contents from the Premises, except in situations where an item is damaged, or where an item is deemed to be dangerous.
   j) not knowingly to do anything which may invalidate or increase the premium payable in respect of any insurance of the Premises
   k) not to cause a nuisance or annoyance to the Landlord or any occupiers of neighbouring or adjoining Premises
   l) to meet the cost of reasonable and necessary expenses incurred by the Landlord as a result of any breach by the University of the terms of this Agreement (provided the Landlord has mitigated its losses as far as reasonably practicable)
   m) not to allow any pet or domestic animal to be kept on the Premises
   n) to allow the Landlord and/or the Landlord's properly authorised agent at any reasonable time after 10:00am, and with a minimum of 7 days' notice (save in the case of emergency) access for the following purposes:
      (i) to inspect the Premises and Contents

(ii) to carry out remedial and improvement works as is required from time to time, and at the request of the University. Access will not be granted for planned major repair works as these are not permitted during the term of this agreement
(iii) to carry out testing of the Fire Alarm System in accordance with the terms and conditions set out in the Premises HMO Licence.

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o) to require all Occupiers to keep the landing, hallway, stairs and other communal passageways clear from obstruction at all times. Landlord agrees to allow 48 hours for remedy of this situation unless this is causing a serious health and safety issue.

p) to give vacant possession of the Premises at the expiry or sooner determination of the Term.

q) not to use appliances provided in the Premises if they have been declared broken or unsafe to use

r) to pay the Landlord for the reasonable cost of replacing the locks and cutting new keys if any keys are not returned to the Landlord when the Occupier moves out.

s) to report maintenance issues to the Landlord in a timely manner.

t) not to keep, use or permit to be used any oil stove, paraffin heater or other portable fuel burning appliance, or other appliance against the terms of the insurance of the Premises, except as provided by the Landlord.

u) to pay for any sterilisation and cleansing of the Premises made necessary under the Public Health (Control of Diseases) Act 1984 as a result of a person with a Notifiable Disease having been in the Premises during the Term and pay for any reasonable costs, fair wear and tear excepted, of redecoration or replacement required as a result of the work carried out.

v) to check the inventory and report any errors/deficiencies to the Landlord, returning a copy with any annotations/corrections as necessary within 14 days.

w) not to alter the operation of, or disable, the smoke alarms.

x) not to disable or alter the operation or code of any burglar alarm.

3. The Landlord agrees

a) to allow the University to access the Premises upon reasonable notice prior to the commencement of the tenancy for the purpose of showing the Premises to prospective Occupiers

b) to allow the University access to the Premises to undertake inspections prior to letting it out to Occupiers.

c) i) to keep the Premises insured against fire, storm, material damage and such other risks as the University may from time to time require and including third party liability
(ii) to insure the Contents for a reasonable amount that covers the replacement in the event of a claim. It is understood that the Landlord is NOT responsible for insuring the contents belonging to the Occupiers.
(iii) to pay any excess due under the Landlord's insurance policy.

The Landlord also agrees to provide written evidence of the same on request.

d) that provided the University pays the Rent and performs its obligations under this agreement, the University will hold the Premises without interruption by the Landlord or any persons claiming under or in trust for the Landlord

e) to keep the Premises, the roof, main walls and structure and the installations in the Premises for, water , electricity and gas supply in good repair. To maintain the external grounds for the duration of the Agreement. To carry out any

works to the standard and timescale as agreed between both parties, as set out in the Service Level Agreement.

f) that if the tenancy is ended by notice or surrender, to repay to the University the appropriate proportion of any Rent paid in advance

g) that if the Premises constitutes a house in multiple occupation ("HMO") as defined in the most recent published Housing Act

(i) if and for as long as the Premises must be licensed as an HMO, to apply for and obtain the requisite licence and to conduct all works to the Premises and take all actions which may be necessary in order to obtain and retain such licence, and to provide written evidence of the same.

h) (i) to ensure the Premises and the Contents comply at all times with every order, regulation, byelaw, licence, statutory and other legal requirements relating to the Premises, the Contents and/or their use.

i) that the University may disclose to public utilities the name and address of the Landlord for the purposes of facilitating payment of outstanding accounts. To immediately inform the University and if required to do so pass to the University copies of any notices, orders, directions and other documents received which relate to the Premises and/or its use.

j) (i) to provide the University with copies of the following certificates by no later than 7th August 2017. Please be aware that the University will not send out reminders.

- Copy of the current Gas Safety Certificate. If the annual gas service is due for renewal during the period of this agreement, the Landlord agrees to have this work carried out before the current certificate expires, and to forward this within 7 days to the University.
- HMO Licence
- Alarm System/Emergency Lighting Annual Safety Check
- Fire Extinguisher Annual Safety Check.
- PAT test all electrical equipment in situ at the premises belonging to the Landlord.
- Copy of a valid NICEIC safety certificate confirming that the electrical wiring systems in the Premises has been checked and serviced **within the last 5 years**. The University also requires confirmation that all portable electrical appliances provided in the Premises e.g. fridge, vacuum cleaner etc., have been tested within the last 12 months.

(ii) to provide the University with two sets of keys for the Premises for each Occupier (Student Sets), and one additional full set for the Premises for the University (Master Set) by no later than 14th August 2017

iii) until such time as the Landlord has complied with clause 3 j then no Rent shall be payable by the University.

k) To promptly and efficiently carry out accommodation management

l) To deal with the provision of information as requested by the University and deal promptly and efficiently with maintenance requests, queries and complaints

m) To provide and maintain reasonable laundry facilities

n) To provide business grade **fibre** broadband service with unlimited internet usage, wireless router which has provision for wired connections and a service provider that offers 24/7 technical support for end users.

o) The provision of furnished bedrooms in accordance with the attached furnishings list.

p) To provide soft furnishings which are fire retardant to level 5.

q) To carry out testing of the Fire Alarm System in accordance with the terms and conditions set out in the HMO Licence for the Premises.

4. The parties agree that:

a) This Agreement may be terminated prior to the Term Expiry Date in the following circumstances:

(i) should the Landlord dispose of its interest in the Property to a third party, the Agreement may be terminated either by the Landlord giving three months' notice or by the University giving one months' notice;
(ii) if the Rent is more than three months in arrears and provided that the Landlord is not in breach of the Agreement, the Landlord reserves the right to end this Agreement on one months' notice and resume possession of the Premises;
(iii) should either party be in material breach of the terms of this Agreement, the other party may give one months' notice of termination;

and this Agreement shall determine on the expiry of any notice served by either party pursuant to the terms of this Agreement but without prejudice to the rights and remedies of either party in respect of any breach committed by the other.

b) the Contracts (Rights of Third Parties) Act 1999 shall not apply to this Agreement
c) if, after having been given reasonable notice of any defect or want of repair, which (except in the case of emergency) shall mean in accordance with the Service Level Agreement, the Landlord fails to remedy any defect or want of repair in the Premises for which they are responsible, the University may carry out those works and recover the costs (together with any administrative costs incurred by the University and any compensation paid by the University to the Occupiers) from the Landlord and the University may deduct these amounts from the Rent
d) where works are required as a case of emergency, the University will take reasonable steps to contact the Landlord and/or their nominated contractors. If the Landlord cannot be contacted or the Landlord refuses to or does not carry out the necessary repairs immediately, the University may carry out the works required and recover the cost of the works together with any administrative costs incurred by the University and any sums paid out by way of compensation to the Occupiers from the Landlord and the University may deduct these amounts from the Rent
e) it is the responsibility of the Landlord to ensure that the limit on their insurance cover for the Contents is sufficient to cover the value of the Contents and the cost of reinstating them and if not to arrange additional cover as required by clause 3 c)(ii) at his own expense
f) This agreement is personal to the parties and shall not be transferable in any way.
g) This agreement is governed by English law
h) Notices given under this Agreement shall be served by hand or first class post to the addresses given at the start of this Agreement, and in the University's case, marked for the attention of the Director of Estates.

This offer is held open for your consideration until 25th February 2017. Any acceptance after this date may be subject to alteration of the original offer.

Signed by the Landlord: Signature:..... Print Name:

in the presence of:	Signature:..... Print Name:.....
Witness address:	……
Signed on behalf of the University of Worcester	Signature:..... Print Name:
in the presence of:	Signature:..... Print Name

Furnishings List

Study Bedrooms

- ☐ Bed + Mattress
- ☐ Wardrobe
- ☐ Desk
- ☐ Ergonomic Desk Chair
- ☐ Task Lighting
- ☐ Bin
- ☐ Storage & Shelves
- ☐ Curtains/ blinds
- ☐ Mirror
- ☐ Minimum of 4 electric points
- ☐ Noticeboard
- ☐ Radiator

Security

- ☐ All study bedrooms lockable (thumb turn euro cylinder)
- ☐ All windows should be lockable (particularly those at ground floor level)
- ☐ All doors should be secure. Front door should be able to be opened from the inside, without the use of a key (e.g Yale lock).

Kitchen

(Furniture & appliances to be appropriate for the number of occupants residing in the Premises)

- ☐ Dining Table & Chairs
- ☐ Oven & Hob
- ☐ Fridge
- ☐ Freezer
- ☐ Cupboard Storage (at least 1 cupboard per resident)
- ☐ Microwave
- ☐ Toaster
- ☐ Kettle
- ☐ Washing Machine

Misc

- ☐ Iron & Ironing Board
- ☐ Vacuum

- ☐ Dustpan & Brush
- ☐ Mop & Bucket
- ☐ Broom

Lounge

- ☐ Comfortable seating (sufficient for the number of occupants residing in the Premises)
- ☐ TV Ariel socket
- ☐ Radiator

Minimum Lettable Standard

- ☐ Single study bedroom to be at least 6.52 m²
- ☐ Single study bedrooms and communal areas to be furnished in accordance with the Furnishings List (attached)
- ☐ Premises to be thoroughly cleaned prior to handover. Any property left behind by the previous occupants to be removed.
- ☐ Décor to be neutral and of a good standard.
- ☐ Grounds to the front and rear of the Premises to be well maintained and litter free.
- ☐ Any obvious maintenance issues (or previously identified issues) to be resolved.
- ☐ Heating systems tested to ensure that they are in good working order, and offer a good distribution of heat within rooms.
- ☐ Any evidence of damp/condensation to be investigated, and appropriate action taken.
- ☐ Gas and electrical installations certified as safe by suitably qualified persons.

University of Worcester

Service Level Agreement

Emergency Repairs

Emergency repairs are those required in order to avoid danger to health, risk to the safety of residents or serious damage to the buildings or residents' belongings. **These repairs should be completed within 24 hours or made safe until a permanent repair is possible.**

eg, faulty gas appliances, no hot water, broken WC, faulty external door locks, broken cooker.

Urgent Repairs

Urgent repairs are those defects that materially affect the comfort or convenience of the residents **These repairs should be completed within 7 days.**

eg, leaking roofs, minor mice infestation or minor cracks in windows, replacement white goods

Non-Urgent Repairs

Repairs that are not covered by either of the above two categories. **These repairs should be completed within 28 days.**

eg, blocked guttering

Landlords Undertaking

In the unlikely event that the Landlord is unable to respond within the required timeframes, the Landlord undertakes to notify the University within 24 hours and accepts that in the interests of the Occupiers the University may carry out the required repairs, either using its own or sub-contracted labour. In this instance the University will arrange repairs and either charge the Landlord directly or subtract the amount from the next payment due. In addition, the University will charge an administrative fee of not less than £50.

During normal office hours, you can inform the University of an unresolved maintenance issue at your Premises by telephoning 01905 855300, or by emailing accommodation@worc.ac.uk. Outside of these hours, you should contact the University's Main Reception on 01905 855000 (manned 24/7).

University Undertaking

The University will act as the first point of contact for students reporting maintenance issues, and we will undertake to report these to you in a timely manner, and usually within normal working hours. We will only contact you outside of these hours in the event of an emergency.

University of Worcester

Keys Required

- Master Set – 1 Set Required
  (A master set being a key for each external door – normally front and back door, a key for each internal door – bedroom keys, together with window keys and gate keys if applicable)

- Student Sets – 2 Sets Required
  (A student set being a room key specific to their room, a front door key, a back door key, and a window and gate key if applicable)

If one window key fits all window locks, then we are happy for a couple of these to be left at the Premises, rather than attached to the student sets. The same applies to gate keys. The only thing that we would ask is that if they are left in the Premises, they are attached to large key fobs (to deter Occupiers from taking them out of the Premises), and also that they are labelled clearly.

LICENCE AGREEMENT FOR UNIVERSITY MANAGED ACCOMMODATION <SA:AcademicYear>

This agreement is between The University of Worcester and <SD:Forename> <SD:Surname>

<SD:CurrentAddress1>
<SD:CurrentAddress2>
<SD:CurrentAddress3>
<SD:CurrentAddress4>
<SD:CurrentAddress5>

Tel No:	<SD:Telephone>
Mobile No:	<SD:Mobile>
E-Mail:	<SD:PreferredEmail>
Hall:	<SA:SubblockName> <SA:BlockName>
Room:	<SA:RoomName>
Licence Period:	**From <SA:LicenceStart> until <SA:LicenceEnd> <sa:TermBreakText>**
Total Licence Fee:	<SA:LicenceTotal>
Damage Deposit:	£300.00 (refundable providing all rent is paid and no damage charges incurred.)

It is important to read and understand the attached Terms and Conditions before you sign this agreement.

Declaration:
I hereby agree to be a student residing in University Managed Accommodation at the University of Worcester for the Academic Year <SA:AcademicYear> subject to the terms and conditions of the Licence Agreement attached. In particular:-

1. I confirm that I will be a full time student in <SA:AcademicYear> and that part time students are not eligible for accommodation. If I become part time at any point during the Licence Period, I agree to notify the Accommodation Department immediately.
2. That only in certain circumstances will I be released from the Licence before the end of the Academic Year (clause 9.1)
3. I agree to abide by the terms and conditions of the Licence Agreement.
4. I agree to abide by The University of Worcester IT regulations

Signed: Date:

Print Name: <SD:Forename> <SD:Surname> Student ID: <SD:StudentID> Signed on behalf of

The University of Worcester <US:FullName> Date:<DATE>

Terms and Conditions of the Licence for Accommodation at The University of Worcester

Please note you must read this document and sign it to confirm you understand and accept the conditions set out below.

1. **Student undertaking**

1.1 Acceptance of an offer of a place in University Managed Accommodation is also acceptance of the Terms and Conditions of Residence currently in force

1.2 This Licence regulates the relationship between the University and Students who are residing in its accommodation.

2. **Definitions**:-

"the Student"	shall mean the Student (whose name and address are set out in the Licence Agreement for University Managed Accommodation), who is enrolled and in attendance on a full-time programme of study at the University and who has been offered and has accepted a place in its accommodation;
"the University"	shall mean at The University of Worcester or subsequent title;
" University Managed Accommodation"	shall mean the residences available for occupation by students and in which the Rooms are situated;
"*the Common Areas*"	shall mean all the parts of the accommodation which are not rooms and include kitchen areas, shared bathrooms, lounges and toilets;
"*the Deposit*"	shall mean a sum payable by the Student to the University on acceptance by the Student of the University's offer of a place in University Managed Accommodation. Such sum will be determined by the University annually and notified to the Student when the offer of a place is made. The terms on which the Deposit is held are set out in clause 4.2
"*the Licence Fee*"	shall mean the fee for the Room as determined by the University prior to the Licence Period and shall be notified to the Student;
"the Licence Period"	shall comprise one period, the dates of which shall be published on the University's Accommodation notice board prior to the commencement of each academic year;
"the Room"	shall mean part of the University Managed Accommodation which is occupied by the Student as an individual private study bedroom;
"the Licence"	shall mean this Licence Agreement for accommodation in University Managed Accommodation and these Terms and Conditions;
"Child"	shall mean a person under 18 years.
"UMH"	UMH (University Managed House) Property owned by a third party which is leased to the University for the purpose of residential letting for students. **Please Note: The term UMH will be used through this agreement to define differing Terms and conditions relating to these properties.**

Terms and Conditions of Residence

3. **Occupancy**

3.1 Subject to the Student remaining a registered full-time student of, and attending, the University, paying the Accommodation Fee and complying with this Licence, the University gives the Student the right to use the Room as a private study bedroom**.** No commercial activity, business, trade or profession shall be carried out either from the Room or any part of the University Managed Accommodation. Nothing in this Licence shall be interpreted as creating a relationship of landlord and tenant between the University and the Student.

Note: The Licence is for the duration of the Licence Period. Accordingly, the Student remains responsible for payment of the Licence Fee until the end of the Licence Period, even when the Licence is terminated prematurely, unless otherwise provided for in the Licence

The University will not give any student a Licence to occupy a Room as a Student if any part of the Licence Fee from the previous Licence Period is still outstanding

3.2 This Licence is personal to the Student. As a consequence, the Student is not permitted to transfer the rights under the Licence to any other person or otherwise permit any other person to occupy the Room, except as provided for in clause 3.7 below (overnight guests). **Note:** breach of this clause is regarded as a serious breach of the Student's obligations which may result in the termination of this Licence

3.3 The Student is required to vacate their room by midday on the day of departure.

3.4 Where the Student signs the Licence without face-to-face contact with a member of the Accommodation Office staff (i.e. at home), a 5 day 'cooling off' period will apply. If the Student changes their mind within 5 working days of moving in to University Managed Accommodation, they will be released from the Licence with no financial penalties. Notification must be in writing to the Accommodation office.

3.5 This Licence does not refer to any specific University Managed Accommodation or Room. The University reserves the right to transfer a Student's occupation to a different Room on reasonable written notice. Where the University unreasonably exercises this right and the Student does not wish to change rooms, the Student may terminate this Licence and should inform the University accordingly in writing within 10 days of date of the University's notice. The University will reimburse to the Student the balance of the current period of the Licence Fee and any other sums that are properly due. Students on contracts longer than the standard 39 weeks, will normally be asked to move to alternative University Managed Accommodation at the end of UMS semester 2 (normally early June)

3.6 1.1 In exceptional circumstances, the Accommodation Office will consider the Student's request to change Rooms during the Licence Period. Such requests will be considered on their merits, and in the light of the availability of alternative Rooms and the practical and financial implications for the University of granting such consent. Any change in occupation is subject to clauses 4.4

3.7 Where a Student occupies a Room as a single, private study room, he/she is permitted to have one overnight guest in the Room, ***for no more than two nights in any one week****,* provided that the Student:

3.7.1 signs his/her guest in by emailing accommodation@worc.ac.uk.

3.7.2 ensures that his/her guest is aged 18 or over.

3.7.3 ensures that his/her guest complies with the fire safety procedures and insofar as is reasonably practicable, with the health, safety and conduct provisions of this Licence. The student will be held responsible for any failure on the part of his/her guest(s) to comply with such procedures.

3.7.4 Where a student occupies a twin/shared study room overnight guests are not permitted.

3.8 While the University will endeavour to respect the Student's right to privacy, it reserves the right:

3.8.1 for authorised personnel on reasonable notice to enter the Room at any time to inspect its condition, to carry out such repair works as the University thinks necessary, to serve a notice to vacate the Room in accordance with the termination provisions and for other appropriate purposes which in the reasonable opinion of the University require entry to the Room, emergency access will granted without notice in emergency situations

3.8.2 to prohibit visitors at any time if necessary in the interests of security and/or the health and safety of other residents and for such other purposes as the University reasonably decides requires the prohibition of visitors

3.8.3 to use portable and fixed surveillance equipment for the purposes of crime prevention, health, safety and wellbeing and for the detection of anti-social behaviour, where it is felt by the University that such use will assist in the apprehension of offenders. Personal information and images captured through this equipment shall not be used for any other purpose other than for which they were intended.

3.9 The Licence does not confer any right to car-parking facilities at the University or to the Accommodation or any other University premises.

4. **Charges**

4.1 The Licence Fee is payable upon signing this Licence. The University is prepared however, to accept payment by instalments in recognition of the dates upon which the Student will receive payments from the Student Loans Company. A Deposit of £300 is payable on electronically signing the Licence Agreement. You will be asked to indicate how you wish to pay.

Note: If the Student fails to pay the full amount or the full instalment of the Licence Fee as relevant on the due date, the University may terminate this Licence by serving on the Student a notice to vacate the Room. If the Student fails to vacate the Room within the time required by the notice, the University may apply to the Court for an Order to evict the Student from the Room

If the Student is experiencing difficulties in paying the Licence Fee instalments by the due dates, he or she should contact the Finance Office prior to the date for payment

4.2 The University shall hold the Deposit during the Licence Period as security for performance of the Student's obligations and against damage to the Room and the Common Areas or anti-social behaviour within the Room and the Common Areas. The Student will not receive interest on the Deposit. Subject to the deduction of any payments, charges and outstanding amounts payable under this Licence Agreement, the Deposit will be repaid to the Student as soon as is reasonably practicable following the end of the Licence Period or earlier termination of this Licence. If the outstanding amounts payable by the Student to the University under this Licence exceed the value of the deposit (the shortfall), then the Student will be liable to pay the shortfall within 14 days of receipt of an invoice from the University specifying the shortfall.

4.3 If damage is caused to the Common Areas, or to any fire safety equipment located there, the Student shall, together with all other occupants of the flat or corridor or residence where the damage has occurred, account to the University for the cost of remedying the damage as reasonably determined by the University. A minimum administrative fee of £25 per person will also be charged.

Note: When living in University Managed Accommodation, the Student forms part of a community of students for the period of the Licence. Like any other community, it depends on each and every member playing a part in ensuring its safe and efficient running. Where safety and efficiency are compromised and costs are incurred by the University as a result of damage to the Common Areas, or to any fire safety equipment located there, it will be necessary to pass the reasonable cost of repair and/or cleaning onto the Student and to other student occupiers of accommodation collectively and in equal amounts. The provision is also necessary to deter an increase in accommodation fees to meet such costs. The communal damage charge will only be

imposed, where, after reasonable investigation, the person or persons responsible for the damage cannot be identified

The Student may appeal in writing against the imposition by the University of the cost of the damage in relation to clause 4.3 to the Student Behaviour Review Board within 5 working days of the date of the notice of the charge. The decision of the Registrar shall be issued to the Student within 5 working days of receipt of the appeal.

A separate invoice will be raised in respect of communal damage and the Student shall pay the charges within 30 days of the date of the invoice. Where the Student appeals against the imposition of the charge and the appeal is unsuccessful or the charge has been varied as a result of the appeal, payment should be made within 5 working days of the date of the notice of the outcome of the appeal. **Where the Student fails to make the payment within the relevant time limit, the charge shall be deducted from the Deposit on the expiry of the relevant period.**

4.4 A fee of £60.00 will be charged to a Student who requests and is permitted to change Rooms during the Licence Period in accordance with clause 3.6

4.5 A proportionate reduction in the Licence Fee will be made for a Student who accepts an offer to occupy a Room after the beginning of the Licence Period. The Student will pay the remainder of the current instalment and other subsequent instalments of the Licence Fee as required by clause 4.1

4.6 No refund of the Licence Fee will be made on termination of the Licence for any reason, at any time in the Licence Period except as indicated at clauses 4.6.1, a 28 day notice period will apply to any termination of the Licence

4.6.1 Where a Student who wishes to vacate the Room continues to be a student at the University and either the Student or the University, using reasonable endeavours, finds a replacement Student (who is not already occupying a University residence place), the University will as soon as reasonable practicable repay to the Student the balance of the Licence Fee for which the replacement Sudent becomes responsible.

4.7 The Student accepts responsibility for all keys and access cards that they have been issued under this agreement for the duration of the Licence Period. Where a Student loses their key, the University will charge the Student a standard administration cost of £25 plus £25 per key and £25 per card should there be a need to change the lock a further £110.00 will apply. Repeat offenders will be referred to the Student Behaviour Review Board. Students are forbidden from lending their key to anyone else.

4.8 An administration charge of £25.00 plus a minimum charge of £15.00 per hour is made for additional cleaning of the Room and/or common areas where in the reasonable opinion of the University the Student fails to maintain reasonable standards of cleanliness and tidiness.

4.9 The student accepts responsibility for the condition of their Room for the duration of their Licence Period. The University publication 'Moving Out' details the procedure to be followed when vacating University Managed Accommodation, and also provides a list of charges which may be applied to a Students account, should any damage be caused to the Room or Common Areas.

5. **Vacation Periods**

5.1 The Student is entitled to use the Room during the Christmas and Easter vacations if those periods are included within the student's letting period.

6. **Conduct, health and safety**

The Student will not do anything that may prejudice good estate management and the smooth running and efficiency of the University and will:

6.1 abide by the Conditions of Residence contained in this Licence.

6.2 comply with the University Health & Safety Policy and fire safety guidance and regulations and:

6.2.1 not bring into or use within the University Managed Accommodation, or any other University building, any unlawful drugs or other such controlled substances. This extends to the use of 'legal highs' which are not permitted and may result in the University Managed accommodation being withdrawn.

6.2.2 not bring into or use within University Managed Accommodation, or any other University building, any naked flames, candles or portable gas equipment

6.2.3 not allow any Child to stay overnight within University Managed Accommodation without prior consent of the Residential Services Manager.

6.2.4 not bring into University Managed Accommodation anything which in the University's opinion is or may become dangerous, offensive, combustible, corrosive, inflammable, radioactive or explosive including, but not limited to, firearms, air rifles, pistols, cross-bows, swords, non-domestic knives or any other weapons, camping gas cylinders, oil burners and laser pens

6.2.5 not bring into, or store in the Room, corridors, kitchens or common areas, any items of furniture other than those provided by the University.

6.2.6 not replace soft furnishings provided by the University with their own, this includes mattresses and curtains.

6.2.7 not bring into, or store in the Room, corridors, kitchens and other Common Areas, fire escape routes or exits any bicycle or similar item which may cause an obstruction

6.2.8 not sleep or allow any of their guests to sleep in common areas within University Managed Accommodation, or in any external spaces on the campus.

6.2.9 not interfere with any door (by wedging open), fire alarm, smoke detector or fire exit or other fire safety mechanism or device in University Managed Accommodation. Breach of this may lead to disciplinary action and/or criminal prosecution

6.2.10 not interfere with any electrical installation in University Managed Accommodation and shall not use any form of radiant fires, heaters, fridges (unless supplied for the storage of medicines), cooking equipment, kettles and/or irons in the Room

6.2.11 not cook in the Room

6.2.12 not climb onto the roofs of, or into the roof spaces within University Managed Accommodation, as these are highly susceptible to damage and involve costly repairs. It is dangerous and may result in injury or death

6.2.13 not use barbeques within, or in the immediate vicinity, of University Managed Accommodation. Barbeques should only be used in the designated areas.

6.2.14 ensure that the electrical appliances which are used by the Student in University Managed Accommodation but which are not provided by the University are safe, paying particular attention to the fuse and wiring. The Student must ensure that any portable electric appliance that they choose to bring with them to the University has been PAT tested.

6.2.15 follow guidelines for the prompt evacuation of any area of University Managed Accommodation in the event of a fire alarm. This information is located in each bedroom. Failure to comply with these guidelines may lead to disciplinary action.

6.2.16 report within a reasonable time any hazards/deficiencies in the residential arrangements to the Accommodation Office or the University's Security Staff

6.3 The University may in its absolute discretion enter the Room and confiscate any article which in its reasonable opinion presents a risk to the health and safety of other residents and /or staff of

the University and should not be within the Room. The article will then either be handed over to the police or retained by the University, at the Student's reasonable expense, until collected by the Student and removed from University grounds. If at the end of the Licence Period the article has still not been collected by the Student, the University will give the Student 28 days' notice to retrieve the article and if unclaimed after such period the University reserves the right to dispose of it. The reasonable disposal costs incurred by the University shall be reclaimed from the Deposit

6.4 In the interests of the well-being of fellow residents, the Student shall not engage in anti-social behaviour within University Managed Accommodation. In particular the Student shall:

6.4.1 not impede University staff in the performance of their duties and comply with reasonable instructions issued by a University Manager and any other staff or persons acting on behalf of the University

6.4.2 behave in a considerate manner towards staff and fellow residents and will not create or allow to be created noise that may cause nuisance or annoyance to others at any time, and in particular between 11:00 p.m. and 8:00 a.m. and at all times during revision and examination periods

6.4.3 not throw any object however small, including food and litter, out of any window

6.4.4 not cause damage, annoyance or nuisance to other residents or staff in University Managed Accommodation, or to occupants of neighbouring properties

6.4.5 not keep pets in the Rooms or elsewhere in University Managed Accommodation. This provision does not apply to registered assistance or guide dogs

6.4.6 not affix notices, pictures, or posters or anything else to the walls and doors of the Room with sellotape, blu-tac, adhesives or drawing pins or in any other way which may cause damage to the wallpaper, plaster work, woodwork or furniture

6.4.7 not make changes to the decoration anywhere within University Managed Accommodation.

6.4.8 not affix notices, posters or pictures in any part of the Common Areas of the accommodation other than on the pin boards provided

6.4.9 not smoke anywhere within University Managed Accommodation, or any other University building, or within 5 metres of any University building.

6.4.10 not make the Common Areas dirty and untidy and, in particular, ensure that kitchen equipment including cooking utensils, crockery and cutlery is washed and put away promptly after use. Spillage in fridges and cookers must be cleaned up immediately. Waste and re-cycling bins must be emptied regularly.

The University is committed to increasing its recycling rate and labelled bags/ bins are provided in the kitchens areas for the recycling of plastic bottles, all cans, paper and light card. The Green bags should be used for all the recyclables and the Black bags are for all other rubbish. Students are responsible for regularly emptying the Green and Black bags into the appropriate Green and Black eurobins provided adjacent to the halls of residence.

6.4.11 not use chip pans, rice cookers anywhere in the University Managed Accommodation , including the kitchens

6.4.12 refrain from any behaviour which may be perceived as harassment or annoyance to other residents on any basis and in particular on grounds of gender, nationality, race, disability, religion or belief or sexual orientation

6.4.13 not display on windows, within the Room, or in any other prominent place within University Managed Accommodation posters, advertisements, images or text which in the reasonable opinion of the University could be construed as offensiveto other students, members of staff or members of the general public.

7. **Breaches of Conditions**

7.1 Breaches of these conditions will result in a written warning and a charge where appropriate. More serious or repeat breaches of these conditions will be dealt with by referral to the Student Behaviour Review Board, which shall have the power either to impose fines and a range of other sanctions. A tariff of fines and other sanctions for each academic session will be posted in all University owned and managed accommodation at the start of each session.

Note: Breach or breaches of these conditions may also be dealt with under the Student Code of Conduct, a copy of which may be found on the University website.

7.2 Any Fines remaining unpaid at the end of the Licence Agreement will be deducted from the Deposit.

8. **Responsibilities of the University**

8.1 The University shall provide in respect of the accommodation: -

8.1.1 adequate furniture and fittings

Halls of Residence

8.1.2. lighting, water and heating without further charge (but the University does not accept any liability for interruptions to these services unless such interruption is as a result of the negligence of the University)

Note: Residents of UMH's will be required to pay for Gas and Electricity in addition to their basic rent.

8.1.3 reasonable toilet and laundering facilities

Halls of Residence

8.1.4. cleaned accommodation on occupation, kitchen and multi-use bathrooms/WC's. These areas will be cleaned on a regular basis

Note: Residents of UMH's will have cleaned accommodation at initial occupation but no further cleaning will be carried out by the University for the duration of the licence.

9. **Termination**

9.1 This Licence may be terminated by the Student:

9.1.1. if the University is in serious breach of its obligations under this Licence. In these circumstances, the University will reimburse the Student the balance of the current period of the Licence Fee and any other sums which are properly due to the Student, or;

9.1.2. if the Student withdraws from the University in the course of the Licence Period, provided the Student supplies the Accommodation Office with written confirmation of withdrawal from Registry, before departure. If such confirmation of withdrawal is given the University will as soon as reasonably practicable reimburse to the Student the balance of the current period of the Licence Fee and any other sums which are properly due. Unless such confirmation of withdrawal is given the Student remains responsible for the remainder of the current instalment of the Licence Fee and any other sums due under this Licence but not for any subsequent instalments of the Licence Fee; Where the Student has paid the full Licence Fee the balance from the date of withdrawal shall be repaid to the Student.

9.1.3. in accordance with clause 3.4

9.2. This Licence may be terminated by the University, in the event of:

9.2.1. serious breach by the Student of these Conditions of Residence

Note: if the breach is also an offence under the Student Code of Conduct, disciplinary action under the Code may also be invoked.

9.2.2. the Student having failed to pay when due all or any part of the Licence Fee to the University

Note (1): The Student will not be permitted to remain in a Room at the beginning of a new semester if any part of the Licence Fee which is due for payment is still outstanding

Note (2): **By exercising its right to terminate this Licence for non-payment of some or all of the Licence Fee, the University is not prevented from exercising any other right or remedy available to it. For example, the University may seek to recover from the Student any outstanding payments in addition to terminating the Licence**

9.2.3. the Student no longer being an enrolled student at the University

9.2.4. A decision to terminate the Licence under above clause shall only be made by the Director of Estates and Facilities or any other member of the Board of Executive Management after a meeting has been called to consider all relevant facts. At the meeting you will be afforded the opportunity of knowing what is alleged against you and making such reply as you may wish. You may be accompanied at the meeting by a student colleague, or a Student's Union representative. You shall have the right to appeal to the Registrar

The appeal must be made, in writing, to the Registrar or Nominee giving full supporting evidence within five working days of the date the decision was notified to you by the Director of Estates and Facilities. The University however reserves the right to invoke the University's Disciplinary procedures as an alternative to the procedure set out in this clause where the alleged serious breach of the Licence is also a serious breach of the Student Code of Conduct.

9.3 Upon termination, the Student will vacate the Room and remove all personal belongings from the Room and Common Areas. Failure to remove all belongings will entitle the University to:

9.3.1. remove belongings from the Room and/or the Common Areas and place them in storage. The University will give to the Student 28 days notice to retrieve the belongings and if unclaimed after such period the University reserves the right to dispose of them. Perishable items will be disposed of immediately. The reasonable disposal and/or storage costs incurred by the University shall be reclaimed from the Deposit or from the Student.

9.3.2. charge the Student the current conference room rate for each extra day in residence. If the Student fails to return their key at the end of the Licence Period, the University will replace both the lock and the key and invoice the Student £135.00.

10. **Responsibilities of the Student**

10.1 During his or her occupation under this Licence the Student is responsible for:

10.1.1 the tidiness and cleanliness of the Room at all times On departure, the Student shall leave the Room and the Common Areas in a clean and tidy condition. Breach of this condition may incur a charge under clause 4.8

10.1.2. damage to the Room and to University property in the Room and in the Common Areas (jointly with other residents sharing them), including to fire safety equipment

10.1.3. the behaviour of visitors who are in University Managed Accommodation at his or her invitation

10.1.4 Students of UMH's shall also be responsible for the up keep and tidiness of all garden frontage and other external areas of the property.

11. **Personal Property**

11.1 Except in cases of the University's negligence, the University will not be liable for the loss of, or damage to, personal property in the Halls of Residence

March 2015

Appendix H: Landlord Interview Questionnaire - Developed and Used by Carolyn Roberts for Energize Worcester

This is the questionnaire used by Professor Carolyn Roberts to interview landlords. We received permission from Professor Roberts to use some of the results from the interviews she conducted.

Energize Worcester Landlord Questionnaire

General Instructions

This questionnaire is a basis for a discussion, and (subject to agreement from the landlord) the results of the discussion will also be captured on a digital recording.

Respondents will be interviewed individually.

Respondents' identities will be protected, and if they do not wish to answer any or all questions, they are free to do that. However, their assistance would help the researchers to identify key aspects of the influences on people's ability to manage their household energy consumption successfully. Information will not be shared with anyone else, including their tenants. The findings of the research may enable tenants to be more comfortable in their houses, and for both tenants and landlords to spend less on energy.

DETAILS OF PROPERTY (IF LANDLORD OF MORE THAN ONE, THEN CHOOSE THE LARGEST)

1. Address
2. Number of bedrooms in property
3. Number of other rooms including kitchen, but not bathrooms, hallways and landings, or conservatory
4. Is the property
    a) terraced
    b) semi-detached

c) detached?

5. Does the property have double glazing or secondary glazing?
6. Other relevant details about the physical nature of the property, which you feel important in relation to energy consumption. . . .

DETAILS OF HEATING SYSTEM IN THE PROPERTY

7. Does the heating system include
   a) gas boiler and central heating
   b) Electric central heating
   c) Other form of central heating (please describe). . . .?
8. Have you ever explained the heating system arrangements to your tenants, verbally or in writing (for example, when they moved into the property)? Please say a little more. . . ..
9. Does the heating system include any form of 'smart' control? If so, say more. . . . . .
10. Is there a single thermostat for the house, or several?
11. In which room is the thermostat located?
12. Is the thermostat easily visible?
13. If the house has a thermostat, who actually controls the timing and temperature of the heating?
    a) The group of tenants
    b) One of the tenants on behalf of the group of tenants
    c) You, as landlord
    d) Some or all of the above (please explain). . . ..
    e) Don't know
14. If you have smart energy management controls, who can theoretically control the heating?
    a) The group of tenants
    b) One of the tenants on behalf of the group of tenants
    c) You, as landlord
    d) Some or all of the above (please explain). . . .
15. If you have smart controls, who actually controls the timing and temperature of the heating?

a) The group of tenants

b) One of the tenants on behalf of the group of tenants

c) You, as landlord

d) Some or all of the above (please explain)....

e) No one really controls the heating

f) Don't know

16. Does your group of tenants turn down the heating, or turn it off if they leave the property for several days, or during a longer holiday? (Always/Almost always/Sometimes/Rarely/Never/Don't know)

17. Do you usually look at your property's energy use on a monthly (or more frequent) basis, for example through the meter, or through looking at the bill?

18. What do you as landlord see as the most challenging aspect of managing the house's energy use? Please explain.....

19. Any observations on the tenants' use of energy in the property.....

20. Have you had any disagreements with the tenants about energy use in the house, or payment for it? Say a little more about this....

21. Do you feel that you personally need more information or training about managing energy in your property?

22. If one is not already present, would you consider installing a smart energy management system in your property? Please say a little more.....

23. Do you see any potential limitations on the use of an energy management system in your property? Please say a little more.....

24. Have there been any issues with significant dampness in the house (for example as mould growth on bathroom or kitchen walls) or other indications that the house is not kept sufficiently warm for some reason? Please say a little more.....

25. Any other observations on the tenants' management of energy in the property?.....

QUESTIONS ON RESPONDENT'S EDUCATION IN, AND ATTITUDES TO, ENVIRONMENTAL ISSUES AND SUSTAINABILITY

26. Have you ever studied environmental or sustainability issues as part of a school, Further or Higher Education (College or University) course? Please say a little more....

27. How would you rank your own understanding of domestic energy management? (1 – I feel that I know a lot, 2 - I know quite a bit, 3 - I know a medium amount and am somewhat informed, 4 - I don't know much about it, 5 - I know nothing about it)

28. Rank each item in the following list in terms of where you obtain your current, trusted understanding of environmental issues, from 1 – nothing, to 10 - major source

    a) Friends or relations (face to face)
    b) Friends or relations online
    c) Websites
    d) TV and radio
    e) Reading books
    f) Reading national newspapers (hard copy or online)
    g) Reading local newspapers (hard copy or online)
    h) A workplace or employer
    i) Other (please specify)

29. Rank each item in the following list in terms of where you obtain your current, trusted understanding of energy issues, from 1 – nothing, to 10 - major source

    a) Friends or relations (face to face)
    b) Friends or relations online
    c) Websites
    d) TV and radio
    e) Reading books
    f) Reading national newspapers (hard copy or online)
    g) Reading local newspapers (hard copy or online)
    h) A workplace or employer
    i) Other (please specify)

30. The following five core areas of sustainable development are widely accepted amongst practitioners as being significant:

    - Living within environmental limits
    - Ensuring a strong, healthy and just society
    - Achieving a sustainable economy

- Promoting good governance
- Using sound science responsibly.

Please say a little more about any aspects of sustainability that you think are particularly important .....

31. If you have significant concerns about future environmental sustainability, what is the most important element that you think you personally could influence? Please say a little more.....
32. To what extent do you think technological developments may provide some solutions to environmental challenges? (1 – almost none, to 10 – almost complete solutions)?

GENERAL DETAILS ABOUT RESPONDENT

33. Name of respondent
34. Gender male/female/prefer not to say
35. Email address of respondent
36. Length of time for which the interviewee has been a landlord
37. How would you describe your attitudes to information and communications technology? (1 – I am uncomfortable or hopeless with new technology, to 10 – I am a keen adopter of new technology).
38. Please say a little more about this, and give an example.....

DETAILS OF THE TENANCY

39. Total monthly rental for the whole property
40. Does the rental paid by tenants include part or all of utility bills, including

    a) gas
    b) electricity
    c) other fuels
    d) water
    e) telephone
    f) Broadband/WiFi
    g) I don't know?

    (tick all that apply)

41. If the rental includes only part of the utility bills, or has a ceiling charge on utility bills (e.g. beyond £10 per month, then the tenants must pay excess charges), explain this....
42. What do you estimate is the tenants' typical monthly expenditure on gas? (If you do not know, please say so)
43. What do you estimate is the tenants' typical monthly expenditure on electricity? (If you do not know, please say so)
44. During this tenancy, have excess energy charges ever been paid to you, the landlord?
45. How would you describe your working relationship with your tenants? (1 – Poor, to 10 – excellent)?
46. Please say a little more about the tenants' general relationship with you, their landlord...

DETAILS OF THE INTERVIEW

47. Would the respondent be willing to be interviewed again, in a few month's time?
48. Date of interview
49. Time of completion of interview

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