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Recruitment and Energy Audits of Small and Medium Enterprises in Reigate

An Interactive Qualifying Project Report submitted to the Faculty of
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Abstract

This study investigated different methods for engaging small and medium enterprises (SMEs) in the Borough of Reigate and Banstead to participate in energy audits. Energy audits were conducted of interested businesses and the team developed individualized reports for each audited SME. The team analyzed the audit and solicitation results in order to provide insights for the Council to continue effectively reducing the energy usage of small businesses and increase future participation.

Authorship

This report was developed through the collaborative efforts of Nicholas DeMarinis, Sarah Dinwoodie, Richard Kelly, and Heather Parker. All group members contributed equally to the completion of this project.

Acknowledgments

We would like to extend our appreciation to the individuals who helped us complete this project so we could support the Reigate and Banstead Borough Council in creating a more energy conscious business community.

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Raymond Dill, our sponsor, for providing us with the opportunity to work with the Reigate and Banstead Borough Council in providing energy audits for small and medium enterprises. We greatly appreciate his constant support and knowledge he so willingly provided to our group.

Ian Sharpe of the Surrey County Council, for allowing our group to shadow him on two audits so that we could learn more about the auditing process and also for suggesting areas worth investigating in a business the we otherwise would not have considered.

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Finally, we would also like to thank our advisors, Guillermo Salazar and Mark Claypool, as well as our Social Science Research Professor Dominic Golding for all their help and advice while undertaking this project. Without their continued support and feedback, our project would never have reached where it is today.

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Executive Summary

This project assisted the Reigate and Banstead Borough Council in engaging small and medium enterprises (SMEs) to participate in energy audits by exploring various methods of targeting potential businesses. The team expanded upon the Carbon Reduction in Reigate and Banstead (CRIRB) team's auditing methodologies in order to identify and present easily-implemented, inexpensive, and money-saving recommendations for small and medium enterprises in Reigate and Banstead. As the Council does not currently possess the resources to continue conducting energy audits, this project created case studies that can be used as marketing tools for the Council in the future. These case studies categorized our auditing results and those provided by the CRIRB team to detail the common problems, recommended solutions, and estimated savings for specific industries in the Borough. This could provide small and medium enterprises the opportunity to reduce their carbon emissions without the need for audits conducted by the Council.

To conduct audits, the team performed a walkthrough of each business following an audit checklist, identifying areas where energy savings could be made. The team prepared an individualized report for each audited business. The reports outline the proposed energy-saving solutions, the initial investment cost, and the estimated savings associated with each solution. To develop the case studies, the team compiled the audit results and those provided by the CRIRB team to determine the common areas for improvement and recommended solutions for different types of businesses, creating industry specific material that could be distributed to target audiences. Through the case studies, the team provided the Council with insight on how to best engage SMEs in the future in order to reduce carbon emissions.

The team compiled a sample of 300 businesses using online directories to solicit by phone, email, in-person visits, and referrals. This sample was then stratified for each solicitation method based on the available contact information. Each business was then approached using the selected method, following which the team analyzed the response rates and time required for each method to analyze the effectiveness of each solicitation type.

Email solicitations were conducted of 36 businesses in the Holmethorpe Industrial Estate, a group of businesses in Redhill. These solicitations were conducted in three iterations to test varying message formats and sending addresses. This approach resulted in only a single positive response. As future solicitations via email can be automated for efficient distribution through the

use of mail merge facilities, further investigation of this method by the Council is recommended.

In addition, the team solicited 172 businesses by phone through the use of a calling script. These solicitations were conducted in two iterations using differing call scripts to analyze the effects of caller affiliation, first as an agent of the Council and, second, as a university student working for the Council. This method of solicitation resulted in two positive responses; however, it was found that 21% of the businesses we attempted to contact were unable to respond due to the unavailability of a manager or owner. In the future, the Council could train future solicitors in professional telemarketing procedures in order to more effectively solicit businesses.

The team also selected 30 businesses centered in Reigate and Redhill to individually visit in order to investigate the effectiveness of a more personal solicitation method. These businesses were selected based on their proximity to each other and the Reigate and Redhill rail stations—mainly around high streets. As such, the sample was mainly comprised of retail businesses, many of which were discovered to be chain businesses, not small businesses targeted by this study. The team obtained two positive responses from local businesses within these areas. In addition, 24% of the businesses listed in the sample no longer existed, further underscoring the out of date content of the sample.

The team also investigated soliciting businesses via referrals to explore contacting businesses through channels business owners may already deem credible. The sponsor provided two such referrals, one of which resulted in a positive response due to his contacts with public service workers in the Borough. In addition, the team attempted to contact the chairs of the Holmethorpe Industrial Estate in an effort to disseminate information regarding the opportunity for audits, though this yielded no additional responses. Overall, our team solicited over 300 businesses and received six positive responses for a 2% total response rating, as outlined in Table 1:

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Table 1: Overall solicitation findings

	Total	Positive	%	Percent Unreachable	Time/ Solicitation	Time for one audit
Email	36	1	3%	17%	30 sec.	N/A
Phone	231	30	2	7%	3 min.	4 hours
In-person	30	2	7%	72%	15 min.	3.8 hours
Referral	3	1	*Dependent on reliability of connections.*			
Total	**300**	**6**	**2%**	**25%**		

The in-person visits showed the highest proportion of positive responses. Based on the response rates and estimates of the time required for typical solicitations, the team determined the time required for solicitations of a given method to result in a single audit. As in-person visits required slightly less time per audit, it was the most effective solicitation method for this study. This team investigated four solicitation methods ranging from efficient, impersonal email solicitations to more personal and time-consuming in-person visits. This demonstrated a tradeoff between the degree of personal communication and the time required to conduct the solicitation. Future investigations by the Council could examine methods for conducting more personal email or phone solicitations or less time-consuming visitations to discern an effective "balance" between personal communication and time effectiveness.

The team then conducted six audits of businesses around Reigate and Redhill, which included a restaurant, printing business, charity, community and public service building, and two retail businesses. The team focused on recommending inexpensive and easily implemented solutions. The most frequent recommendations included: installing passive infrared (PIR) sensors, using natural light when available, replacing incandescent bulbs with CFLs, and replacing inefficient fluorescent tubes with more efficient varieties. The overall savings are outlined in Table 2, categorized by the amount of money saved, tonnes of carbon dioxide reduced, and kWhr reduced.

Table 2: Overall audit findings

	Initial Expense	Savings			Payback Period
		£/yr	Tonnes CO_2/yr	kWh/yr	
Average	£960	£940	5.1	9,450	1.12 years
Total	**£5,700**	**£5660**	**31**	**56,700**	

The team's auditing of six businesses can potentially save the Borough £940 and 5.1 tonnes of carbon dioxide emissions per business per year. Throughout the course of our project, our team suggested changes that could result in potential savings of £5,600 and 30 tons of carbon dioxide emissions per year. If similar audits were to take place for the 5,700 businesses within Reigate and Banstead, it would save the Borough approximately £5,300,000 and 29,000 tonnes of carbon dioxide emissions per year.

The team analyzed a listing of businesses within the Borough categorized by industry to determine types of businesses prevalent throughout the community. This listing was used to investigate methods of targeting the most prevalent types of businesses. Based on the audit results and those provided by the CRIRB team, the team developed case studies of commonly recommended solutions to provide examples for other businesses of the same industry. Using available auditing data, the team compiled case studies in the form of fliers for retail businesses, restaurants, printing companies, and community and public service buildings. Future efforts by the Council could disseminate these fliers in order to promote energy awareness among businesses without conducting audits on a large scale.

The purpose of the project was to identify and test several methods of solicitation and conduct energy audits of small businesses within Reigate and Banstead and propose an efficient approach for the Borough to help engage SMEs in their attainment of the objectives of their Strategic Energy Strategy. Through the solicitation and auditing of companies this study has: (1) provided insights on how the Council could solicit businesses in the future, (2) developed an improved auditing checklist that can be used in future audits, (3) explained the estimated benefits if solicitation and auditing were applied on a larger scale, and (4) provided case study materials for future marketing.

Based on the solicitation and audit results, the team's investigation of solicitation methods and energy auditing demonstrated a worthwhile means of reducing businesses' energy usage. Future efforts by the Council could expand upon this team's methodologies to continue promoting energy-conserving habits among SMEs in the Borough.

Phone solicitations may prove more effective with professional telemarketing training and accurate contact details for business owners, rather than primary phone numbers for businesses, thus, further investigation of phone solicitation may prove beneficial. In addition, 24% of our solicitations were unable to contact a business owner due to inaccurate listings; solicitation of SMEs could prove more efficient with a Council-compiled list. The Council could benefit from recruiting students through other IQP groups or local universities to continue the project. In addition, the Council could also attempt to compile a list of companies while processing tax data, and promote awareness of business owners' consideration of their utility bills.

1. Introduction

Recent research points to man-made sources as the major contributor to the rise in carbon dioxide emissions around the world, causing global climate change. Many countries, including the United Kingdom, have established targets for the reduction of carbon dioxide emissions under the Kyoto Protocol. The United Kingdom has set especially aggressive goals for reducing its carbon emissions. According to the Department of Energy and Climate Change (2011), the United Kingdom plans to reduce its emissions by 34% by 2020 and ultimately by 80% by the year 2050 based on 1990 levels ("The Carbon Plan"). In order to achieve these national targets, many local governments have established programs and policies to help raise awareness and promote energy conservation among the population.

In order to motivate environmental change within the community, the Reigate and Banstead Borough Council has developed a Strategic Energy Strategy that outlines a plan to meet the national goals ("The Community Plan"). As a result, the Council must assess sources of energy inefficiency throughout the Borough in an effort to reduce emissions. One way to identify and help reduce emissions is through energy audits. Energy audits contribute to the reduction of carbon emissions by detecting areas of energy waste and proposing inexpensive and efficient solutions that can reduce energy usage. Additionally, audits can evaluate the behavioral practices of employees or residents, proposing methods to increase energy efficiency at little to no cost.

In the spring of 2011, the Council commissioned a group of Worcester Polytechnic Institute (WPI) students to provide energy audits for SMEs in the local community. Their study conducted seven audits of SMEs; however, their team cited difficulty in recruiting businesses to participate (Lombardo, et. al, p. 74). Recent studies conducted by Climate South East (2010), an organization promoting climate awareness, have shown that while owners of SMEs are aware of the issues presented by climate change, they may not understand how their actions can impact climate change on a global scale (p. 9). Therefore, small and medium business owners may not view investing in energy efficiency as a priority and thus are not willing to take advantage of the opportunities an energy audit can provide.

In an effort to assist the Council in engaging businesses to participate in audits, this project explored possible methods of targeting businesses and expanded upon the CRIRB team's

auditing procedures. This was accomplished by: (1) determining possible methods of soliciting businesses' participation, (2) researching and developing extensive lists of businesses to contact, (3) attempting to recruit these small and medium enterprises using these methods, (4) performing energy audits of the recruited businesses, (5) presenting businesses with "action plans" demonstrating how small businesses can reduce their carbon emissions and profit from the effort, and (6) analyzing the results of the solicitation attempts in order to identify insights regarding how to best communicate with small businesses.

The team presented compiled results of the audits and solicitation attempts as insights regarding how the Council could continue to promote energy-conserving habits among small businesses in the future. After soliciting 300 businesses via email, phone, in-person visitation, and referral, culminating in six positive responses, the team concluded that in-person visitations proved most time effective for this study. Upon completion of the energy audits, the team recommended an average of £940 and 5.1 tonnes of carbon dioxide in annual savings per business. Based on this, this team reinforces the CRIRB team's conclusion that conducting audits for small and medium businesses can provide a valuable means for reducing the Borough's carbon footprint.

As the Council does not currently possess the resources to continue conducting energy audits, this team categorized its audit results to develop case studies detailing the common problems, recommended solutions, and average savings for specific industries in the Borough. This could provide small and medium enterprises the opportunity to reduce their carbon emissions without the need for formal audits conducted by the Council.

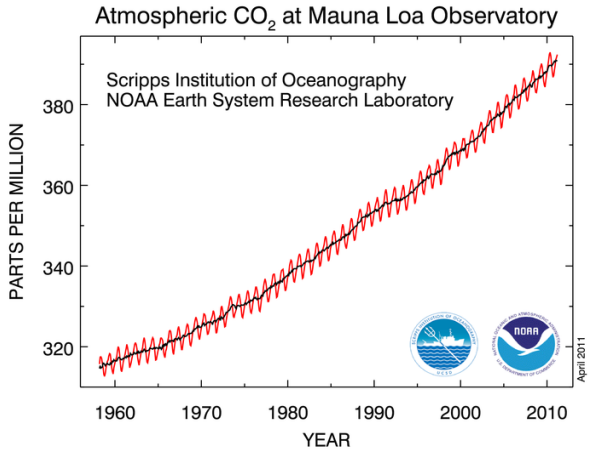
2. Literature Review

Scientists have found that the significant increase in man-made greenhouse gas emissions, primarily carbon dioxide, is accelerating changes in our global climate (The Royal Society, 2010, p. 4). The United Kingdom and the Reigate and Banstead Borough Council (2009) have responded by settings goals for reducing their carbon dioxide emissions by 2050 (p. 3). This section discusses the effects of climate change and local and national goals for taking action against it, specifically the Reigate and Banstead Borough Council's prior investigation into energy auditing to reduce the emissions of small businesses. Additionally, this section continues to discuss the scope and methods of energy auditing, possible energy-saving solutions for small businesses, and the challenges involved in recruiting businesses for audits and marketing recommended changes in audit reports.

2.1. Effects of Greenhouse Gases

According to The Royal Society (2010), greenhouse gasses in our atmosphere reflect the infrared energy absorbed by the earth, retaining heat within our atmosphere—as greenhouse gas levels increase, more of this heat is trapped, increasing global temperatures. While these changes occur naturally, countless research studies have shown that human activities have contributed to the rising levels of greenhouse gas emissions, with a particular focus on the increase of CO_2 emissions from the combustion of fossil fuels (p. 4). Figure 1demonstrates this steady increase of carbon dioxide emissions over the past few decades (Tans, 2011).

Figure 1: Trend in mean atmospheric carbon emissions (Trans, 2011)



Increased greenhouse gas emissions cause the earth's temperature to increase, which could lead to adverse consequences for the entire population. Bill Freedman, author of "The Greenhouse Effect" (2008), states that average global surface temperatures have increased over recent decades; scientists fear that future increases will result in further melting of ice sheets and rising sea levels, which will endanger coastal populations. Furthermore, increased temperatures could also lead to an increased level of water vapor in the atmosphere, altering weather patterns (Freedman & Gilman, 2008). He noted that carbon dioxide released into our atmosphere "stays there for well over a century" (Freedman & Gilman, 2008). Thus, despite efforts to reduce our carbon emissions, the reversal process would require a significant amount of time to take effect.

In 1988, the United Nations and the World Meteorological Office created the Intergovernmental Panel on Climate Change (IPCC) to answer the public's questions about climate change. The IPCC consists of the world's leading scientists who have come to a consensus that the climate crisis is a man-made problem (Fisher, 2011a). These scientists and researchers generate scenarios and reports on the possible effects of climate change for different regions. As a result of increased emissions, the IPCC projects that regional temperatures could rise up to five degrees Celsius, above pre-industrial levels, by 2100 (The Royal Society, 2010, p. 11), a difference as significant as "between now and the last ice age" (Fisher, 2011a). Such effects of our greenhouse gas emissions could pose severe consequences for our population in the future.

The report the IPCC generated for the South East region of the United Kingdom predicts that the coming years will bring warmer temperatures, increased sunny weather due to reduced cloud cover, and more variable and extreme storms (Fisher, 2011a). Based on this report, the Surrey County Council has already begun outlining the climate changes their region can expect, shown in Table 3:

Table 3: Surrey County Council predictions for climate change (Reigate and Banstead Council, 2009)

Phenomenon and direction of trend	Likelihood that trend occurred in the late 20th century (typically post 1960)	Likelihood of a human contribution to observed trends	Likelihood of future trends based on projections for 21st century using SRES (special report on emission scenarios) scenarios
Warmer and fewer cold days and nights over most land areas	Very likely	Likely	Virtually certain
Warmer and more frequent hot days and nights over most land areas.	Very likely	Likely (nights)	Virtually certain
Warm spells/ heatwaves. Frequency increasing over most land areas.	Likely	More likely than not	Very likely
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas.	Likely	More likely than not	Very likely
Areas affected by droughts increases.	Likely in many regions since 1970s	More likely than not	Likely
Intense tropical cyclone activity increases.	Likely in some regions since 1970	More likely than not	Likely
Increased incidence of extreme high sea level (excluding tsunamis).	Likely	More likely than not	Likely

As the IPCC projected, the population of Surrey has already witnessed increased rainfall and instances of severe flooding. Furthermore, the Surrey County Council is wary that summers will become drier, which will cause farmers to plant alternative crops, potentially harming the county's agricultural economy (Fisher, 2011a). In addition, increased temperatures pose risks not only to the county, but to the United Kingdom, and globally as well. Both national and local governments must combat climate change in order to mitigate these risks to their economies, resources, and populations.

2.2. Current Carbon Reduction Goals in the United Kingdom

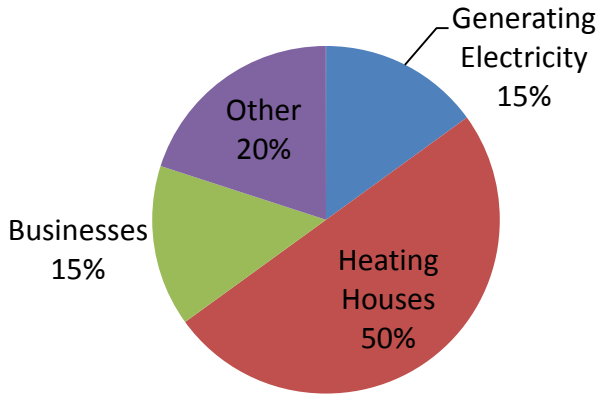
Since 1997, 191 countries have signed the Kyoto Protocol in an effort to set goals for efforts against climate change (Milne, 2003). The Protocol is an agreement among countries to reduce emissions of four main greenhouse gases: carbon dioxide, methane, nitrous oxide, and

sulfur hexafluoride (Milne, 2003). As a signatory of the Kyoto Protocol, the United Kingdom has pledged to reduce its emissions in accordance with other nations around the world.

Since the 1990's, the United Kingdom has enacted many forms of legislation to address the growing climate crisis on the national, regional, and local levels. In 2011, the Department of Energy and Climate Change published "The Carbon Plan," a specific plan of action for reducing its carbon footprint. This plan has, at its center, the Climate Change Act, ratified by Parliament in 2008, requiring that greenhouse gas emissions, based on 1990 statistics, be reduced by 34% by 2020 and 80% by 2050. Specifically, the nation is managing its emissions by "budgeting" its carbon emission allowances in 5-year periods (Department of Energy and Climate Change [DECC], 2011). This should allow the government to easily monitor its progress as it continues to work toward its emission-reduction goals.

The Climate Change Act sets a standard for reducing the United Kingdom's carbon emissions by 2050. However, the United Kingdom will require significant efforts at the national, regional, and local levels in order to meet the guidelines it defines. According to the Department of Energy and Climate Change, 80% of the United Kingdom's greenhouse gas emissions are produced by three main sectors: heating, businesses, electricity generation, and businesses, as shown in Figure 2 (DECC, 2011). Changes to these major contributing sectors are vital for the success of the United Kingdom in its efforts to reduce its carbon emissions, thereby reducing its carbon footprint and overall impact on the environment.

Figure 2: Breakdown of United Kingdom carbon emissions by sector (DECC, 2011)



On the Borough's regional level, the Surrey Climate Change Partnership (SCCP) was established in 2007 to aid the region in contributing to the national goals. The Surrey County

Council describes the Partnership as an organization containing "all the Surrey borough and district councils and the county council, working together to tackle climate change" (Fisher, 2011b). The Partnership aims to inspire a countywide movement against climate change and to implement energy conscious practices among the community (Fisher, 2011b). The Partnership established the Surrey Climate Change Strategy, which educates the local community about the climate crisis, promotes awareness of how individuals of the community can contribute, identifies how businesses can work together to effectively reduce their emissions, and evaluates the possible impacts climate change could have on the county (Fisher, 2011b). In this way, the Surrey County Council can facilitate change toward the national goals among its boroughs, including Reigate and Banstead.

2.3. Reigate and Banstead Goals

The Community Plan (2008) published by the Reigate and Banstead Borough Council addresses the future of the environment and their goals for the community to minimize their impact on climate change. The Council hopes to move towards a more sustainable lifestyle to safeguard the Borough from hardships in the future. For example, in order to prevent future electricity shortages, the Council hopes to investigate alternative power sources and conservation methods. In addition, they stress the importance for the community to "encourage sustainable lifestyles so we can live within our means" (p. 9). In this way, the Council hopes to educate individuals to take responsibility for their energy use and waste. By promoting energy conservation awareness and investigating renewable energy sources, the Council can begin to reduce its carbon footprint.

In June 2009, The Reigate and Banstead Borough Council developed a Sustainability Energy Strategy to "aim to lead the community towards addressing the targets set in the national Climate Change Act" (Reigate and Banstead Borough Council, 2011). The Strategy outlines five themes on which to focus their efforts in order to achieve this goal: (1) providing community leadership; (2) improving energy usage in Council buildings, fleet, and services; (3) investigating sustainable energy in homes, businesses, and social sector, (4) deploying sustainable energy in new developments, and (5) creating a fund for local energy projects (p. 3). Its analysis notes that in order to reduce their carbon-emissions by 80% from the 1990 baseline and meet their goals, the Borough needs to reduce its carbon emissions by at least 13,227 tons per year until 2050—a

formidable goal (p. 3). To set this target for reducing its emissions, the Council categorized the Borough's carbon footprint by sector, as shown in Table 4.

Table 4: Breakdown of Reigate and Banstead carbon emissions by sector (p. 14)

Breakdown of Reigate &Banstead Borough CO_2 emissions by end user			
(Units of CO_2 emissions = kT CO_2)	2005	2006	2006 - %
Domestic	348	354	44%
Transport	185	179	22%
Industry and commerce	266	271	34%
Total footprint	**799**	**804**	**100%**
Population	128,200	130,000	
Tonnes of CO_2 per capita	**6.2**	**6.2**	

As the Borough's industry accounts for 34% of its carbon footprint, the Council investigated targeting small businesses as a means of reaching its sustainability goals. According to the Council's economic profile (2011), the Borough contains approximately 5,700 businesses, a majority of which are small and medium enterprises (SMEs) containing less than 50 employees ("Economic Profile" 2011; "Business Survey," 2010, p. 3). Thus, a significant portion of the Borough's carbon footprint is divided among small businesses throughout the Borough. To investigate this, the Council sponsored a team of students from Worcester Polytechnic Institute during the spring of 2011 to "develop energy auditing protocols used to identify carbon reduction opportunities of selected SMEs in the Borough" (Lombardo, McCarthy, Mondor, & Solarz, 2011, p.2). Their research team, named the Carbon Reduction in Reigate and Banstead (CRIRB) team, conducted audits of small businesses to identify methods to reduce their carbon footprint. After conducting audits of seven small businesses and four Council facilities, they found their energy audits to be "useful and efficient," and concluded that continued support for the project is an "effective way to achieve [the] carbon reduction goals set forth by the Reigate and Banstead Borough Council, as well as England itself" (p. viii). Based on their study, further investigation into methods for auditing can help the Council continue to work toward their sustainability goals.

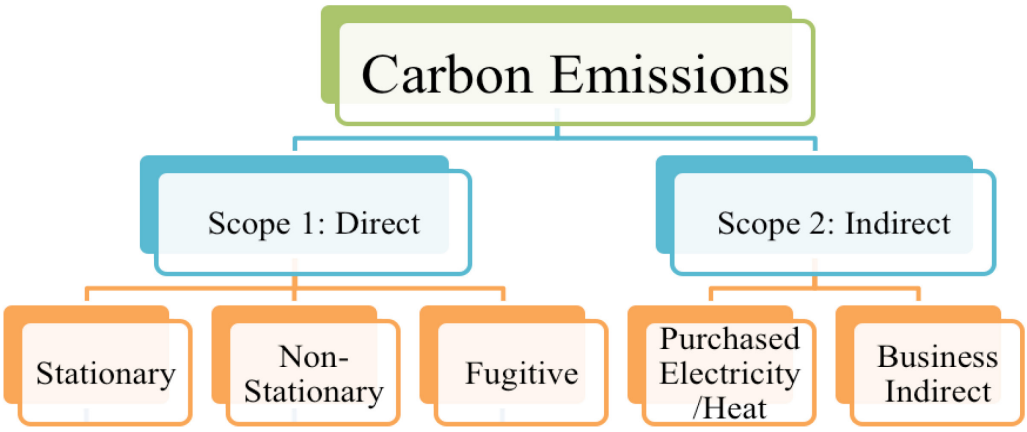
2.4. Scope of an Energy Audit

Energy audits can provide businesses with information to help them determine methods to reduce their carbon footprint. These audits assess the energy usage and carbon emissions

associated with a specific company's operations. The data collected during an audit can identify energy efficiency measures and opportunities that will enable the company to reduce their carbon emissions while also cutting costs (Baker, 2009). To accomplish this, an auditor must categorize the emissions of a business to identify the areas which a given business can feasibly change.

As shown in Figure 3, Huang, Weber, and Matthews (2009) distinguish between two "scopes" of carbon emissions produced by a business: direct and indirect. Direct emissions stem from sources owned or controlled by the company (Bishop, 2000). The second "scope" of emissions includes all indirect emissions associated with electricity and heat that are generated off-site and purchased by the company (Baker, 2009).

Figure 3: Hierarchy of carbon emission scopes



Energy audits for businesses, as outlined in the examples above, focus on determining causes for direct emissions. These sources, which are controlled by a given business, include areas that can be easily identified during a walkthrough audit. Audits conducted by the CRIRB team mainly identified sources of direct, stationary emissions, most commonly recommending changes to lighting, employees' behavioral habits, and boiler settings (Lombardo et. al, p. 59). Indeed, these direct sources encompass areas of a business' carbon emissions feasible to observe during a walkthrough and subsequently identify solutions for reducing those emissions.

2.5. Energy Auditing Methods

An energy audit is a method of identifying the energy consumption of a business in order to determine ways to reduce usage. While different terms are used for energy audits, such as carbon audits or energy surveys, the general procedure and goals are quite similar. According to

the *Handbook of Energy Audits* (2008), there are three levels of audits, a walkthrough audit, standard audit, and a computer simulation (Thumann & Younger, 2008). The walkthrough audit comprises of a basic analysis of limited energy consumption data and a visual assessment of energy consuming systems. This type of audit is commonly used as a preliminary audit to find the most readily apparent energy saving methods and improvements. The standard audit is more extensive and includes a numerical analysis of energy use and loss, a measurement of the efficiency of various systems, and an economic feasibility analysis of the changes. Finally, the most detailed energy audit is computer simulation, which involves an in depth analysis of emissions and possible solutions of energy usage using simulation software. This is the most expensive and extensive type of audit due to the software and the information required to construct the simulation; it is only commonly used for large businesses and manufacturing plants (Thumann & Younger, 2008).

Thumann and Younger identify four steps to carrying out a traditional energy audit, pre-site, site visit, post-site, and the audit report (p. 5). The pre-site involves making a sketch of the building plan and collecting and organizing any available data to become familiar with the facility data. Typically, the data collected at this stage includes two years of utility energy data and mechanical, architectural, and electrical drawings (Thumann & Younger, 2008). Thumann and Younger suggest creating a site sketch, which includes each audited building, utility meter locations, and other available information to allow easy note taking and reference. The end result of the pre-site audit should be a familiarity with the site and a specific list of questions to ask during the visit.

The CRIRB team employed a simplified version of the above professional methods, conducting what they termed as "walkthrough plus" audits, which combined the walkthrough audit methods discussed above with an evaluation of any available energy bills and metering data (Lombardo et. al, p. 43). They concluded that this method provided an efficient manner for conducting knowledgeable audits of small businesses in a short period of time (p. 43). Based on their recommendations, similar audits could be conducted using their methodology.

The *Handbook of Energy Audits* notes that the purpose of the site visit is to ask questions of key staff (e.g., building managers) and examine the site's systems, suggesting that auditors plan at least one day per walkthrough (Thumann & Younger, 2008), although this will vary according to the size and complexity of the facility. The main sections of the site visit are a

discussion with the building manager and filling out audit data sheets. The purpose of speaking with the building manager is to discuss intangible parts of the business such as occupancy schedules, observe common practices, and obtain answers to the questions developed in the pre-site. Data sheets should be used to organize the walkthrough to collect the information. Taking pictures of mechanical equipment and any other relevant areas is also suggested in order to help document what was inspected and the state of the building. The result of the site visit should be a large amount of information on the buildings and practices of the business. The post-visit is meant to organize the gathered data. As soon as possible after the audit, the *Handbook of Energy Audits* suggests, it is important to examine the notes taken on the walkthrough to note any information that the auditor was unable to gather as well as to clarify the notes that were taken (Thumann & Younger, 2008). The final part of the post-visit is to organize all the information gathered both for storage and for inclusion in the audit report.

The *Handbook of Energy Audits* contains additional information on both lighting and heating audits in particular, providing a four-step process to conduct an extensive audit of lighting systems. The first step is to assess the building itself, which includes classifying each room in the building and recording the dimensions, number, and types of lighting fixtures in the room. Next is to analyze the effectiveness of the current lighting by examining the level of lighting by looking for excessive glare, and talking to users to determine if the area is over, or insufficiently, lit. Following this, the *Handbook* recommends that an auditor estimate the current consumption and cost of the lighting system. Finally, calculations are performed for a proposed refit to determine the business' possible savings. The methodology for a heating audit is quite similar, the *Handbook* suggests recording the temperature settings for each room, as well as the occupancy, comparing them to a given table of suggested temperature and adjusting accordingly either manually or using automatic controls.

In order to conduct efficient and thorough assessment of buildings' lighting and heating, the CRIRB team developed, and followed, a checklist to be used when conducting their audits (Lombardo et. al, p. 75). Using the checklist ensured that their audits followed a set procedure and noted areas for improvement without professional training. Similar auditing checklists, like an extensive checklist developed by the University of Washington's Cooperative Extension Energy Program, outline possible solutions for each area an auditor should observe ("Energy

Auditor Checklist", 2003). Using this format, an auditor without professional experience can conduct a concise audit to identify areas for reducing carbon emissions.

2.6. Carbon Reduction Methods and Solutions

Many of the reports prepared by the CRIRB team recommended elaborate solutions, specifically for lighting technologies, with expenses well beyond the price range of a small business (Lombardo et. al, p. 99). Such a high spending margin could exclude many small businesses from the benefits an energy audit can provide. Alternatively, auditors can instead recommend simpler, inexpensive solutions that can still significantly impact a small business' energy usage and, subsequently, its carbon footprint.

2.6.1. Behavioral Changes

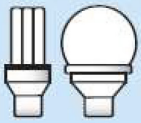
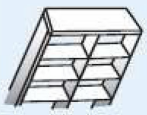
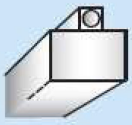
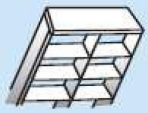
The Carbon Trust, an organization funded by the Department of Energy and Climate Change, publishes pamphlets regarding energy-saving opportunities for businesses. According to their "Better Business Guide" (2010a), a business can easily reduce its energy usage at no cost by modifying its employees' behavioral habits (p. 2). The simplest of these changes include modifying employees' office habits by turning off lights, shutting down computers, and turning off monitors when they are not needed. While these changes may appear simple, they can present a significant opportunity for reducing the energy usage of any office space. The Carbon Trust's pamphlet notes that office equipment accounts for 20% of business energy use; switching computers off at nights and on weekends can save 75% of their energy consumption (p. 10). Similar practices could be applied to office areas of small businesses, to provide a simple method to reduce their energy usage at no cost.

2.6.2. Energy Efficient Lighting

Businesses can begin to inexpensively reduce their energy usage by taking steps to modify their lighting. According to a Carbon Trust pamphlet entitled "Lighting: Bright Ideas for Efficient Illumination" (2010b), lighting can account for up to 40% of a business' electricity bill, meaning that even small changes to lighting can entail significant savings and improve a business' working environment (p. 3). The Carbon Trust also recommends identifying areas with enough natural light for work and turning off lights in such areas when possible. In addition, replacing outdated lighting methods with more recent, efficient options can

significantly reduce the energy consumed by lighting while providing the same amount of light, as outlined in Table 5.

Table 5: Alternative lighting sources (Thorn, 2011, p. 10)

Existing lamp type	Energy efficient option	Energy saving/benefits	Application notes
 Tungsten light bulbs	 Replace with compact fluorescent lamps (CFLs) in the same fitting	75% saving plus longer lamp life	Modern CFL replacements may also be acceptable for display and task lighting
 38mm (T12) fluorescent tubes in switch-start fittings	 Replace with equivalent 26mm (T8) triphosphor fluorescent tubes of lower wattage	8% saving plus longer lamp life	General lighting, but even better use with modern fittings (see below)
 Mains voltage reflector lamps, filament spot and flood types	 Replace with low-voltage tungsten halogen lighting or metal halide discharge lighting	30-80% saving for equivalent lighting performance	Spot lighting in considered areas, such as reception or displays. If low voltage tungsten halogen spotlights are installed use 35W infrared coated (IRC) bulbs instead of the standard 50W bulbs
 Fluorescent fittings with the old 2ft 40W, and 8ft 125W fluorescent lamps	 Replace with efficient fittings using reflectors/ louvres or efficient prismatic controllers with high-frequency electronic or low loss control gear	30-45% saving with much improved lighting quality. The use of high frequency electronic control gear eliminates flicker, hum and stroboscopic effect	General lighting
 Fluorescent fittings with opal diffusers or prismatic controllers which are permanently discoloured	 Replace with new prismatic controllers or replace complete fittings as above	No reduction in energy consumption but increases the amount of light by between 30% and 60%	General lighting

In addition, businesses can significantly reduce the energy usage of their lighting by replacing their current lighting with LED lights, which use 75% less energy than traditional solutions and can save businesses £9 per light bulb annually (Buckley, 2011). LED bulbs also have at least 15 times the lifespan of an incandescent bulb, decreasing a business' overall replacement lighting costs (Buckley, 2011). However, LED lighting solutions are a developing technology and thus significantly more expensive than the above lighting solutions, possibly out of the price range of a small business.

Another solution to decrease lighting costs is to install occupancy sensors in intermittently occupied areas of a building. These sensors can automatically turn off lights in unoccupied areas, eliminating the energy consumption of such lights when they are not in use

(Evans, 2007). The efficiency of these sensors is based on the occupancy of the room in which they are installed. Estimates are outlined by the type of area in Table 6.

Table 6: Potential energy savings for occupancy sensors (Evans, 2011)

Type of Space	U.S. EPA Prediction
Private Offices	13-50%
Classrooms	40-46%
Conference Rooms	22-65%
Restrooms	30-90%
Corridors	30-80%
Storage Areas	45-80%

2.6.3. Regulating Boiler Settings

The Carbon Trust (2010a) recommends that regulating the temperature of the building will not only make employees more comfortable, but will also reduce a building's energy usage. Their "Better Business Guide" noted that it is also important to not open windows when the heat, or air conditioning, is on in order to reduce the loss of energy expended to control the building's temperature. The building manager or owner should also ensure the heating and air conditioning systems are not running simultaneously to avoid wasting money and resources (p. 5-6). Their pamphlet also notes that buildings are frequently overheated, and that maintaining constant temperatures can reduce businesses heating cost up to 8% per degree Celsius of overheating (The Carbon Trust, 2010).

2.7. Soliciting Small Business Owners' Participation

Despite the simple and inexpensive solutions available to small businesses, many business owners may be unwilling to investigate the opportunity an energy audit can provide. In their analysis, the CRIRB team discussed that they encountered difficulty in recruiting businesses to participate in their audits. They noted that many of the businesses they targeted were unaware of their initial recruiting attempts, via a flier in an electronic newsletter, and were forced to resort to soliciting the businesses by phone (Lombardo et. al, p. 68-69). This difficulty in engaging businesses could seriously hinder attempts to reduce business' energy usage on a large scale.

In addition to difficulty contacting businesses, the CRIRB team encountered resistance from businesses owners during their recruitment attempts. They noted that many business owners "thought they were energy efficient [already] … whereas others simply weren't [sic] interested," as an explanation for their difficulty (Lombardo et. al, p. 59). Indeed, despite all of the simple solutions available to help businesses reduce their carbon footprint, many business owners may be unwilling or unaware of opportunities to seek advice concerning reducing their energy usage. Increased spending concerns and the limited budget of a small business may render its management more resistant to taking action against climate change. A pilot study by Climate South East (2010) found that business owners "see climate change as a low priority," confirming the CRIRB team's findings that the Borough's target audience hesitate to participate in such opportunities (p. 3). Many businesses, therefore, are unlikely to act to reduce their carbon footprint on their own, direct action must be taken to explain and demonstrate how small businesses can inexpensively reduce their energy usage.

As such, small business owners may not view reducing their energy, as a factor that can have an impact on global climate change. A further study by Step Ahead Research, an independent research business commissioned by Climate South East (2008), conducted a survey of 304 small businesses in the South East region to help understand small business owners' views and actions regarding climate change. They noted that around 95% of surveyed small business owners stated they were taking *some* action against climate change, such as recycling, reducing their energy usage, cutting waste, or altering their transportation habits (Norrington & Underwood, p. 11). However, they also cited a similar study in the North West region of the United Kingdom, which concluded that 37% of small businesses surveyed lacked the necessary time and resources to take action against climate change, and similarly noted that many of their own participants saw climate change as a cost issue (KPMG as cited in Norrington & Underwood, p. 16; p. 7). This provides a possible explanation for the solicitation issues encountered by the CRIRB team.

Alternative techniques for presenting the opportunity energy audits can provide may help encourage business owners to participate. Kolter and Zalton (1972) suggested that social issues, like safe driving or cancer research, can be effectively promoted through the use of marketing techniques. They stated that marketing strategies can render a social issue "familiar, acceptable, and even desirable to an audience" (p. 7). In this way, the social issue of reducing businesses'

carbon emissions could employ marketing strategies to better motivate businesses to participate. A pilot study conducted by Climate South East in 2010 attempted to market their climate change seminars to SMEs by tailoring their "product" to the specific needs and concerns of SMEs. Their seminars focused on presenting climate change as an "opportunity," stressing how businesses could "make money from climate change"; as a result, their seminar engaged over 300 SMEs (p. 7-8). Based on their success, similar marketing strategies could aid in soliciting small businesses' participation.

As attempts by the CRIRB team demonstrated the need for refined approaches to recruit SMEs to participate in energy audits, this study investigated differing communication approaches as a method of soliciting businesses in Reigate and Banstead. The CRIRB team initially attempted to contact businesses in the Holmethorpe Industrial Estate via a flier created by Raymond Dill, which was included in a newsletter and distributed by email to all members of the Estate. After receiving limited responses, the CRIRB team continued their recruitment efforts by calling businesses in the Estate, finding that many never received the electronic newsletter (Lombardo et. al, p. 66-68). While the CRIRB team did not publish details of their solicitations, they cited difficulty in recruiting businesses, noting that many were disinterested or believed they were already energy efficient (Lombardo et. al, p. 59). As such, it is necessary to investigate more rigorous methods for recruiting businesses' participation.

When attempting to solicit businesses by phone, the CRIRB team followed a script they devised to help their team members quickly solicit businesses (Lombardo et. al, p. 74). Such scripts are widely used throughout the telemarketing industry, from professional telemarketing firms to charity organizations seeking donations. At their most basic level, these scripts can aid inexperienced solicitors in making calls efficiently and concisely (Stavarz, 2003). The CRIRB team's script, as shown in Figure 4, already makes an effort to use the marketing techniques discussed above to encourage business owners to participate.

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Figure 4: CRIRB phone solicitation script

Good morning Mr./Mrs. _____,

My name is _____ calling on behalf of the Reigate & Banstead Borough Council. We have recently distributed a flyer regarding free energy surveys from the Council. We were wondering if you have any interest in this.

(if yes, schedule the audit) (if no) Is there a later date you wish us to call in order to schedule the survey?

(if yes, note date for return call)

(if no) Ok thank you very much for your time. If you do wish to set up a time for an energy survey, please contact Raymond Dill at the Reigate & Banstead Borough council to arrange a date.

(if they ask what it entails) Results from an energy survey may save you a substantial amount of money off of your annual utility bills. Two individuals working on behalf of the council would conduct this energy survey. These two individuals would examine lighting, building envelope, heating, and the behavioral habits of the staff during a walkthrough of the building. A walkthrough will typically last anywhere from 15 minutes to an hour. After finishing the walkthrough of the building, we will then produce a report with our energy saving recommendations for your business. Do you have any interest in this?

Furthermore, investigation of additional recruiting methods provided insight into more efficient solicitation of small businesses. A study by Lock et. al (1999) testing the effectiveness of differing recruiting methods for an alcohol intervention program, found that solicitation by phone, while widely used by many marketing organizations, produced a lower response rating than in-person marketing methods (p. 696). This gives some level of credence to the low response rating achieved by the CRIRB team. However, Lock et. al cited the higher response rating of in-person marketing as a tradeoff. After testing solicitation by phone, postal mail, and in-person marketing, a cost analysis showed in-person marketing methods to be the most expensive (p. 697). This is easily explained by the time and effort required to visit and explain issues to each test subject. Despite this tradeoff, in-person solicitation could provide a more effective forum for contacting small businesses in the Borough.

2.8. Marketing Carbon-reducing Solutions to Businesses

Given the budget concerns of a small business and subsequent skepticism of business owners, as mentioned above, the possible solutions presented to a business owner following an audit may be met with resistance, no matter how low the expense. Audit reports prepared by the

CRIRB team accounted for this in their recommendations, listing the projected cost, estimated annual savings, and length of time required for payback for each of its recommendations, clearly demonstrating exactly how much a business can save over time (Lobardo et. al, p. 83). In addition, their detailed reports contained an introduction, summary of their findings, outline of potential savings, explanation of recommendations, and, finally, an overall conclusion (Lombardo et. al, p 28). Although the CRIRB team did not study the effectiveness of their reports, this format may have proved too verbose to entice business owners to continue reading the report and implement the team's recommended solutions. As an alternative, reports prepared by the Carbon Trust, instead provide a concise table of their recommendations, their subsequent expected savings, and payback period (Thorn, 2009, p. 9). Such a concise explanation of the report's recommendations and expected savings could encourage a business owner to investigate the listed solutions.

In addition to providing resources on energy-conserving technologies, The Carbon Trust also manages the distribution of tax incentives to corporations that implement energy-saving technologies through the Enhanced Capital Allowances, or ECA, program. The program, which is sponsored by the Department of Energy and Climate Change, entices businesses to invest in green technologies by allowing businesses to cite the entire first-year expense as a credit against their taxable profits. In this way, businesses can offset the large initial expense of moving to energy efficient solutions with a tax credit by choosing from over 15,000 products that can help reduce their carbon footprint (The Carbon Trust, 2011b). The Carbon Trust has also recently partnered with Siemens to offer loans to businesses for energy efficient equipment, providing an opportunity for businesses to use the savings of their new equipment to cover its initial expense (The Carbon Trust, 2011a, p. 3). Such generous incentives and others could accompany a report presented to a small business. Outlining the possible ways to cover the expenses could render business owners more apt to accepting our suggested changes.

Despite the United Kingdom's goals to reduce the nation's energy usage, many small business owners are reluctant to take additional actions against climate change. This poses difficulty for Council's attempts to target small businesses as a means of reducing the Borough's overall carbon footprint. While the CRIRB team successfully conducted seven audits of small businesses (and four of Council buildings) in the Borough, they encountered this difficulty when

recruiting businesses for their audits. Based on their efforts, this study investigates methods for soliciting businesses' participation in energy audits in order to develop insights into methods for continuing to reduce the energy usage of small businesses throughout the Borough.

3. Methodology

Our study aimed to help the Council reduce the energy usage of small businesses by providing insights into how future Council efforts could effectively solicit small businesses for energy audits. These energy audits can help reduce small businesses' energy usage, and subsequently, the Borough's carbon footprint. Our team developed the following objectives to achieve this goal:

1. Investigate available solicitation methods for contacting SMEs in Reigate and Banstead and develop a sample of local SMEs to contact,
2. Recruit small businesses for energy audits using these methods,
3. Characterize best practices in energy auditing for SMEs in Reigate and Banstead and conduct energy audits of recruited businesses,
4. Develop individualized audit reports detailing opportunities for each business to profit based on the audit results, and
5. Analyze the solicitation outcomes and audit results to develop insights into how the Council could effectively promote energy-conserving techniques through further energy audits and marketing materials.

In order to accomplish these objectives, our team attempted to engage businesses using four methods of solicitation: email, phone, in-person visitation, and referral. We observed businesses' reactions to our solicitation attempts to explore the effectiveness of these methods and ascertain as much as possible about small businesses as an audience for future solicitation. After testing our solicitation methods, we conducted energy audits to locate areas where each recruited business could feasibly, and inexpensively, reduce its energy usage. Our team then prepared audit reports to be presented to each business owner, designed in a way that would encourage them to take the time and spend the money to implement our recommendations. A feedback survey accompanied our audit reports, which inquired as to business owners' motivations for participating in our audits to understand how to better conduct future solicitations. We also categorized our results as well as those provided by the CRIRB team by industry in order to identify common areas for improvement and frequently recommended solutions. We then developed case studies using the compiled results as marketing materials to encourage businesses owners of the same industry to reduce their energy usage. Our analysis

concluded with an examination of the effectiveness of each solicitation method identifying possible insights for how the Council could continue to solicit businesses for energy audits in the future.

Our solicitation, auditing, and analysis were conducted in a seven-week period, while background research for developing our auditing strategy was conducted before our team arrived in the United Kingdom. During this period, we completed our solicitations and began conducting audits in our third week; in total, our team solicited 300 businesses and conducted six independent audits. We then provided recommendations as to how those businesses could reduce their energy usage. The following sections explain in detail the methods and rationale our team used for soliciting businesses and conducting audits to identify insights for how the Council could continue to audit small businesses as a means of reaching their sustainability goals.

3.1. Objective 1: Investigate solicitation methods for contacting SMEs

Determining how to solicit businesses effectively using different methods required our team to investigate available methods of solicitation and how each could be employed to recruit businesses in Reigate and Banstead. Our team determined the methods we would test based on the experiences of the CRIRB team, our sponsor's recommendations, and the feasibility of obtaining a viable sample of businesses.

Prior to this study, the CRIRB team conducted seven energy audits of small businesses as well as four energy audits of Borough and County facilities, concluding that energy audits can feasibly help the Council reduce the Borough's carbon emissions. As mentioned in section 2.3, their team cited difficulty in recruiting businesses for their study.

Based on their attempts, our team decided to test soliciting businesses via phone and email with a larger sample size in order to determine the time efficiency of these methods. Given the ease of, phone and email solicitations, on a large scale, both could prove very time effective for future efforts by the Council.

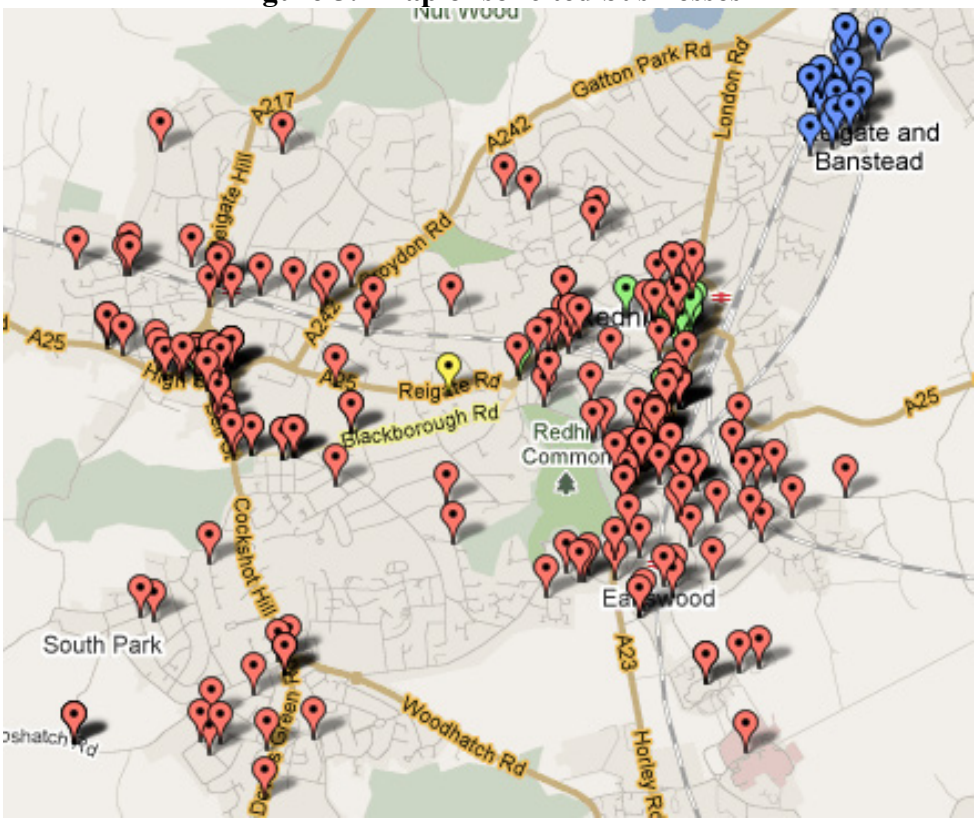
In an effort to test solicitations using a more personal method, we chose to solicit a group of businesses by in-person visitations. These visits would explain our goals to help businesses reduce their energy usage, saving money and reducing their carbon emissions in the process.

In addition, discussions with our sponsor suggested that referrals through business associations, industrial estates, and other organizations with connections to small businesses could provide another effective mode of solicitation. In this way, businesses owners could be

more apt to participate in an audit if they were informed of the opportunity from a contact they already consider credible or trustworthy, as opposed to a telemarketing call or email message by a person unknown to the recipient.

For security reasons, the Council was unable to provide us with a list of businesses in the Borough we could use as a sample. Instead, we compiled a list of viable businesses using a number of local directories, business indexes for local industrial parks, and maps of local areas. The distribution of our sample across each area is shown in Figure 5.

Figure 5: Map of solicited businesses



In order to minimize the time required to conduct in-person visits, our sample was stratified based on businesses' proximity to the Redhill, Reigate, and Earlswood rail stations. This allowed our team to conduct the visits with the least walking time between each business. As the majority of businesses in these areas are retail businesses, our sample for in-person visits could have been skewed toward the attitudes of retail business owners. Overall, our team identified a sample of 300 businesses to solicit via email, phone, and in-person visits.

3.2. Objective 2: Recruit small businesses for energy audits using these methods

Our team tested engaging businesses via the listed methods and developed insights regarding small businesses as an audience for solicitation. Once we stratified our initial sample, we solicited 300 businesses using all four methods over a period of seven days.

Furthermore, given that the Borough Council did not possess the personnel to continue conducting audits immediately after the conclusion of this study, the number of businesses our study could solicit was limited by the number of audits we could conduct within our seven-week time period. Our solicitations using each method and how they were carried out is outlined in the following section.

3.2.1. Email

Before departing for London, our team composed an email to 36 members of the Holmethorpe Industrial Estate, the area initially targeted by the CRIRB team for their audits. Our study selected this area to contact by email as it was the only accessible directory that contained businesses' email addresses. These email messages were individually sent using a team member's WPI email address.

The body of the message sent to these businesses, shown in Figure 6, explained our goal to provide energy audits to help businesses save money on their energy bills, stressing the opportunity for businesses to profit from the effort.

(This space intentionally left blank.)

Figure 6: Initial email solicitation template

Dear [contact name here],

We are contacting you to inform you of an exciting opportunity. The Reigate and Banstead Borough Council is providing free energy survey of small businesses in order to assess the potential for both energy and monetary savings.

Each survey will be conducted by undergraduate students from the Worcester Polytechnic Institute, Massachusetts, who will be conducting research in the UK conducting carbon audits for the borough throughout May and June. As part of our research, we will produce a practical action plan tailored to your organization's needs.

The surveys will help you:

• Become aware of your energy usage

• Identify energy-saving opportunities

• Define practical solutions

We will strive to make recommendations that have little to no cost. Where capital expenditure is necessary, we will calculate the payback period and explain possible funding opportunities (e.g. Carbon Trust 0% loans). Businesses that implement cost effective energy efficiency measures can save around 20% a year on energy costs.

The surveys will take place between the beginning of May and the beginning of June 2011. However, the number that can be undertaken during this period will be strictly limited; appointments will be made on a first-come, first-served basis.

After receiving no responses within two weeks, we reconsidered our attempt and composed a new message. Discussions with our sponsor led us to believe that the length of the message may have led readers to constitute the message as junk mail. Based on this, a new, brief email was devised, which explained our objective more concisely, as shown in Figure 7:

Figure 7: Brief email solicitation template

Dear [contact name here],

We are contacting you to inform you of an exciting opportunity. The Reigate and Banstead Borough Council is providing free energy survey of small businesses in order to assess the potential for both energy and monetary savings. Please view the attached flier for more information.

A flier created by our sponsor for use by the CRIRB team, shown in Appendix D, was attached to provide additional information for the business owners. By sending both iterations of

our solicitation email to the same group, this study could examine the possible effectiveness of disseminating a brief message over a verbose one.

As shown in Figures 6 and 7 above, both messages stressed how business owners could save money by participating in energy audits using the marketing methods outlined in section 2.7. In designing our solicitations to promote the possible savings for business owners, we acknowledged their monetary concerns, which may help promote energy audits in a manner to entice businesses to participate.

In addition, our initial solicitation emails were sent using our team's WPI email addresses, as they were distributed before arriving in London. After the second set of emails received no responses, the same message was distributed again using our Council email addresses, perhaps bolstering their credibility to local business owners while adding another variable to the effectiveness of our email solicitations.

In this manner, the 36 email solicitations sent allowed our study to determine the effectiveness of attempting to contact small business owners via email to promote energy audits. Our team also estimated the time required to send an email to determine the efficiency of conducting email solicitations on a large scale.

3.2.2. Phone

After receiving no responses from their email solicitations, the CRIRB team resorted to calling businesses to recruit them for their audits. In order to accomplish this, their team developed a script to follow when contacting each business. Our team developed a similar script to utilize with our phone sample, which is shown in Figure 8. In order to conduct more effective audits our team decided to further stratify our sample based on businesses that owned or rented their facility. We chose to first offer audits to businesses that owned their facility, continuing to businesses that rented. We decided that businesses that rented their facility would be less able to implement any suggestions, so we chose to first offer audits to businesses that owned their facility.

Figure 8: Initial phone solicitation script

Good Morning,

My name is _____ calling on behalf of the Reigate and Banstead Borough Council. We are doing a quick survey of local businesses. Could you please tell me if the business owns the building in which it resides?

(If yes) We are offering free energy audits from the Council. We were wondering if you have any interest in this.

(If they ask what it entails) An energy survey may save you a substantial amount of money off of your annual utility bills. Two individuals working on behalf of the council walk through your facility and examine its lighting, insulation, heating, and the behavioral habits of the staff. A walkthrough will typically last anywhere from 15 minutes to an hour. After finishing the walkthrough of the building, we will then produce a report with our energy saving recommendations for your business. Would you be interested in this?

(If yes) We also have a small survey we would appreciate you filling out that includes some preliminary information that will be helpful for our energy survey. Would you prefer us to e-mail or fax it to you? What email/fax number can you be reached?

(Schedule audit) We are available Mon-Fri from 11:30am until 3:30pm, which time and day works best for you?

(If no) Ok, thank you very much for your time.

(If rent) Ok, thank you very much for your time.

When conducting these calls, if the caller established that the business owned their facility, they were offered an energy audit. As in our email messages, the calling script promoted energy audits by outlining the possible benefits for savings for business owners in order to encourage their participation in our audits.

After pilot testing within our team, the script was used to contact 172 local businesses. During each solicitation attempt, the following data was recorded:

- **The businesses' response**: Whether a business decided to participate in an energy audit, their response allowed an examination of the effectiveness of phone solicitations.
- **Call termination point**: Noting the point at which the business refused an audit or declined to respond to our questions provided insights into the script's design and how it could better explain the purpose of our audits before the business terminated the call

- **Call Time:** Once our solicitations were completed, we determined the average time required for our attempts to estimate the time efficiency of our calls.

After receiving few positive responses, we revised our script, as shown in Figure 9, in order to provide additional context as to our credibility as students working for Council.

Figure 9: Revised phone solicitation script

> Hello,
>
> My name is _____, I'm a university student working with the Reigate and Banstead Council. We're helping the Council provide free energy audits that can help reduce your energy bills. Are you interested in this?
>
> (If they ask what it entails) An energy survey may save you a substantial amount of money off of your annual utility bills. Two individuals working on behalf of the council walk through your facility and examine its lighting, insulation, heating, and the behavioral habits of the staff. A walkthrough will typically last anywhere from 15 minutes to an hour. After finishing the walkthrough of the building, we will then produce a report with our energy saving recommendations for your business. Would you be interested in this?
>
> (If yes, schedule the audit)
>
> (If no) Ok, thank you very much for your time. If you do wish to set up a time for an energy survey, please contact Raymond Dill at the Reigate and Banstead Borough Council to arrange a date.

This revised script explained our premise at the very beginning of the call, before the recipient was given the chance to refuse to answer the first question. Our team tested this script on the 72 businesses of our initial sample of businesses to solicit by phone that rented their facility. During these solicitation attempts, our team recorded the same data noted above as well as the call recipient's demeanor in order to determine if our revised script helped to alleviate tension created by the previous script. These responses were categorized on a gradient to encompass respondents angered by the call; those were dismissive; or intent on terminating the call as quickly as possible; and those who responded kindly. Weightings for this gradient were assigned as shown in Table 7.

Table 7: Recipient response ratings for revised phone solicitation script

Value	-3	-2	-1	0	1	2	3
Response	Angry	Cold	Annoyed	Indifferent	Dismissive	Nice	Kind

Using these weightings, we computed the average of the values assigned to each category which allowed us to determine the average response of our calls.

3.2.3. In-person Visits

In addition to the above methods attempted by the CRIRB team, our group visited businesses in Redhill and Reigate. We choose this method as a more personal alternative to solicitation via phone and email. A sample of businesses centered around the Reigate and Redhill rail stations was selected. This group was first called in order to stratify our sample based on businesses that owned their facility. Two team members then visited these businesses leaving fliers, identical to those distributed by email, shown in Appendix D, at businesses where owners were unavailable. During these visits, we noted the businesses response, positive or negative, to determine the effectiveness of this solicitation method.

Over a period of five days, our team conducted 30 in-person visits. After the visits were completed, our team estimated the average time required for successful and unsuccessful visits. This data was then used to provide an estimate for the time required to conduct visitations on a large scale. These data and estimations were utilized to weigh the overall return of our solicitations against the effort required to determine an efficient method of solicitation to recommend to the Council.

3.2.4. Referrals

Our study also attempted to recruit businesses through business associations and other organizations with connections to groups of businesses in the Borough. In this way, solicitation attempts could be disseminated through channels small business owners may already find trustworthy or credible. After discussions with our sponsor, our team identified that such referral solicitations could occur directly, by receiving information regarding businesses to audit from a credible contact, or indirectly through business organizations. Direct referrals could occur via

any of the above solicitation methods. Conversely, indirect referrals could prove efficient for the Council to employ for contacting small businesses, as the solicitation itself is performed by the business organization.

After guidance from our sponsor, we contacted the chairman of the Holmethorpe Industrial Estate, Robert McIntyre, who agreed to contact the affiliated businesses and inform them of our audits. In addition, our sponsor provided two contacts to solicit directly using his name to perhaps bolster our credibility.

3.3. Objective 3: Develop an auditing method and conduct energy audits for recruited businesses

Our group conducted audits for the small businesses that agreed to participate during our recruitment. In order to accomplish this, our team developed an auditing procedure tailored specifically for small businesses. As noted in section 2.7, the budget concerns of small businesses required that our audits seek out areas for improvement and recommend solutions these businesses would be likely to implement. This entailed both an understanding of energy auditing procedures and familiarity with common areas to recommend to small businesses that could be addressed with simple and inexpensive solutions.

Our team developed our auditing procedure by reviewing literature in the field regarding common auditing procedures for large facilities and the methods of the CRIRB team. These procedures, mainly outlined in the *Handbook of Energy Auditing* (2008) by Therman and Younger, provided a basic overview of methods behind an energy audit, though many of the procedures required the acquisition of data during the audit, such as lux-level measurements using a light meter, which would have proved infeasible to collect for such small-scale audits. In addition, the methods outlined in the *Handbook of Energy Auditing,* as well as reports prepared by the Carbon Trust, demonstrated the calculations necessary to evaluate the energy savings and possible payback period of recommended solutions. These sources proved useful for devising a basic walkthrough auditing procedure and outlined the data we were required to collect during our small-scale audits.

Prior to conducting our own audits, our team shadowed Ian Sharpe, an energy auditor from the Surrey County Council, on two walkthrough audits of County facilities located in Reigate and Banstead. Ian demonstrated how to apply our walkthrough procedure in the field by

explaining common areas for improvement. During the walkthroughs, he explained how to deconstruct a facility's boiler system to identify its energy usage and possible recommendations for reducing its energy consumption. He also noted areas that could benefit from the use of infrared light controls or natural lighting. Further recommendations included improving insulation around doors and windows to reduce energy usage. These observations helped guide development of our own auditing procedure and checklist.

The development of our auditing procedure culminated into two methods of gathering data to recommend solutions and generate our reports: a survey to distribute to businesses before the audit, and a checklist to guide our auditing procedure in the field. Both the pre-audit survey and checklist, described in detail below, helped us to concisely conduct our audits and recommend simple solutions to encourage small businesses to reduce their energy usage.

3.3.1. Pre-Audit Survey

In order to gather basic information about a business before conducting the audit, we requested that each business complete a short survey upon scheduling each audit. Those businesses which requested to receive the survey by email were sent a link to a Google survey; otherwise, a hard copy of the same survey was hand-delivered to the business. The caller scheduling the audit requested that the business complete the survey before the scheduled date for the audit. If the business did not complete the survey, our team asked the same questions at the beginning of the audit to obtain the information needed for our reports.

The survey requested straightforward information about the facility's employees, operating hours, means of obtaining heat, and any energy concerns they wished to provide (see Appendix G for details). In this way, audited businesses were given the chance to raise any specific concerns in regards to their energy usage, giving our team the opportunity to tailor our audit process accordingly. As the calculations required for estimating the energy savings of our solutions sometimes required the overall energy usage of a facility, the survey asked the business to provide their energy bills during the audit.

3.3.2. Audit Checklist

Our team also developed a checklist to follow as we conducted each audit to outline and collect our observations. Review of traditional auditing procedures, the Carbon Trust auditing

methods, and the CRIRB team's previous auditing work in the Borough, all demonstrated use of such a checklist as a method of cataloging such data. As previously noted in section 2.5, these checklists denote areas for examination of a facility's lighting, heating, insulation, and behavioral practices to ensure auditors note specific observations and recommendations for each area.

Our checklist was based heavily on the CRIRB team's checklist and the Carbon Trust's office based checklists, shown in Appendices H and I, respectively. As the CRIRB team and our team shared the same audience as our audits, their checklist was already tailored to observing areas that could be improved with simple solutions; and we used their checklist as a basis for our own. In addition, however, we incorporated the inline suggestion format of the Washington State University checklist, Appendix J, to allow the audit team to suggest possible solutions while conducting the audit. In this way, the solutions for a given area could be easily evaluated during the audit, based on the businesses' specific needs. This checklist could also prove useful for conducting future audits, as it ensures a standard auditing procedure and outlines possible solutions, meaning the audit need not be conducted by a highly-trained energy auditor, familiar with a variety of possible solutions.

Two team members conducted each audit using this checklist, recording observations of possible areas for improvement in lighting, heating, insulation, and behavioral practices of employees through discussions with a manager of the facility. The checklist aimed to provide a platform for recording concise observations in each area for improvement and outline possible solutions. The observations, energy usage data, and discussion notes were used to recommend solutions in our audit reports.

3.4. Objective 4: Develop individualized audit reports detailing opportunities for each business to profit based on the audit results

Audit reports, or "action plans," were prepared for all audited businesses explaining the observations gathered during the audits and providing specific solutions for reducing the each business' energy usage. As mentioned previously, our study aimed to recommend simple, inexpensive solutions in order to entice business owners to take action to reduce their energy usage and subsequently their carbon footprint. The observations and possible solutions gathered for each audit provided data from which to evaluate and prioritize the solutions for recommendation to small businesses. Reports were then generated for each audit stressing how

each business could profit from implementing these simple solutions to reduce their energy usage.

After analyzing the auditing data and suggested solutions, our team chose to prioritize the solutions we suggested to only include those that could provide the best energy and cost saving benefits at the least initial expense. In performing this cost-benefit analysis for each solution, we aimed to reduce the length and complexity of the report by evaluating and recommending only solutions business owners would be most likely to implement, specifically those solutions requiring little or no expense. Given the time and budget constraints of small business owners, we designed our reports to explain the recommended solutions as concisely and intuitively as possible. This was intended to make the solutions easier for the owners to implement, and therefore more likely for them to do so.

This method contrasts the extensive audit reports prepared by the Carbon Trust, or the lengthy summaries of findings of the CRIRB team's reports, excerpts of which are included in Appendices K and L, respectively. Despite this, our reports presented each solution in a manner similar to the Carbon Trust and CRIRB team's reports, outlining the estimated expense, savings, and payback period in a table describing the solution, as shown in Table 8:

Table 8: Carbon Trust audit solution table

Priority no. 5	Improve the Building Management System (BMS).			
Cost Saving £/yr	CO_2 Savings tonnes/yr	Energy Savings kWh/year	Cost £	Payback Years
3,217	26.7	145,348	1,500	0.5

Creating an easy to read, overview of the report ensured that a reader could understand the possible savings associated with a solution without being required to read the entire report and calculations. Following this, our rationale for suggesting each presented solution was explained using our observations from the audit—including photographs where applicable—as well as background information on the suggested solutions.

The possible savings and payback period were calculated using observations gathered during the audit and estimates of the possible savings of the suggested energy-efficient devices. We obtained these estimations from our sponsor, who provided the calculations spreadsheet for lighting estimates (shown in the calculations section of Appendices N, O, P, Q, R, and S), as well

as the Carbon Trust's publications on the subject. Based on these estimates and facility's current energy usage, which was determined during the audit, our team estimated the payback period for each expense proposed to business owners.

Our solutions were summarized in the first page of the report with a table listing each solution and the possible savings incurred by each method. We chose to incorporate this method from the Carbon Trust's audit reports, as shown in Appendix L, as we believe it could provide a quick overview of our solutions for business owners, providing the most critical information—the cost and possible savings of each solution—on one page, without the need to spend time to read the remainder of the report. The concluding section of our reports summarized our solutions and the overall energy savings for the business.

After the report was prepared, the audit team printed a copy of the report and scheduled a time to meet with the business owner to discuss the report. These discussions were typically short, and involved a brief discussion of findings and recommendations for each solution, with the hope that personally explaining our solutions to each business owner would add credibility to our findings.

In order to help gauge the effectiveness of our audits and solicitations, our team distributed a feedback survey to business owners with our audit report. This survey, shown in Appendix M, requested businesses' opinions regarding our auditing technique, the quality of the reports, and the method by which they would have preferred to be solicited. The data gathered from these feedback surveys not only allowed us to determine how businesses perceived our auditing procedure and reports, but also provided feedback regarding our initial solicitation attempts.

3.5. Objective 5: Analyze the solicitation outcomes, audit results, and feedback from SMEs to identify insights for the Council

Over the course of our study, our team solicited 300 businesses and conducted energy audits for six businesses. Once our audits and solicitations were completed, our team analyzed: the data obtained during our solicitations through email, phone, in-person visitation, and referrals; the overall energy and carbon savings recommended in our audit reports; and the results of the feedback surveys from business owners. This allowed our team to determine both the effectiveness of our audit and solicitation methods and identify how the Council could best continue to solicit small businesses. While our team was informed that the Borough does not

currently possess the personnel to continue the project in the near future, we aimed to recommend how the Council, or a future project, could continue to solicit SMEs in the future.

In order to accomplish this, our team analyzed our solicitation results to determine which method proved most effective for our study. Our study allowed us to observe the effectiveness of varying levels of body text in emails as well as the effects of in-person visits compared to impersonal methods such as: phone and email solicitation. Based on the solicitation results we were able to obtain, we identified factors that contribute to businesses willingness to participate in our audits.

In addition, our team categorized our audit results by industry to identify common areas for improvement and recommend solutions for specific types of businesses. We also incorporated the audit findings of the CRIRB team to expand our examples when compiling case studies for specific types of businesses. Using these case studies, the Council could present industry-specific recommendations for businesses to outline potential energy savings. Our team then used these examples to create marketing materials for each industry in the form of fliers to demonstrate how the Council could promote energy saving techniques among small businesses without the need to conduct audits on a large scale.

Our team then used this analysis to recommend how the Council could continue to communicate with small businesses to promote energy-conserving habits in the future. This entailed outlining how the Council could utilize the insights we developed to more effectively solicit businesses. In addition, we presented an overview of our audit results, including a summary of our recommended solutions. This overview echoed the conclusions of the CRIRB team that energy auditing can prove a worthwhile measure for reducing the energy usage of both small businesses and the Borough. Based on these conclusions and those drawn from our solicitation results, we were able to provide guidance on how the Council should continue energy auditing for small businesses, in whatever capacity possible, in the future.

4. Results and Analyses

During our seven-week time period, our team developed and carried out procedures for soliciting and auditing businesses in Reigate and Banstead. We set out to solicit businesses and conduct audits to identify insights regarding how the Council could solicit businesses for energy audits in the future. In doing so, our team identified commonalities in both our solicitation practices and audit findings that could help the Council to continue its work to reduce the energy usage of small businesses.

4.1. Developing a sample of businesses to solicit

As discussed in section 3.1, our team compiled a sample of 300 businesses to solicit around Reigate, Redhill, and Earlswood. This list was obtained by searching online directories, including Google Maps, which provided lists of businesses around our targeted areas. Our list was then stratified into groups to contact via each solicitation method based on their location and the availability of the necessary contact information. Based on this, the distribution of our sample across each method, as shown in Table 9:

Table 9: Distribution of businesses by solicitation method

Method	Businesses	Positive Responses
Email	36	1
Call	172	2
In-Person Visit	30	2
Referral	2	1
Total	**300**	**6**

4.2. Email Solicitations

Our team identified a sample of 36 businesses to solicit by email within the Holmethrope Industrial Estate, the area initially targeted by the CRIRB team. Contact information, including email addresses, for these businesses were listed in a directory on the Estate's website. In contrast, the other directories searched only listed addresses and phone numbers of local businesses.

As discussed in section 3.2.1, our team conducted three iterations of solicitations. These three iterations allowed our team to test variations in the message body and sending address using the same sample of 36 businesses in the Holmethorpe Industrial Estate, as outlined below in Table 10:

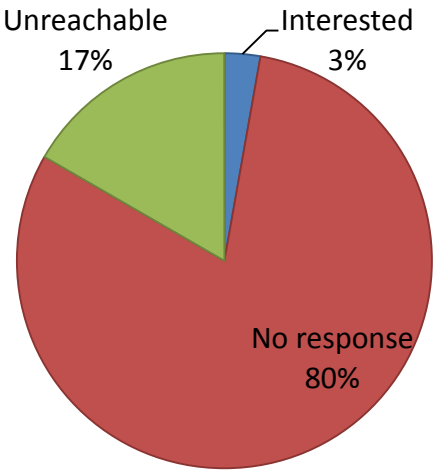
Table 10: Email Solicitation Variations

Iteration	Sending Address	Message Body	Positive Responses
1	WPI	Verbose	0
2	WPI	Brief with attached flier	0
3	Council	Brief with attached flier	1

Examples of our brief and verbose email templates, as well as the attached flier, which was provided by our sponsor, are found in Appendices B, C, and D, respectively.

After sending three iterations of emails to the businesses of the Holmethorpe Industrial Estate, we received a single positive response; the distribution of responses among the 36 contacted businesses is in Figure 10:

Figure 10: Distribution of email solicitations by response



As these email addresses are publically available on the Internet, our team speculates that the addresses provided in the Estate's directory are inundated with email as their addresses are so

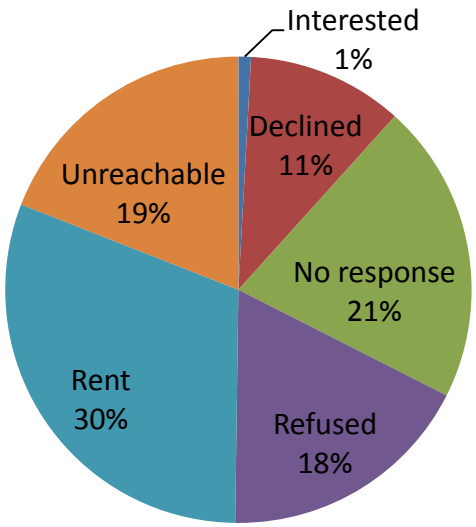
readily available. Based on this, our solicitation attempts may have been buried among countless marketing emails and mistakenly perceived as junk mail by a business owner or mail filter. In addition, eight of the email addresses listed in the Estate's directory no longer existed. As such, a proportion of the other addresses from which we did not receive a response may have been the result of outdated listings as well. This underscores the difficulty of obtaining an accurate sample of businesses to solicit. .

As our team members personally addressed each message, we estimated each solicitation required 30 seconds to complete by timing a mock attempt to send such an email. Based on this, such efforts by the Council could require similarly little time. Furthermore, automation systems for mass email distribution could significantly reduce the time require to completely this solicitation process on a large scale.

4.3. Phone Solicitations

Our team solicited 172 businesses using our initial script, shown in Appendix E. Solicitations using this script stratified our sample by businesses' ownership of their facility, as businesses owning their facility would be unhindered by lease restrictions and thus free to implement changes our audits could recommend. Our solicitation attempts using this script resulted in two positive solicitations of 172 businesses solicited; the distribution of responses across this sample can be seen in Figure 11:

Figure 11: Distribution of initial phone solicitations



Of the remainder of our responses, 11% of solicited businesses responded that they owned their facility, but declined our offer of an energy audit. An additional 19% of the listed phone numbers were no longer in service, further exemplifying the inaccuracies in our compiled sample of businesses.

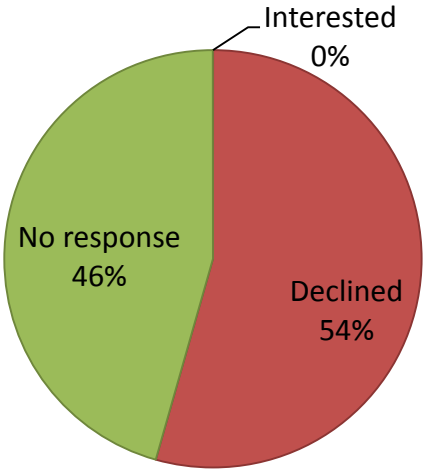
While calling these businesses, our team also encountered difficulty in reaching a member of each business who could answer our script's initial question, "does your business own the building in which it resides?" Many of our calls initially reached a receptionist or salesperson, while our solicitations require contact with a manager or business owner who can consent to an audit. As such, 21% of our solicitations resulted in a lack of response from a business, as the recipient of the call was unable to answer our question or connect us to a member of the business qualified to respond.

An additional 18% of the recipients of our calls outright refused to answer our inquiry regarding the businesses' ownership of the facility. One such respondent replied, "if you were actually working for the Borough, you would know that information", demonstrating that the owner did not trust us from the beginning of the call (for details regarding our access to this data, see section 3.1).

As noted in section 3.2.2, our team revised our calling script to explain our position as students working for the Council in an attempt to bolster our credibility before asking a question of the recipient. This revised script was tested on the 72 businesses of our initial sample to solicit by phone that responded they rented their facility. The distribution of responses for these solicitation attempts is shown in Figure 12:

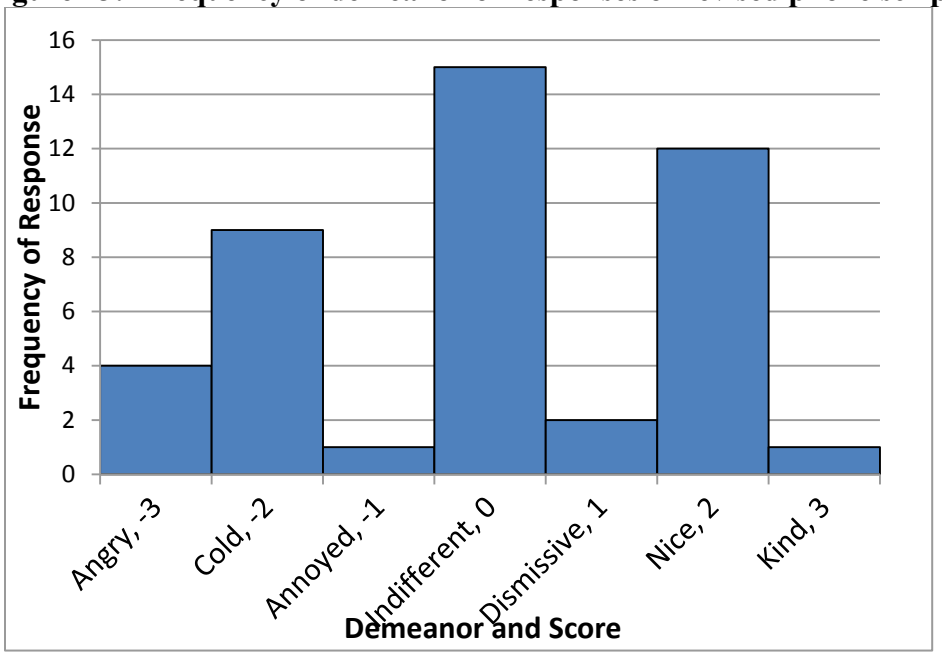
(This space intentionally left blank.)

Figure 12: Distribution of responses for revised phone script



While solicitations using this script did not yield any additional positive responses, our team was unable to reach 46% of owners or managers capable of responding to our offer. In addition, our team also recorded the demeanor of the respondents to investigate the possible effects of our alterations to the script. As discussed in section 3.2.2, the demeanor of our respondents was recorded on a gradient scale as shown in Figure 13:

Figure 13: Frequency of demeanor of responses of revised phone script



Data for those businesses that did not provide a response is based on our interactions with the recipient of the call. The remainder of businesses of the sample did not answer. Based on the scores shown in Figure 15, our revised script received an average response of 0.05, meaning that businesses were mostly indifferent when responding to our solicitations. While our team cannot compare the effectiveness of our two scripts using this method, we can assert that our revised script did not demonstrate any significant change in ability to engage businesses to consider our offer.

Our team also recorded the time required to conduct solicitations using our revised script. Summary statistics for these attempts are shown in Table 11:

Table 11: Summary statistics of call times for revised script

	Time (sec)
Min	50
Mean	173.8
Median	150
Max	600

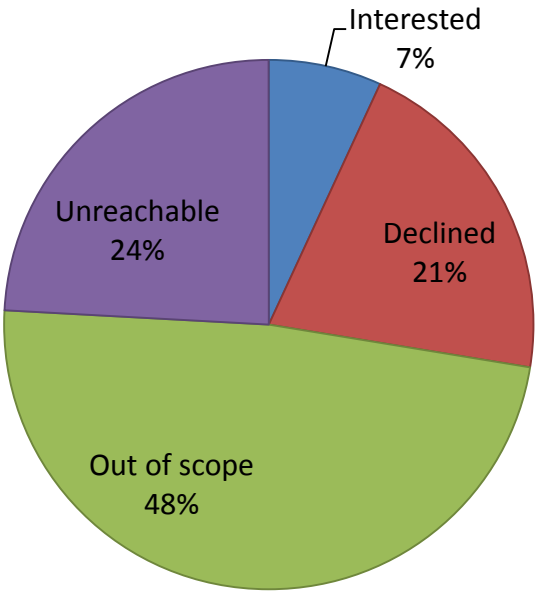
Recorded times were based on the length of the call. A scaling factor of five was determined to account for the time required to record the solicitation data and process any positive solicitations. The scaling factor was determined such that the sum of the scaled times approximately matched the time required to conduct this group solicitations, around one hour. Based on a mean solicitation time of 173.8 seconds—or around 3 minutes, future efforts by the Council could conduct these solicitations relatively quickly.

After conducting 172 phone solicitations, our team received two positive responses, or 1% of our total solicitations. Based on our low overall response volume, our team recognizes the difficulty in attempting to engage business owners to consider reducing their energy usage in the short time frame before the call is terminated. As noted in section 2.7, professional telemarketing firms make the effort to carefully devise scripts to quickly appeal to their target audience. The same professional training and consideration may be required to effectively conduct phone solicitations of small business owners.

4.4. In-person Visits

Our team also identified a sample of 30 businesses to personally visit to investigate alternatives to impersonal email and phone solicitations. In this way, such personal communication with businesses could support our credibility as individuals working for the Council. As discussed in section 3.2.3, our team selected our sample of businesses by identifying a group within walking distance of each other to minimize the required transit time between solicitations. Of the 30 businesses solicited in this manner, our team received two positive responses; the distribution of these responses is shown in Figure 14:

Figure 14: Distribution of in-person visits by response



Most of the businesses our team personally solicited were retail businesses, as our sample was composed of businesses around main streets in Redhill and Reigate. Based on this, we discovered that 48% of the businesses comprising this sample were part of larger chains, meaning they were not small businesses to which we could offer energy audits. An additional 24% of our listings provided an inaccurate address, continuing to stress the need for an accurate sample of businesses to solicit. Of the 30 businesses contacted around Reigate and Redhill contacted, 21% of these businesses declined to participate.

After conducting these visitations, our team estimated the time required to conduct an average visit. Including the travel time between businesses, we estimated a typical solicitation

required 15 minutes. Although these solicitations required significantly more time for us to conduct, solicitations by the Council could conduct the same solicitations more quickly through use of a car to reach each business.

4.5. Referrals

As noted in section 3.2.4, our team also investigated contacting businesses using connections business owners may already deem credible. In this way, business owners may implicitly trust our message based on our connections to a known source. Our team began to investigate direct referrals—soliciting businesses directly after receiving recommendations from a contact. We used two connections provided by our sponsor, one for a local police station operated by the Surrey County Council, and one for a local retail business. These facilities were solicited by phone and in-person visitation, respectively, mentioning that our sponsor had recommended their facility as a candidate for an energy audit. This was successful for the local police station, given our sponsor's connections to other public service employees. However, the retail business was unable to recall a connection to our sponsor during the visit, but considered the opportunity and politely declined.

In addition, our team also investigated indirect referrals by contacting the businesses of the Holmethorpe Industrial Estate again through contacting Robert McIntyre, the chair of the Estate, who agreed to disseminate information about our audits through email. However, this attempt did not yield any additional positive responses.

While solicitations by referral can prove efficient as it provides targeted businesses to contact and, in the case of referrals conducted by a third-party, eliminates the need to solicit businesses directly. However, based on this, the effectiveness of this method is limited by the strength of the contacts' connections to these other businesses.

4.6. Solicitation Findings

Overall, our team solicited 300 businesses using email, phone calls, in-person visits, and referrals to obtain six positive responses—a 2% return, as shown in Table 12:

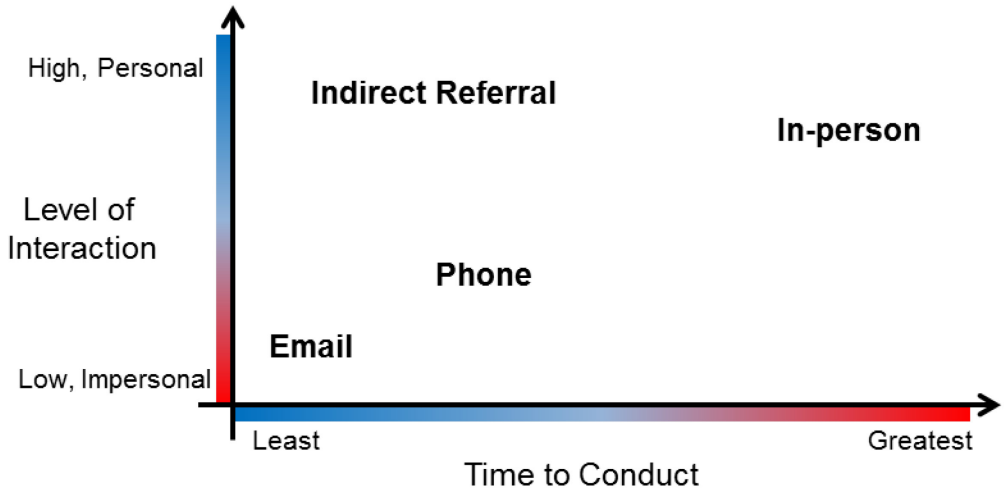
Table 12: Overall distribution of solicitation results

	Total	Positive	%	Percent Unreachable	Time/ Solicitation	Time for one audit
Email	36	1	3%	17%	30 sec.	N/A
Phone	231	2	2	7%	3 min.	4 hours
In-person	30	2	7%	72%	15 min.	3.8 hours
Referral	3	1	*Dependent on reliability of connections.*			
Total	**300**	**6**	**2%**	**25%**		

We estimated the efficiency of our attempts by determining the ratio of the estimated time required to conduct our solicitations and the proportion of positive responses. This estimates the time required to obtain one audit for a given solicitation method. While in-person solicitations showed the highest proportion of positive responses, it also required the most time to conduct each solicitation. Conversely, phone and email solicitations can be conducted more quickly, both in fewer than three minutes per solicitation, though our attempts yielded a lower proportion of positive responses. It is also important to note that 25% of our overall solicitations were unable to reach their targeted audience due to inaccurate contact information for businesses. Based on this analysis, in-person solicitation was the most effective method of solicitation for this study.

After soliciting businesses by email, phone, in-person visitation, and referral, our study has identified that both the time required and ability to communicate our credibility have played key roles in performing solicitations effectively. Our team explored methods employing a variety of time requirements and levels of interaction between the solicitor and business owner, as shown in Figure 15:

Figure 15: Level of interaction vs. time to conduct of solicitation methods



Email solicitations require the least time to conduct; however, a static email message does not actively encourage interaction between the sender and recipient. While solicitation by phone fosters discussion between a solicitor and the recipient, the recipient may terminate the call before the solicitor can establish his or her credibility. Conversely, in-person solicitations immediately establish a more personal interaction between the solicitor and a solicited business owner at the expense of the additional time required to personally visit each businesses. Direct referrals are more difficult to quantify, as they rely on the connections between referring parties and business owners: they could occur using any of the above methods with greater level of interaction a solicitor unknown to a business owner could not achieve. In addition, indirect referrals conducted by a third party would require less time on the part of the solicitor at the same increased level of interaction. However, referral solicitations require an entirely different process to establish contacts with strong connections to business owners.

Based on this, our team identified a tradeoff between conducting impersonal solicitations in large quantities using phone calls and emails and conducting fewer, more individualized solicitations through in-person visits. Given our response rates, our team found in-person solicitations to be the most effective despite the significant time required to conduct each visit. Future attempts by the Council could further investigate methods to enhance the level of interaction portrayed in phone or email solicitations or reduce the time required for in-person visits. This could provide a balance between the level of interaction demonstrated and time required for a solicitation method to recruit businesses more effectively.

4.7. Audit Findings

Our 300 solicitations resulted in reaching six businesses to audit throughout Reigate and Redhill. These businesses varied widely including a restaurant, charity, florist, clothing store, printing company, and police station. This allowed our team to identify commonalities across a variety of business types. A profile of each business is listed in Table 13:

Table 13: Profile of audited businesses

Name	Type	Location
Frankie & Benny's	Restaurant	Redhill
Gerrard's	Retail (Clothing)	Reigate
Greensleeves	Retail (Florist)	Redhill
Printmates	Printing company	Redhill (Holmethorpe Industrial Estate)
Reigate Police Station	Public Service	Reigate
Salvation Army	Charity	Redhill

As discussed in sections 3.3 and 3.4, audits of these businesses were conducted and reports prepared that stressed simple, easy to implement solutions. While conducting these audits, our team members followed our defined checklist and recorded areas for improvement and possible solutions to recommend. None of the audited businesses responded to our pre-audit survey covered in section 3.3.1. When asked for this information during the audit, none of our audited businesses were able to provide complete heating and electric bills to outline their utility costs and average usage. While we were still able to recommend solutions for these businesses, this inhibited some or our estimations as to the impact of our solutions compared to their current total energy usage.

For each of the six audits, our team prepared audit reports, shown in Appendices N, O, P, Q, R, and S, to recommended simple, inexpensive solutions in an attempt to encourage business owners to begin to take action against climate change. By refraining from recommending expensive, large-scale solutions, our team attempted to entice business owners to see that they can easily make changes to reduce their energy usage, to promoting awareness of the issue,

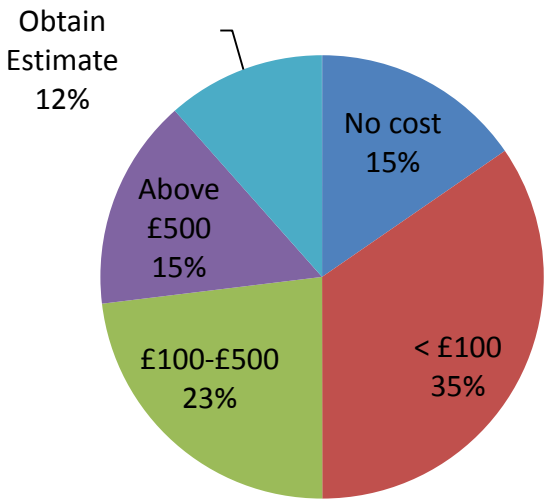
which may lead to further consideration of more large-scale solutions. As such, our reports most commonly recommended the following solutions:

- Using infrared sensors to automatically turn off lights in infrequently-occupied areas
- Turning off lights when sufficient natural light is available for work
- Replacing incandescent bulbs with more efficient Compact Fluorescent bulbs (CFLs)
- Replacing inefficient T-12 fluorescent tubes with T-8 or T-5 fluorescent tubes
- Improving energy awareness by asking employees to turn off lights and shut down computers when not in use

In addition, our team also recommended a variety of additional solutions, including regulating boiler settings, improving insulation, and LED lighting to replace halogen lights. Our team also recommended more elaborate solutions for Printmates, as the request of its owner, investigating a new boiler system and the installation of solar panels to fit into its owner's plans for renovations.

As shown in Figure 17, most of these recommended solutions required very little initial expense—over half of our recommendations cited < £100 in expenses, while 15% of our recommend solutions result in savings with no investment expense

Figure 16: Distribution of solution costs



Overall, our six audits recommended just under £5,700 in yearly savings with a total initial expense of around £5,800, culminating in a potential savings of 31 tonnes of carbon dioxide emissions annually. As shown in Table 14, our recommended solutions would provide an average of £940 in annual savings to each business, with our solutions requiring an average payback period of 1.12 years.

Table 14: Overall audit savings

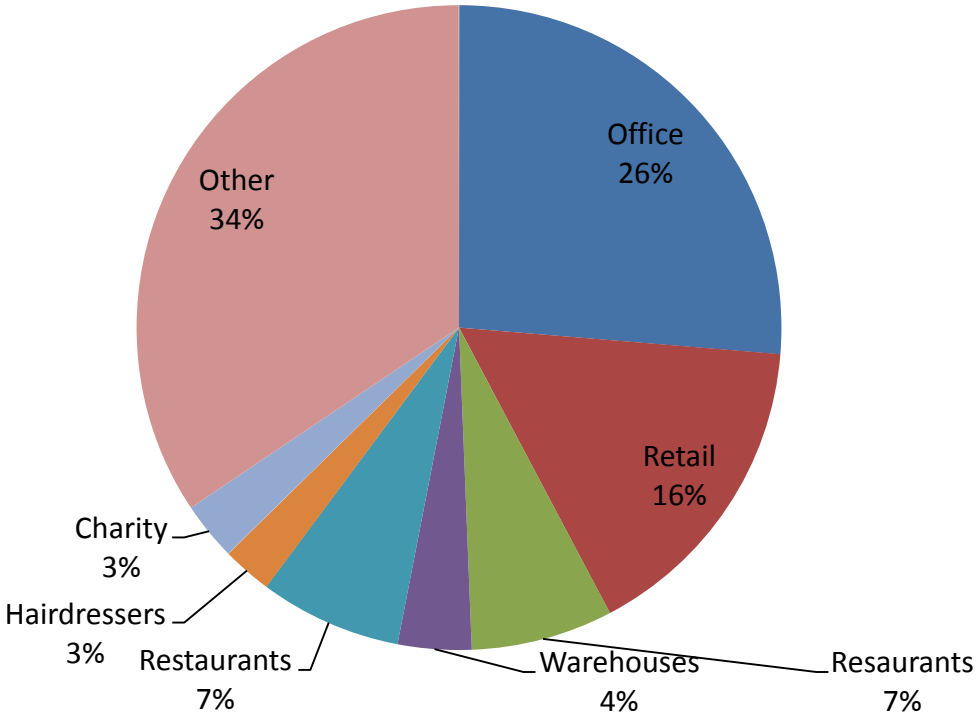
	Initial Expense	Savings			Payback Period
		£/yr	Tonnes CO_2/yr	kWh/yr	
Average	£960	£940	5.1	9,450	1.12 years
Total	**£5,700**	**£5,660**	**31**	**56, 700**	

4.8. Marketing Materials

While our six audits only account for a small portion of small businesses within the Borough, the results from those audits and those of the CRIRB team could be used to develop targeted marketing materials for different industries. Based on this premise, our team classified businesses in the Borough by industry to determine prevalent categories of businesses to target using case studies. Nick Woolley, a health inspector for the Council, provided a listing of businesses in the Borough separated by industry (N. Woolley, personal communication, June 6, 2011). As shown in, analysis of this listing revealed that the greatest proportion of businesses throughout the Borough is classified as offices, while the next most prevalent categories include retail businesses, restaurants, and warehouses:

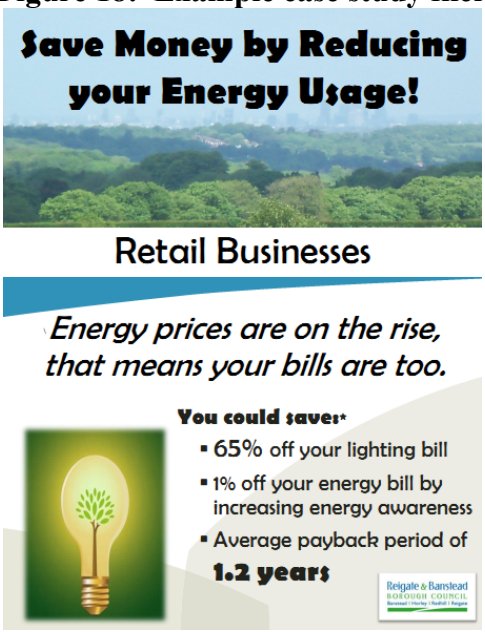
(This space intentionally left blank.)

Figure 17: Distribution of businesses in Reigate and Banstead by Industry (Woolley, 2011)



Using this information as a guide, our team categorized our auditing data and the data provided by the CRIRB team to identify common areas for improvement and possible solutions for specific industries. While neither of our teams conducted audits of audited any office spaces, a collation of our data, shown in Appendix T, yielded samples of two audit results for restaurants, retail businesses, community and public service buildings, printing companies. Our team then compiled our case studies in the form of filers, shown in Appendices U, V, W, and X, as a possible method in which the Council could continue to promote energy awareness among businesses in the future. The flier for retail businesses is shown in Figure 18:

Figure 18: Example case study flier



These case studies aimed to market our example problems and recommended solutions for business owners to encourage them to investigate energy-conserving habits in their own facility. The front of the flier stated, "Energy prices are on the rise, that means your bills are, too," in order to connect our recommended solutions with business owners' expense concerns, as outlined in section 2.7. In this way, business owners may view our fliers as an opportunity to reduce their energy costs and consider investigating the solutions. To reinforce this, the front of the flier also outlined the possible savings and payback period of our solutions.

The reverse side of the flier contained more specific details of the areas for improvement and recommended solutions. Each solution quantified the possible savings, as determined using the data from our audits, as a percentage of a businesses' lighting or heating bill. Details regarding methods for implementing each solution were also briefly listed to encourage business owners to investigate taking action to reduce their energy usage on their own.

Distribution of these fliers for businesses by type could help the Council promote energy-saving habits among small business owners without the need to conduct audits on a large scale. Any audits the Council could conduct in the future could target additional prevalent types of businesses, such as office buildings, to further develop marketing materials. In addition, future auditors could continue audits for the types of businesses targeted by our case studies to identify further areas for improvement and recommended solutions.

5. Conclusions and Recommendations

Our study identified and tested several methods of solicitation and conducted energy audits of small businesses within Reigate and Redhill. We proposed in order assist the Borough to help attain the objectives outlined in their Strategic Energy Strategy. After testing different methods of solicitation and completing six energy audits of small businesses in Reigate and Redhill, our group provided personalized audit reports to each small business with recommendations to help them reduce both their carbon emissions and expenditures on their energy bills

Through the analysis of the success of each solicitation method and the analysis of the personalized energy reports, we were able to recommend how the Council should continue their efforts to help small businesses reduce their carbon footprint and energy consumption. In this way, the Council can work to reduce the energy consumption of small businesses as a means of meeting their goals laid out in the Council's Sustainability Energy Strategy.

5.1. Contributions toward Reigate and Banstead Goals

Through the solicitation and auditing of businesses our project has (1) provided insights how the Council could solicit businesses in the future, (2) developed an improved auditing checklist that can be used in future audits, (3) explained the estimated benefits if such a procedure were applied on a larger scale, and (4)provided case study materials for future marketing efforts.

If the six businesses our group audited implement the suggestions provided, each business could save approximately £940 per business per year and 5.1 tonnes of carbon dioxide emissions per business per year. Overall the Borough would reduce their carbon footprint by 31 tonnes1 tons of carbon dioxide emissions per year. If audits similar to ours were to take place on the 5,700 businesses within Reigate and Banstead, it would save the Borough approximately £400,000 per year and 29,000 tonnes of carbon dioxide emissions per year. If the procedure was further expanded throughout the United Kingdom it would have a proportionally larger impact.

As noted in section 2.1, in order to reach the goals outlined in the national Climate Change Act, the United Kingdom must reduce its carbon emissions by approximately 200 million tonnes of carbon dioxide emissions by 2020 and by 470 million tonnes by 2050.

If the entirety of the 4.67 million small businesses in the United Kingdom adopted the same auditing procedure, the United Kingdom could expect to save £4.4 billion pounds per year and 23.8 million tonnes. Our auditing process, if applied to the entire United Kingdom, would help achieve their overall goal in 20 years – by the year 2031.

5.2. Recommendation 1: Recruit university students to continue providing energy audits

Our project and the CRIRB team have demonstrated that conducting energy audits of small businesses can provide a valuable impact on the Borough's carbon reduction goals for 2050. As previously mentioned by our sponsor, without the teams from Worcester Polytechnic Institute, no other personnel are working to reduce the energy usage of small businesses. Given the Borough's limited resources for conducting energy audits of the small businesses, future IQP projects continue these could conduct efforts as a means of determining more effective methods for engaging small businesses to participate in reducing their energy usage. As it would be infeasible for any team to conduct audits and prepare reports for the 5,700 businesses within the Borough, future efforts could investigate the effects of distributing materials to promote awareness based on our case studies. Future project teams could also conduct audits of types of businesses not investigated in our audits—particularly office buildings—to develop additional case studies to more effectively target groups of businesses throughout the Borough.

In addition, both our team and the CRIRB team did not follow up with audited businesses determining if owners have implemented any of our suggestions and, if so, the actual effects of their changes based on our estimates. These data could prove valuable in continuing to develop the case studies and identify better methods for developing recommendations for future audit reports.

Unpaid students from local universities could continue our efforts as well. This could provide a valuable opportunity for local students to work with environmental issues present throughout their nation. Recruiting such students would allow the energy audits to be continued without requiring the need for significant additional resources.

5.3. Recommendation 2: Develop an accurate list of businesses in the Borough

Our team also recommends that the Council develop an accurate list of businesses to solicit for future efforts to target small businesses. As 25% of our sample of 300 businesses was inaccurately listed, a more accurate list of business would significantly streamline any future

attempts to solicit small businesses for audits. This list could be developed through the use of tax data that is submitted to the borough each year; to eliminate the need to compile a list from existing archives. Alternatively, future efforts could investigate the feasibility of contacting utility companies to obtain a list of companies with substantial energy usage. Based on these data, the future Council auditors could investigate businesses that could receive the greatest benefits from an energy audit.

5.4. Recommendation 3: Obtain accurate energy usage data for audited businesses

The Council could also promote businesses' awareness of their energy bills, which could provide energy awareness and encourage owners to reduce their energy usage solely by considering the rising costs of energy. Promoting awareness of energy usage on bills could encourage owners to retain these bills to consider the change in their own energy usage over time, perhaps enticing owners to take toward reducing their energy usage.

5.5. Concluding Remarks

Our project set out to investigate differing modes for soliciting small businesses in Reigate and Banstead to participate in energy audits in order to develop insights into how the Council could effectively target small businesses for energy audits in the future. Our team solicited 300 businesses via email, phone calls, in-person visits and referrals to ultimately schedule six audits. After an analysis of the time required to conduct our solicitations, we found in-person visitations were the most effective method for our study. In addition, we have identified a tradeoff between the level of interaction presented and time required to conduct each solicitation, recommending that future solicitors investigate methods to "balance" both areas to solicit businesses more effectively. Given the Council's resource limitations and further development of our case studies and study marketing materials to businesses, by industry, could assist the Council further by promoting energy usage awareness among small businesses throughout the Borough on a large scale.

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Appendix

Appendix A – Initial Email Template

Dear [insert contact here],

We are contacting you to let inform you of an exciting opportunity. The Reigate and Banstead Borough Council is providing free energy survey of small businesses in order to assess the potential for both energy and monetary savings.

Each survey will be conducted by undergraduate students from the Worcester Polytechnic Institute, Massachusetts, who will be conducting research in the United Kingdom conducting carbon audits for the Borough throughout May and June. As part of our research, we will produce a practical action plan tailored to your organization's needs.

The surveys will help you:

- Become aware of your energy usage
- Identify energy-saving opportunities
- Define practical solutions

We will strive to make recommendations that have little to no cost. Where capital expenditure is necessary, we will calculate the payback period and explain possible funding opportunities (e.g. Carbon Trust 0% loans). Businesses that implement cost effective energy efficiency measures can save around 20% a year on energy costs.

The surveys will take place between the beginning of May and the beginning of June 2011. However, the number that can be undertaken during this period will be strictly limited; appointments will be made on a first-come, first-served basis.

If you are interested in taking advantage of this opportunity, then please contact:
The Reigate IQP Team, reigateiqp@wpi.edu**.**

Thank you,
The Reigate IQP Team

Appendix B– Brief Email Template

Subject: Reigate and Banstead Council offering Free energy audits

Dear [insert contact here],

We are contacting you to let inform you of an exciting opportunity. The Reigate and Banstead Borough Council is providing free energy survey of small businesses in order to assess the potential for both energy and monetary savings. Please view the attached flier for more information.

If you are interested in taking advantage of this opportunity, then please contact:

The Reigate IQP Team, reigateiqp@wpi.edu.

Thank you,

The Reigate IQP Team

Sarah Dinwoodie
Heather Parker
Nick DeMarinis
Richard Kelly

Appendix C – Flier distributed by email by Raymond Dill

Appendix D– Initial Calling Script

Good Morning,

My name is _____ calling on behalf of the Reigate and Banstead Borough Council. We are doing a quick survey of local businesses. Could you please tell me if the business owns the building in which it resides?

(If yes) We are offering free energy audits from the Council. We were wondering if you have any interest in this.

(If they ask what it entails) An energy survey may save you a substantial amount of money off of your annual utility bills. Two individuals working on behalf of the Council walk through your facility and examine its lighting, insulation, heating, and the behavioral habits of the staff. A walkthrough will typically last anywhere from 15 minutes to an hour. After finishing the walkthrough of the building, we will then produce a report with our energy saving recommendations for your business. Would you be interested in this?

(If yes)We also have a small survey we would appreciate you filling out that includes some preliminary information that will be helpful for our energy survey. Would you prefer us to e-mail or fax it to you? What email/fax number can you be reached at?

(Schedule audit)We are available Mon-Fri from 11:30am until 3:30pm, which time and day works best for you?

(If No) Ok, Thank you very much for your time.

(if rent) Ok Thank you very much for your time. (take note of their business)

Raymond's number (to leave as a callback): 01737 276211

Appendix E – Revised Calling Script

Hello,

My name is _____, I'm a university student working with the Reigate and Banstead Council. We're helping the Council provide free energy audits that can help reduce your energy bills. Are you interested in this?

(If they ask what it entails) An energy survey may save you a substantial amount of money off of your annual utility bills. Two individuals working on behalf of the Council walk through your facility and examine its lighting, insulation, heating, and the behavioral habits of the staff. A walkthrough will typically last anywhere from 15 minutes to an hour. After finishing the walkthrough of the building, we will then produce a report with our energy saving recommendations for your business. Would you be interested in this?

(If yes, schedule the audit)

(if no) Ok, thank you very much for your time. If you do wish to set up a time for an energy survey, please contact Raymond Dill at the Reigate and Banstead Borough Council to arrange a date.

Appendix F –Pre-audit survey

Pre-Audit Survey

Please answer the following questions to the best of your ability.
Any information you can provide will be very helpful in conducting the audit.

Occupancy

- What are the typical operating hours for the business on Weekdays? Weekends? Holidays?
- How many full-time employees are there? How many part-time?
- Approximately, how many hours of the day are the lights on?
- Approximately, how many hours of the day are computers (if any) on?
- Is it common practice for the computers to be placed in standby or shut down at night? Over the weekend?

Building

- How many buildings are included within the business?
- What is the age of building(s)?
- What is the purpose of the building(s)?
    - Storage
    - Retail outlet
    - Manufacturing facility
    - Other
- Do you own, rent, or lease this space?
- Would you be able to provide building plans to the group to be used during the audit?
- Would you be able to provide the most recent utility bills, including electric, water, and heat?
- How many square meters does the business cover?
- How many stories does the building have?

- What construction materials is the building built from? (i.e. brick, lumber, rock, concrete, etc.)

Observations

- Please list any complaints you may have in regards to the heating and lighting of the business.

- How energy efficient do you believe the business to be? (1 – very poor, 10 – very efficient)

- Please list any other observations you have in regards to the energy efficiency of your business.

Appendix G –Audit Checklist

Basic Information	
Date of Energy Audit:	
Department/Building/Area covered:	
Persons conducting audit:	
Normal occupancy hours of building:	

Lighting	
Are any tungsten lights present? Look particularly in store rooms, up lighters, desk lamps etc. · replace with compact fluorescents · replace with LED · Not Practical to replace	
If there are several light switches, can they be labeled to make it more obvious which switches relate to which fixtures?	
Is daylight being used effectively? · Locate work stations adjacent to windows · Turn off lights when daylight is sufficient · Clean windows and skylights · Install light sensors and dimming equipment which	

compensates for natural lighting	
Lights on in intermittently occupied spaces(bathrooms, storerooms ..) · Install sensors · Install timer · Behavioral change	
Are any external lights on during daylight hours? · Install sensor · Put on timer · Behavioral change	
Are light levels too high or is there lighting from multiple sources? · Turn off main lights to make use of ambient lighting	
Is the light level to low/are bulbs dull? · Clean light fittings	
Have two lamps been removed from four-lamp fixtures where possible?	
Number of T-5 lights	
Number of T-8 lights	
Number of T-12 lights	
Number of Halogen lights	
Number of CFLs	

Heating

What is the actual temperature in the space?	
Does the temperature vary much during the day? · Change the location of thermostats from areas subject to extreme temperature fluctuations, such as next to window, or over a heating or cooling unit.	
Do occupants complain it is too hot or too cold?	
If there are Thermostatic Radiator Valves (TRVs), are they set correctly? Do they actually work or are they broken?	
Are radiators effective and giving consistent heat? They may need bleeding of air or maintenance to remove dust and sediment.	
If the room tends to overheat, is there any bare pipework that could be insulated?	
Are radiators blocked, restricting air circulation?	
Are external doors and windows closed when heating is on? · Add automatically closing door · Behavioral change	
Are windows in good condition? Are any window panes	

cracked or broken? Are windows insulated? · Replace broken windows · Get double pane windows · Add removable addition to current windows	
Is Heating/cooling started before people arrive or operates during the last hour of occupancy? · Experiment with start times to get satisfactory comfort levels · Reduce or turn off heating or cooling during the last hour of use.	
If there is a roof space, is it insulated? · Before replacing water damaged insulation, repair roof where required. · Verify that vapor barrier faces the conditioned space and is intact. · Add new insulation to meet recommended standard. (check the cost effectivenessof this measure)	
Space temperatures are higher or lower than Thermostat settings. · Recalibrate thermostat. · Ensure that heat generating device is producing heat and that heat distribution to the space is unobstructed. · .Make sure that air intake volume is not excessive.	
Is heating on in unoccupied or little used spaces? · Reduce winter thermostat to 55º in unoccupied areas · Turn off heating if nothing in space can freeze · Use spot heaters in large spaces with low occupancy · Increase summer thermostat setting in unoccupied areas	
Have thermostat settings been adjusted for change in seasons? · Adjust thermostats to 68ºF in heating season and to 78ºF during cooling season.	
Are building temperatures adjusted for unoccupied periods? · Reduce thermostat settings by a minimum of 10ºF at nights, for weekends and holidays during heating season, but maintain ventilation · Shut down air conditioning units at night, on weekends and holidays · Install automated system for above	
How many kW do the boilers use?	
How long is each boiler on per day?	

Cooling and Ventilation	
If there is air conditioning with local controls, make sure it is only on when necessary. Is it obvious how to control it? What temperature is it set to?	
Is air conditioning running at the same time as heating? · Check heating and cooling set points	
Are all external doors and windows closed when air conditioning is on? · Behavioral change · Automatically closing doors	
Is natural ventilation (e.g. windows and doors open with no air conditioning on) being used?	
Is air conditioning on in unused spaces, such as cupboards, corridors? · Turn off air conditioning in these spaces · Close or block vents	

Electrical Equipment	
Are computers, printers, photocopiers and other equipment switched off at the end of the day? · Set to turn off automatically · Behavioral change	
Can computers and other electrical equipment be programmed to 'power down' or 'energy save' mode?	
Can a 7 day timer be put on some equipment (e.g. photocopiers, water coolers, cold drinks machines) to regulate when systems are powered down?	
Can any equipment be switched on later and switched off earlier?	
Can kettles be removed if there is a wall mounted boiler?	
Are fridges places next to heat sources?	
Do evaporator coils have heavy ice build-up · Defrost coils regularly · Determine if the defrost system is improperly adjusted or defective · Determine if air is leaking into refrigerated area from defective door gaskets or poorly sealed wiring or piping	

penetrations.	
Is the fridge thermostat working and set to the right temperature (2-4 °C)?	
Is equipment clearly labeled so that staff knows how to activate energy saving features or switch it off?	

Water Use

Is there any evidence of water leaks? (e.g. wet pathways on a dry day)	
Are taps left running? Are there any dripping taps? Do taps need maintenance?	
Are hot water heater timers set correctly?	
How long does the hot water calorifier take to heat up?	
How long is the hot water calorifier on for per day?	
Is a surrey council water audit recommended?	

Awareness and Building Usage	
Are there posters/guidance displayed to remind people of good practice?	
When is the building primarily used and what is it used for?	

Made with reference to the State University Cooperative Extension Energy Program Energy Auditor Checklist

Appendix H –Excerpt of Checklist from D11 IQP Team

Basic Information

Date of Energy Audit:	
Department/Building/Area covered:	
Persons conducting audit:	
Normal occupancy hours of building:	

Lighting

Are any tungsten lights present? Can they be replaced with compact fluorescents (energy saving bulbs)? Look particularly in store rooms, uplighters, desk lamps etc.	
If there are several light switches, can they be labelled to make it more obvious which switches relate to which fixtures?	
Can lights be switched off to make use of daylight? (e.g. lights parallel to windows or in corridors)	

Can light sensors be installed in spaces that are intermittently occupied (e.g. store rooms, toilets, kitchen areas, copying rooms, corridors, etc)	
Are any external lights on during daylight hours?	
Can main lighting ever be switched off to make use of ambient light and desk lamps?	
Do any light fittings need cleaning?	
Do windows and skylights need cleaning to allow in more natural light?	
Number of T-5 lights	
Number of T-8 lights	
Number of T-12 lights	
Number of Halogen lights	
Number of CFLs	

Appendix I – Carbon Trust Office-based checklist

Example energy walk round checklist

Date of energy walk round:	Checked	Further action needed y/n
Heating (see page 4)		
Are there staff complaints about the temperature?		
Have heaters/boilers been serviced in the last 12 months?		
Are portable heaters being used?		
Are heaters and air conditioning units operating in the same space?		
How is hot water provided?		
Do all areas have the same heating requirements?		
Is the room thermostat working and set to the correct temperature?		
Are the timers working and on the correct settings?		
Are other heating controls working and on the correct settings?		
Are there obstructions in front of radiators or heaters?		
How are extractor fans controlled (e.g. in toilets)?		
Are windows and doors open when heating or air conditioning is on?		
Are there any cold draughts coming from windows or doors?		
Lighting (see page 7)		
Are lights switched off (is daylight sufficient/room not in use)?		
Are any old large diameter fluorescent tube lights still in use?		
Are lamps, fittings and rooflights clean?		
Are traditional tungsten light bulbs still in use?		
Are light switches arranged conveniently and labelled?		
Is exterior lighting switched off when not needed?		
In the office (see page 10)		
Have computers got built-in energy saving features and are they activated?		
Are computers left on overnight?		
Are monitors switched off when not in use?		
Are photocopiers located in air conditioned areas?		
Are printers and photocopiers left on overnight/at weekends?		
Are vending machines/water coolers left on all the time?		
In the factory/warehouse (see page 12)		
Are pumps/fans/compressed air switched off when the equipment they serve is not in use?		
Do you hear compressed air leaks?		
Are refrigeration units being run efficiently?		

Appendix J – Excerpt from Washington State University Checklist

COOPERATIVE EXTENSION
WASHINGTON STATE UNIVERSITY
ENERGY PROGRAM

ENERGY AUDITOR CHECKLIST **

A. BUILDING ENVELOPE	Does this problem exist?		Recommended		N/A
	Y	N	Y	N	
1. Improper alignment and operation of windows and doors allows excessive infiltration.	[ ]	[ ]			
Suggested O & Ms:					
a. Realign or re-hang windows or doors that do not close properly. In extreme cases, consider permanent sealing of windows.			[ ]	[ ]	[ ]
b. Make sure automatic door closing mechanisms work properly.			[ ]	[ ]	[ ]
c. Replace or repair faulty gaskets in garage or on other overhead doors.			[ ]	[ ]	[ ]
Suggested ECMs:					
a. Resize exterior doors; i.e., delivery doors, making them smaller to reduce excessive infiltration.*			[ ]	[ ]	[ ]
b. Add expandable separate enclosures, where practical.			[ ]	[ ]	[ ]
c. Install self-closing doors on openings to unconditioned spaces.			[ ]	[ ]	[ ]
d. Install a switch on overhead doors that prevents activation of heating and cooling units when doors are open.			[ ]	[ ]	[ ]
e. Install vestibule doors at major entrances.*			[ ]	[ ]	[ ]
2. Weather-stripping and caulking around windows, doors, conduits, piping, exterior joints, or other areas of infiltration where it is worn, broken or missing.	[ ]	[ ]			
Suggested O&Ms:					

Appendix K – Excerpt of D11 IQP Team Wray Fire Complex Report

Potential Savings

There are many areas for potential savings and energy reduction. These areas are detailed in two different sections: (1) No Cost Solutions and (2) Cost Solutions

3.1 No Cost Solutions

No cost solutions consist of behavioral changes that will allow for monetary savings and energy reduction. These solutions are outlined by building, area, problem, solution, and savings in Table 1 below:

Building	Area	Problem	Solution	Savings
Headquarters	Office Rooms and Kitchen	Skylights provide a decent amount of light, yet lights were on.	Ask staff to turn off lights below skylights during the day when natural light is sufficient	~£95 per year (Based on two 18w tubes with 4w ballast loss in each fixture being run during full daylight hours 10-3 at 11p/kWh)
Headquarters	Kitchen	Furniture blocking radiators, causing a reduction in efficiency	Rearrange furniture so that all radiators are clear from obstruction	This will increase the efficiency of the heating system within the building, resulting in savings
Headquarters	Offices	Windows are being open due to certain areas being too warm	Close windows and lower the operating temperature of the building to adjust for discomfort	By closing the windows, the temperature will reach its desired level, which will let the boilers reduce their output to sustain the temperature
Headquarters	Boiler Room	More hot water is being heated than is actually necessary. The	Look into decommissioning /disabling One of the two	By decommissioning one of the calorifiers, you

		hot water system no longer serves a restaurant, as well as only serving 20 trainee residents as opposed to the 60 residents in the past.	hot water calorifiers.	would reduce your energy use for hot water heating by £366 per year (Based on a 500 liter hot water calorifier with a stored water temperature of 65 degrees running 7 hours per day with a 1 hour heat up time 365 days per year at 2.23p/liter from British Gas)
Dingle	Building	Low occupancy in building, while the whole building is being heated.	Review occupancy of the building, by potentially increasing the number of occupants or moving current occupants out of the building. If this is not an option, consider the cost solution of zoning the building and not heating unused areas.	If occupants move from the building, boilers in the Dingle will be able to be shut off. We estimate this to save £17,000 per year (Based on three 200 kW boilers being run 7 hours per day, 5 days a week for 39 weeks at 80% efficiency with British Gas supplying natural gas at 2.23p/kWh)

3.2 Low Cost Solutions

Low cost solutions are solutions that have a low initial cost with a small payback period. These solutions will result in yearly savings after the payback period has been completed. Table 2 outlines the solution, cost, savings per year, and payback period.

Solution	Investment Cost	Savings Per Year	Payback Period
Replace T-5, T-8, T-12, and Halogen lighting with LED lighting	£4,797	£791 per year	6.1 years (calculations shown in Appendix A)

4. Recommendations

We have arranged our recommendations by priority. Table 3 below illustrates solutions that should be considered moving forward.

Priority no. 1	Improve Energy Awareness		
Cost Savings £/year	**Energy Savings kWh/year**	**Cost £**	**Payback Period**
£1,079	*23,268*	*None*	*Immediate*
Detail	The energy survey revealed that there are potential opportunities to increase energy efficiency and save money via improved housekeeping. As noted in the Summary of Findings, lights were being left on despite ambient light radiating down from skylights. Asking staff to turn off these lights when they are not needed will reduce the electric bill per month, resulting in a moderately high amount of annual savings. The same can be said about turning off computers and other equipment when it is not being used. Additionally, radiators were being blocked by furniture and rooms were being overheated. Closing windows and properly circulating heat around the offices and kitchen area will reduce the cost of heating. We estimate these simple changes to reduce the total energy consumption by 1% annually. In order to accomplish this goal, small notes, posters, and stickers reminding staff to turn off lights and equipment as well as shutting windows are necessary. These notes will help remind staff about energy efficiency. Talking to the staff about energy awareness will also help in reducing cost.		

Priority no. 2	Replace Current Lighting with LED Lighting Solutions		
Cost Savings £/year	**Energy Savings kWh/year**	**Cost £**	**Payback Period**
£791	*7,907*	*£4,797*	*6.1 Years*
Detail	The energy survey revealed that there are potential opportunities to replace current lighting with LED lighting solutions. LED Lighting provides similar lumens at much higher efficiency		

	than current light fixtures. 8 Watt T-5 LED tube outputs almost identical lumens per watt as an 18 Watt T-5 fluorescent tube. Additionally, they last 50,000 hours, which is over 30,000 hours longer than a typical T-5 tube. The calculation takes into account all current lights being replaced by LED lights. Another option would be to only replace current T-8, T-12, and halogen lights with LED lighting solutions. This will reduce the cost savings per year to £566, saving 5,660 kWh/year with an initial cost of £2,791. This gives a quicker payback period (4.9 years) and may be a better option than replacing all lights. Replacing current lighting with LED solutions will have an initial cost, but will save a lot on energy bills after the payback period is completed.

Priority no. 3	Review Boiler Systems and Occupancy of Dingle		
Cost Savings £/year	**Energy Savings kWh/year**	**Cost £**	**Payback Period**
£17,366	*784,820*	*Minimal*	*Immediate*
Detail	The energy survey revealed that the Dingle is an area that is currently underused, yet requires a large amount of energy and money to run. Three boilers in the basement of the Dingle heat the entire building. However, only two offices are used. Moving these offices to a different space would allow for the boilers to be shut down, as the Annex is heated by unit heaters. This will drastically reduce kWh on the gas bill for the Dingle, resulting in a high amount of savings. Additionally, the energy survey also revealed that the two hot water calorifiers in Headquarters used to service a restaurant, as well as an additional 40 residents. Since the restaurant has been decommissioned and there are approximately 20 residents living in the complex, we recommend shutting down one of these hot water calorifiers entirely.		

Appendix L – Excerpt from Carbon Trust action plan regarding carbon reduction opportunities

Priority no. 5	**Improve the Building Management System (BMS).**			
Cost Saving £/yr	**CO_2 Savings tonnes/yr**	**Energy Savings kWh/year**	**Cost £**	**Payback Years**
3,217	**26.7**	**145,348**	**1,500**	**0.5**
Detail	At present Dorking Halls heating is controlled and managed by a stand-alone BMS and overseen by an external contractor, who monitor alarms and carry out remedial works as required. It was reported during the survey that there are a number of issues with the BMS that are costing Dorking Halls. Firstly the BMS was recording an external temperature of 2°C whilst it was manually recorded at 0°C, which will affect all aspects of heating and cooling as most functions of the BMS are controlled by the external temperature. Secondly the timing schedules throughout the theatre turn the heating on from 7am to 12am every day, regardless of occupancy. This equates to unnecessary heating in areas that are vacant and on Christmas Day, when the theatre is closed. Lastly the areas on the BMS that Dorking Halls personnel have access to and adjust, are overly complicated and unclear. It is advised that Dorking Halls carry out a full BMS audit to ensure that the controls system is working correctly and controlling all aspects as designed. It is also advised that Dorking Halls appoint a full time member of staff to get actively involved in the BMS, to update timing schedules on a daily basis to ensure that the sections of the theatre are only heated when required. There may be the potential to link the performance scheduler program utilised when artists are booked into the BMS, to prevent the doubling of work.			
Rationale	A poorly configured BMS has the potential to waste significant amounts of energy and money; Sensibly arranged timer schedules within the BMS have the potential to save money, carbon emissions and wear and tear on equipment; Removing the "human element" from remembering to switch things off leaves one less thing to chance.			
Risks	Lack of expertise on site.			
Next Step	Review and record existing BMS schedules, temperature settings and control parameters; Formulate the site ideal operating profile for heating and ventilation in all areas; Implement changes to the BMS settings in accordance with ideal operating profiles created above. External assistance may be necessary to achieve this stage; Monitor the effect on energy consumption, quantify and disseminate results.			
Relevant Publications	CTG002 - Heating control technology guide GIL155 - How to control heating costs at work GIL156 - How to Maintain Your Heating System CTX603 - Switch to saving DVD - Heating and Lighting			

Appendix M – Feedback Survey

Reigate and Banstead Borough Council Energy Audit Feedback

Thank you for taking the time to complete this survey. Please use the form below to indicate your feedback.

* Required

Name of Business

Date of Audit

Quality of Report and Recommendations

How would you rate the overall quality of the report?

- ○ High Quality
- ○ Good Quality
- ○ Fair Quality
- ○ Poor Quality

Were the recommendations feasbile and useful for the business?

- ○ Yes
- ○ Somewhat
- ○ No

Will any of the recommendations be implemented?

- ○ All
- ○ Some
- ○ None

Was the energy audit a valuable use of time?

- ○ Yes
- ○ No

Would you recommend an energy audit to other businesses?

- ○ Yes
- ○ Possibly
- ○ No

Appendix N– Salvation Army Report

Overview

Our energy audit showed that your facility was already quite energy efficient. Your use of natural lighting in the Church Hall, recreation room, and office and programmable heating timers are excellent methods to reduce your building's energy usage. In addition, our audit team developed a few recommendations to help reduce both your heating and lighting expenses:

Priority	Item	Summary	Expense	Time to Implement	Estimated Savings			Expected Payback Period	More Information
					£/yr	Tonnes CO_2/yr	kWh/yr		
1	Allow heat to coast at the end of the day	By turning off the heat before people leave at the end of the day you save money and allow the residual heat to keep the building warm	*None*	1 Week	23.36	2	371	*Immediate*	Page 3
2	Replace T-12 Bulbs with T-8	T-12 bulbs are the most inefficient fluorescent bulbs and should be replaced with newer T-8s	£8	*Minimal*	9.56	0.06	112	1 year	Page 4
3	Add sensors to automatically turn off hallway lights	Sensors in an infrequently-occupied area like a hallway can automatically shut off lights	£25-30	1 Week	8.45	0.05	99	3 years	Page 5
Total			£38	1 Week	41.37	2.11	584		

Priority 1	Allow heating to "coast" at the end of the day			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
None	23.35	2	371	*Immediate*

Observations

We observed that timers controlled the boiler and heating system and are configured to operate only when the building is occupied.

Analysis

Regulating the operating hours of your boiler is already an efficient means of minimizing its energy usage. In addition, the boiler's operation could be regulated further by modifying the existing settings to turn off the heating and boiler an hour before the end of the day and will allow the residual heat to maintain the building's temperature for the remaining hour.

In this way, our team estimates that modifying the timer settings to shut off the boiler and heating one hour before the end of the day could reduce your gas usage by 371 kWh annually.

Please note: the estimated monetary savings is based on an average estimate for the price of natural gas. Based on your supplier, your actual savings may vary.

How to Implement

During the winter months, observe the time required for the building to cool down after the timers shut off the heating system and adjust the timer settings for the end of each day accordingly. These settings may require some calibration over the first winter season due to fluctuations in temperature and your building's ability to retain heat.

Priority 2	Replace T-12 Fluorescent Tubes with T-8 Tubes			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£8	9.56	27	112	**1 year**

Observations

We noticed two 80W T-12 fluorescent tubes installed in the hallway between the office and recreation area.

Analysis

T-8 fluorescent tubes can provide the same amount of light as T-12 tubes while using 40% less energy. In addition, T-8 tubes cost roughly the same and are compatible with fixtures designed for T-12 tubes. As a result, replacing these T-12 tubes in the hallway with T-8 tubes provides a simple method to reduce your energy usage by 510 kWh/yr.

For additional information, please see the calculations section below.

How to Implement

Purchase 5ft (150cm) T-8 fluorescent tubes to replace the T-12 tubes. Note that the T-8 tubes will have a lower wattage than T-12 tubes while providing the same amount of light.

Priority 3	Add sensors to automatically turn off hallway lights			
Estimated Expense	**Estimated Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£25-30	8.45	0.05	99	**3 years**

Analysis

Fitting the hallway with an infrared sensor that turns on the lights only when occupied can reduce your energy usage and remove the need for occupants to bother controlling these lights with switches while providing the same energy savings.

These sensors can detect the heat emitted by an occupant to switch on the lights when someone is present, and keep the room lit when it is occupied and for a configurable period of time after the occupant has left the room.

If the two T-12 fluorescent tubes in the hallway are replaced with comparable, more efficient T-8 tubes, adding a PIR sensor as well could reduce the energy usage of the tubes up to 70%.

Please note: as PIR sensors will vary the energy usage of the lights based on the occupancy of the room, our calculations can only estimate the possible energy savings for this solution. Our calculations assume that the sensor turns on the lights for 20% of your facility's operating hours, your results may vary. For more information, see the attached calculations spreadsheets.

How to Implement

These sensors usually use passive infrared sensors (PIR) to detect the heat of a human body entering a room. Once triggered, the sensor contains a timer, which keeps the light on for a configurable duration in order to prevent the need for quick retriggering. Such sensors can be installed in the ceiling of the hallway or mounted in wall switches for easy retrofitting to existing systems.

Final Analysis

Overall, our walkthrough audit observed that your building was already very energy efficient. We were impressed to find lights turned off in the recreation room, Church Hall, and office where natural light was available and the boiler controlled to operate within building hours for the entire week. In addition, we have recommended three possible solutions that could help reduce your building's energy usage by an additional 584 kWh. By implementing these solutions and maintaining your already energy-conscious attitude toward lighting and heating, your building can continue to reduce its energy consumption in the future.

If you have any questions or would like any additional information, feel free to contact our team at reigateiqp@wpi.edu.

Appendix O – Printmates Report

Overview

We conducted an energy audit of your business and the table below outlines the energy saving methods we recommend. It is followed by a in depth explanation and analysis of each recommendation.

Priority	Item	Summary	Expense (£)	Time to Implement	Estimated Savings			Expected Payback Period	Eligible for ECA	More Information
					£/yr	Tonnes CO_2/yr	kWh/ yr			
1	Replace T-12 bulbs	Use T-8 bulbs instead of T-12 as they are more efficient	£80	A week or less	143	.91	1685	7 months	No	Page 4
2	Set computers to save energy	Use the power save options to have the computers automatically standby and hibernate	*None*	30 min	27	.17	312	*Immediate*	N/A	Page 5
3	Add an occupancy sensor in bathroom and kitchen	Use a PIR sensor to automatically turn the bathroom lights on and off	£35-45	One day	46.53	0.298	548	*~ 1 year*	N/A	Page 6
4	Replace incandescent bulbs	Use CFL's because they last far longer and use less energy than incandescent bulbs	£12	Less than an hour	*See detailed explanation*			1000 hours of operation	N/A	Page 7

5	Use natural lighting when available in main office	Turn office lighting when enough natural lighting is available for work	*None*	*None*	120.67	0.76	1,420	*Immediate*	N/A	Page 8
6	Seal entrances and exits on production floor	Adding a closer to the office door and a plastic strip curtain to the loading bay door can prevent heat from escaping	£20	Less then a day	*Obtain estimate after heating system is replaced*				N/A	Page 9
7	Solar Panels	Install solar panels on southern facing roof	Est. £16,791, *See detailed explanation*		2,018	1.72	3,165	8y 9m	No	Page 11
8	LED lights for new Dropdown roof	Since you are investing in a new roof we recommend using efficient lighting	*Estimate Required*		*Depends on lighting plan*					Page 13
9	Heating Change	Install an alternative heating source to avoid oil heating	*Estimate Required*						Yes	Page 14
Total					2355	3.858	7147			

Priority 1	Replace T-12 Fluorescent Tubes with T-8 Tubes			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
£80	143	.91	1685	7 months

Observations

We noticed three rows of six T-12 two-tube fixtures, which we estimate to be 6ft(1800mm) long and either 75 or 85 Watts.

Analysis

T-8 fluorescent tubes can provide the same amount of light as T-12 tubes while using 40% less energy. In addition, T-8 tubes cost roughly the same and are compatible with fixtures designed for T-12 tubes. As a result, replacing these T-12 tubes in the hallway with T-8 tubes provides a simple method to reduce your energy usage by 510 kWh/yr.

For additional information, please see the calculations section below.

How to Implement

Measure the length of the existing T-12 bulbs and purchase T-8 bulbs of the equivalent length. Note that the T-8 tubes will have a lower wattage than the T-12 tubes while providing the same amount of light.

Note: If the bulbs are 2.4m long instead of the estimated 1.8m, comparable T-8 tubes are not produced for your fixtures. As an alternative, purchase new, smaller fixtures to accommodate the smaller tubes, or wait to refrain from altering the lighting until the roof is replaced.

Priority 2	Use power saving options on computers			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
None	27	.17	312	**Immediate**

Observations

We saw that almost every computer in the office area and studio was left running while unoccupied.

Analysis

A desktop computer typically consumes between 60 and 250 watts. When placed in sleep or standby mode, computers consume around 1-6 watts. In addition, turning off the computer's monitor reduces the monitor's energy consumption to nearly zero.

All operating systems contain built-in features to automatically control a computer's energy usage. We recommend setting your computers turn off monitors after 15 minutes of inactivity and place computers in sleep or standby after 45 minutes.

Our calculations for energy savings assume a 100 watt desktop with 12 hours of inactivity spread among the six computers per day

1. 100 Watt* 12 hours/1000=1.2 Kwh per day
2. 1.2*5 days=6 kwh per week
3. 6 *52 =312 kwh per year

How to Implement

Simply enable power saving options computers used throughout the office and work area. These power options allow for a wide range of control of a computer's energy usage. Our recommendations only provide examples, we recommend adjusting the settings to meet your needs. To view and modify these settings:

- On Windows machines:
  1. Start
  2. Control Panel
  3. Power options
  4. Select a tab called "Choose when computer sleeps," or similar
- On a Mac OS, open:
  1. Preferences
  2. Energy saver

Priority 3	Add occupancy sensor in bathroom and kitchen			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
£35-45	46.53	0.298	548	~1 year

Observations

We noticed that the lights in the infrequently occupied bathrooms and kitchen area on the manufacturing floor were turned on, despite signs requesting employees to turn them off after use.

Analysis

Fitting the bathrooms and kitchen area with infrared sensors that turn on the lights only when the room is occupied can reduce your energy usage and remove the need for occupants to bother controlling these lights with switches while providing the same energy savings.

These sensors can detect the heat emitted by an occupant to switch on the lights when someone is present and keep the room lit when it is occupied and for a configurable period of time after the occupant has left the room.

If the bathroom and kitchen areas are only occupied for 20% of operating hours, adding PIR sensors to control the three T-8 fluorescent fixtures in the bathroom and kitchen areas could reduce their energy usage by up to 90% compared to leaving the lights on during the entire day.

These sensors usually use passive infrared sensors (PIR) to detect the heat of a human body entering a room. Once triggered, the sensor contains a timer, which keeps the light on for a configurable duration in order to prevent the need for quick retriggering. Such sensors can be installed in the ceiling of the hallway or mounted in wall switches for easy retrofitting to existing systems.

Note: as PIR sensors will vary the energy usage of the lights based on the occupancy of the room, our calculations can only estimate the possible energy savings for this solution. Our calculations conservatively assume that the sensor turns on the lights for 20% of our facility's operating hours, your actual results may vary. For more information, see the attached calculations spreadsheets.

How to Implement

Given that this solution will promise a return on investment in around a year, we recommend waiting to implement this solution until the building is renovated.

Many options exist for differing installation types. If you intend to install sensors before renovating the building, we recommend retrofitting sensors to replace existing wall switches. Otherwise, investigate installing ceiling-mounted sensors when planning your renovations.

Priority 4	Replace incandescent bulbs with CFL's			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/1000h operation**	**kWh/1000h operation**	
£12	£1.46/hr of operation	0.1	17	**1000h of operation**

Observations

We noticed three incandescent bulbs in the upstairs bathrooms and storage rooms. Due to the availability of natural light through skylights in these for our calculations we will assume that the bulbs are a standard 75 watt bulb.

Analysis

Compact fluorescent bulbs last about 10 times longer, use a quarter of the energy, and produce 90% less heat then incandescent bulbs of the same illumination. Replacing these bulbs is an easy solution to reduce your facility's energy usage.

As these lights are turned off during the majority of operating hours, we cannot provide a reliable estimate for the payback period of changing these bulbs. However, CFLs generally consume £1.50 for every 100 hours of operation, meaning a return on the expense of the bulb after 1000 hours of operation. Note that the average lifespan of a CFL bulb is around 8000 hours.

How to Implement

Examine existing incandescent bulbs in the bathrooms to determine their wattage. Using the table to the right as a guide, purchase CFLs with an equivalent wattage to provide the same amount of light as the previous bulbs.

(http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12060)

Table 1. Comparable Wattage of CFLs and Incandescents

Incandescent Wattage	CFL Wattage
25	5
50	9
60	15
75	20
100	25
120	28
150	39

Priority 5	Use natural lighting in office when available			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
None	120.67	0.76	1,420	*Immediate*

Observations

We noticed that fluorescent lighting in the office was turned on despite natural light available through the large row of windows.

Analysis

We noticed that lights in the office hallway, entry area, and restrooms were already turned off because natural lighting was available. Turning off the lights in the office as well is a simple way to further reduce your energy usage.

If enough daylight is available for work during 40% of operating hours, we estimate an annual savings of 1,420kWh. As the amount of available daylight will vary based on weather conditions, actual results will vary.

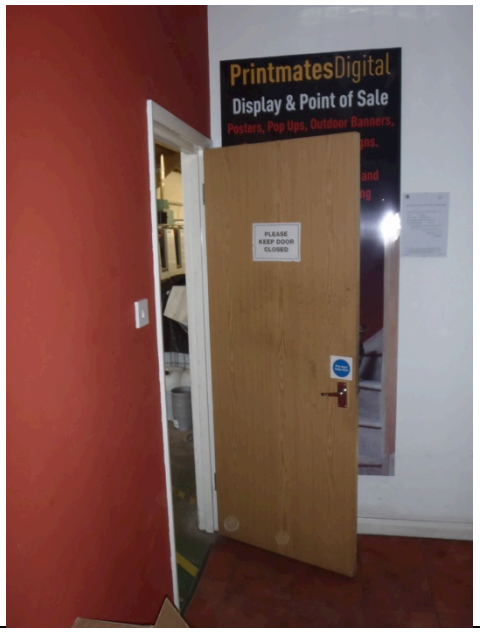
How to Implement

Simply turn off the office lighting when sufficient daylight is available for work. Alternatively, if the fluorescent bulbs in the office support dimming, purchase a light sensor that will automatically dim the office lights when sufficient natural light is available.

Priority 6	Seal entrances and exits on the factory floor to reduce heat loss			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£20	*Obtain estimate after heating system is replaced.*			

Observations

- We noticed that the door between the office and work area was often left open despite the sign on the door. This allows heat and cooling to escape from the office to the more poorly insulated industrial floor.
- We also noticed that the loading bay door was open while the factory was running. While this does not present an issue in the winter, it would allow heat to easily escape the factory floor during the winter months.



Analysis

- Adding a manual door closer is relatively cheap and easy way to guarantee the door stays closed, preventing heat loss during the summer and winter and also reduce noise levels.
- If the loading bay door must be left open during the winter months, adding a plastic strip curtain or air curtain to the loading bay door could prevent additional heat from escaping the facility.

How to Implement

As both the heating system and factory ceiling will soon be replaced, we cannot accurately estimate the possible energy savings of these solutions. We recommend you consider the following solutions and their possible energy-saving opportunities when planning your renovations.

Priority 7	Solar Panels			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
£16,791	2,018	1.71	3,165	8y 9m

Observations

Your 30x18m roof faces North-South at around a 40° angle and is unobstructed by other buildings—a viable opportunity for the installation of solar panels. In order to take advantage of the most available daylight, panels should be installed on the southern-facing side.

Analysis

After reviewing multiple sources outlining estimations for expenses and payback periods for installing solar panels, we determined an average profit of £52,355.49 for the 4kW system used for the calculations over its 25 years lifespan. For exact details of this particular estimate, see http://www.solarguide.co.uk/solar-pv-calculator?sc_form_type=2#bestresult.

Note: pricing for solar panels and Feed-in Tariff rates (see below) will have changed in one year when your business is ready for renovations. Furthermore, these calculations can only estimate the total expense and payback period for a solar panel installation on your roof—we recommend that you seek professional estimates for more exact projections.

Funding Options

The Feed-Tariff (FiT) is a program maintained by the UK to encourage the generation of green energy. It works by paying a certain rate--currently 43.3p for a 4 KW retrofit system, for each kilowatt your system generates. The complete table of tariffs till 2012 can be found at http://www.fitariffs.co.uk/eligible/levels/.

The FiT also ensures an export rate of 3.1p/kW for any unused electricity sold back into the grid, which is indexed to rise with the price of electricity.

More information on the FiT can be found at http://www.fitariffs.co.uk/.

Note: We have recommended a 4 KW system as it qualifies for the maximum FiT rate. The rate bracket is at a 10KW system. Buying a system rated for slightly more then 4 KW is a bad idea as it bumps you into a lower tariff without providing significantly more electricity.

How to Implement

When obtaining estimates for possible solar panel installations, ensure that any contractor you consider is accredited by MCS (the Microgeneration Certification Scheme) in order to ensure your system qualifies for Feed-in-Tariff program.

Our research indicates three methods for obtaining a solar panel system; we have litsted their benefits and drawbacks in order of preference:

- **Purchase the system yourself**
  - **Pros:** Most profit over time
  - **Cons:** Large up front cost
- **Obtain a loan to pay for the system**
  - **Pros:** Little up front cost
  - **Cons:** Due to the interest on the loan the payback period is longer, reducing the profit gained from your system
- **"Rent a Roof" schemes**
  - Some businesses offer to install solar panels for free but then retain ownership of the system in order to profit from the FiT returns, allowing the building to take advantage of the electricity the system generates
    - We do not recommend this solution as it negates any profits from your system and entails relinquishing ownership of your roof the lifetime of the system, usually 25 years.

Suggested Reading:

http://www.squidoo.com/payback-from-photovoltaic-pv-solar-panels-in-the-uk
http://www.solarguide.co.uk/solar-pv-calculator?sc_form_type=4#factors
http://www.fitariffs.co.uk/

Priority 8	Use LED bulbs for new lighting			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
Depends on lighting plan; obtain estimate				

Observations

Since you are investing in a new roof and dropdown ceiling for insulation reasons we recommend in investing in using energy efficient lighting at the same time.

Analysis

You will need to consult a professional to determine the level of lighting required based on the height of your new ceiling. However, we suggest investigating LED lighting, which provides highly efficient directed lighting, or T-5 fluorescent tubes.

While LED lights are more expensive than fluorescent lighting solutions, they have a lifespan of around 30,000 hours or 25-30 years of normal use and produces less heat then other types of lighting. Despite the initial expense, LED lighting solutions will promise excellent returns over their lifetime.

Note: Exact estimates for their efficiency will vary based on the type of fixtures installed in your facility. We recommend obtaining an estimate to determine the expense and payback period of specific solutions for your factory floor.

Enhanced Capital Allowance:

There is an opportunity to subtract the cost of a new lighting system from the business's taxable profit as long as the lighting installed meets the guidelines set out in the Energy Technology Criteria List. The outlines of the ECA and how to claim it can be found here http://www.eca.gov.uk, while specific guidelines on LED criteria is in the PDF on this page: http://www.eca.gov.uk/etl/find/_P_Lighting/105.htm?tab=CriteriaPanel

Priority 9	Replace Oil Heater			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
Estimate Required				

Observations

The factory floor was heated with a large oil-based heater.

Analysis

If you intend to replace the heater during your renovations, we recommend you consider the options below.

- **Air Source Heat Pumps:** These heaters pressurize outside air as a heat source. They do not currently qualify for the RHI incentive (similar to the FiT, except for renewable heating) but the government intends to extend eligibility to air source heat pumps from 2012 depending on successful conclusions of analysis of their costs. A local business called Isoenergy installs air source heat pumps and is MCS accredited.
- **Biomass Boiler:** These boilers burn either wood pellets or logs in order to generate heat and can either feed into a duct system or function as stand alone systems. Biomass boilers require flue for the boiler, zoning permission, and an area to store wood pellets. Biomass boilers will qualify for the RHI incentive when it passes and should save you money on heating. The local business Cowley maintenance sells biomass boilers.

Funding Opportunities

The government is currently investigating a Renewable Heating Incentive (RHI) to provide support for heating systems in a similar manner to the Feed-in Tariff. We recommend that you investigate opportunities provided by this incentive when considering your renovations in a year, when resources explaining available programs have been finalized.

How to Implement

As many available options exist for these renewable heat sources, we recommend obtaining professional estimates when developing your renovation plans.

Final Analysis

Overall, our walkthrough audit observed that your building could greatly benefit from more energy efficient equipment and our recommendations. It is very impressive that you have already shown interest in replacing your roof and purchasing solar panels to improve your energy consumption even more. In addition, we have recommended nine possible solutions that could help reduce your building's energy usage by an additional 7147 kWh. By implementing these solutions and maintaining your already energy-conscious attitude toward lighting and heating, your building can continue to reduce its energy consumption in the future.

We would greatly appreciate your feedback so that we can better conduct future audits. We ask that you fill out the following survey located at: http://tinyurl.com/reigateaudit

If you have any questions or would like any additional information, feel free to contact our team at reigateiqp@wpi.edu.

Appendix P – Greensleeves Audit Report

Overview

We conducted an energy audit of your business and the table below outlines the energy saving methods we recommend. It is followed by an in-depth explanation and analysis of each recommendation.

Priority	Item	Summary	Expense	Time to Implement	Estimated Savings			Expected Payback Period	Eligible for ECA	More Information
					£/yr	Tonnes CO_2/yr	kWh/yr			
1	Take advantage of natural light in main retail area	Turn off lights in main retail area when enough light is provided by natural light.	*None*	*None*	140	0.88	1,635	*Immediate*	N/A	Page 3
2	Install an occupancy sensor in basement/storage room	Use a PIR sensor to automatically turn the basement lights on and off when it is not in use	£35-45	One day	73	0.47	867	~ 6 months	N/A	Pages 4 & 5
3	Replace hallway incandescent lights	Use CFL's because they last longer and use less energy than incandescent bulbs	£12	Less than an hour	*See details*			*1000 hours of operation*	N/A	Pages 6 & 7
Total			£57	One day	£213	1.35	2502	~ 6 months		
Additional Solutions										
4	Replace halogen lighting with LED bulbs	LED light bulbs are 5 times more efficient than halogen light and provide the same level of light.	£368	Two weeks	245	1.56	2980	~ 1.5 years	Yes	Pages 8 & 9

Priority 1	Take advantage of natural light in main retail			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
None	140	0.88	1,635	*Immediate*

Observations

In the main retail room, we noticed 32 halogen lights that remain on for the duration of the operating hours, 7:45-17:45. The front of the store is all windows and glass doors and there is also a window by the register.

Analysis

We recommend reducing the number of hours that the lights are left on to take advantage of natural lighting when sufficient light is provided during daylight hours. Turning off the lights in the office and retail area is a simple way to further reduce your energy usage.

If enough daylight is available for work during 70% of operating hours, we estimate an annual savings of 1,635kWh. As the amount of available daylight will vary based on weather conditions, actual results will vary.

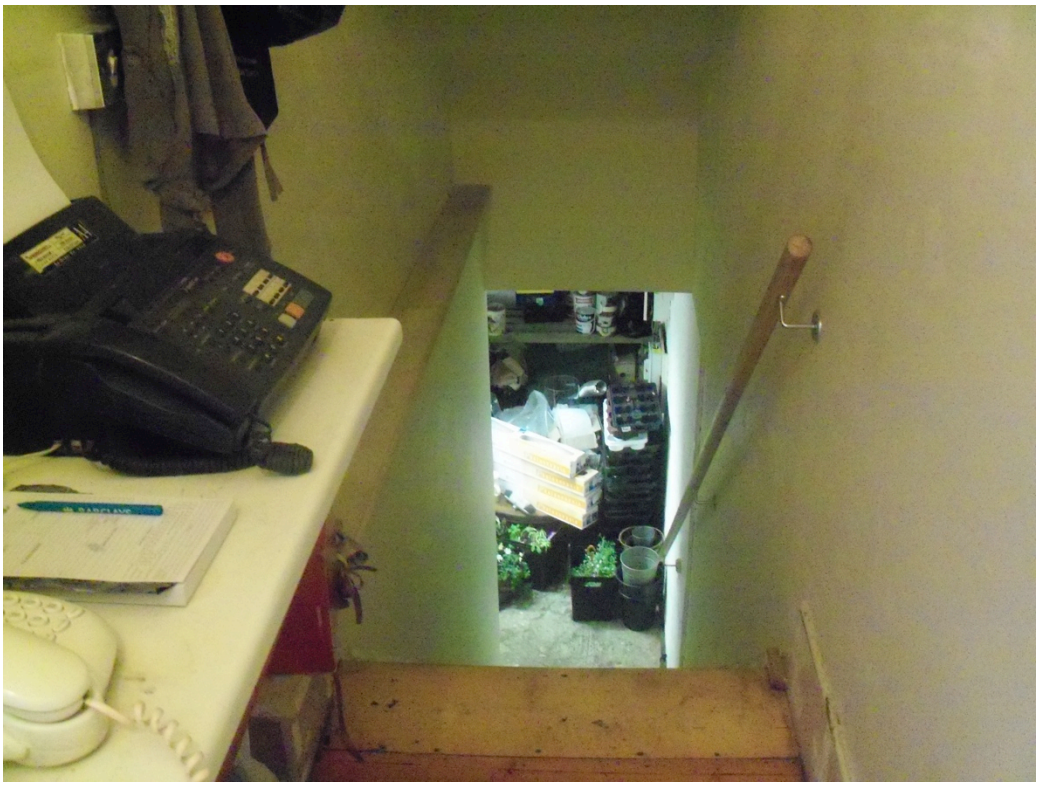
How to Implement

Simply turn off the office lighting when sufficient daylight is available for work. Alternatively, if the halogen bulbs in the office support dimming, purchase a light sensor that will automatically dim the office lights when sufficient natural light is available.

Priority 2	Install an occupancy sensor in basement/storage room			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£35-45	73	0.47	867	*~ 6 months*

Observations

During our visit to Greensleeves we observed that the lights in the basement remained on during the entirety of our visit. We believe that Greensleeves would benefit from installing a Passive infrared (PIR) sensor in the basement in order to reduce the amount of time the lights remain on when the room is not in use.



Analysis

Fitting the basement with an occupancy sensor that turns the light on only when the room is occupied can reduce your energy usage and remove the need for occupants to bother controlling these lights with switches while providing the same energy savings.

These sensors can detect the heat emitted by an occupant to switch on the lights when someone is present and keep the room lit when it is occupied and for a configurable period of time after the occupant has left the room.

If the basement is only occupied for 20% of operating hours, adding a PIR sensor to control the T-8 fluorescent fixture could reduce its energy usage by up to 80% compared to leaving the lights on during the entire day.

These sensors usually use passive infrared sensors (PIR) to detect the heat of a human body entering a room. Once triggered, the sensor contains a timer, which keeps the light on for a configurable duration in order to prevent the need for quick retriggering. Such sensors can be installed in the ceiling of the hallway or mounted in wall switches for easy retrofitting to existing systems.

Note: as PIR sensors will vary the energy usage of the lights based on the occupancy of the room, our calculations can only estimate the possible energy savings for this solution. Our calculations conservatively assume that the sensor turns on the lights for 20% of our facility's operating hours, your actual results may vary. For more information, see the attached calculations spreadsheets.

How to Implement

Simply purchase a PIR sensor for the basement area; many options exist for differing installation types, form ceiling mounted sensors to options that can be retrofitted into existing wall switches. To minimize installation time, we recommend investigating switch-mounted sensors.

Priority 3	Replace hallway incandescent lights with CFLs			
Estimated Expense	**Savings**			**Payback Period**
	£/hr	**Tonnes CO_2/1000hr of operation**	**kWh/1000hr of operation**	
£12	£1.50/100hr operation	0.1	17	1000 hours of operation

Observations

During our walkthrough of your building, we noticed 3 highly inefficient incandescent lights in the hallway.

Analysis

We believe you would benefit from replacing these bulbs with Compact Fluorescent bulbs (CFLs). Compact fluorescent bulbs last about 10 times longer, use a quarter of the energy, and produce 90% less heat then incandescent bulbs of the same illumination.

As these lights are turned off during the majority of operating hours, we cannot provide a reliable estimate for the payback period of changing these bulbs. However, CFLs generally consume £1.50 for every 100 hours of operation, meaning a return on the expense of the bulb after 1000 hours of operation. Note that the average lifespan of a CFL bulb is around 8000 hours.

How to Implement

Examine existing incandescent bulbs in the hallway to determine their wattage. Using the table to the right as a guide, purchase CFLs with an equivalent wattage to provide the same amount of light as the previous bulbs.

Table 1. Comparable Wattage of CFLs and Incandescents

Incandescent Wattage	CFL Wattage
25	5
50	9
60	15
75	20
100	25
120	28
150	39

Priority 4	Replace halogen lighting with LED lighting			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
£368	245	1.56	2980	**~ 1.5 years**

Observations

We noticed a total of 44 halogen lights—32 in the main room. 9 in the office, and 3 in the bathroom throughout the shop.

Analysis

We recommend that you replace the current halogen lighting with more efficient LED lighting.

LED lighting provides similar lighting levels at much higher efficiency than halogen lights. While LED lights are more expensive than halogen lighting, they have a lifespan of around 30,000 hours or 25-30 years of normal use and produces less heat then other types of lighting. Despite the initial expense, LED lighting solutions will promise excellent returns over their lifetime.

Note: Exact estimates for the efficiency and pricing of these lights will vary based on the type of lighting fixtures already installed in your shop. As we were unable to examine the type of fixtures currently in use, we selected an estimate that may match your current lighting. Also note that LED lighting is a quickly evolving technology; more efficient and less expensive fixtures may be available in the future.

Enhanced Capital Allowance

There is an opportunity to subtract the cost of a new lighting system from the business's taxable profit as long as the lighting installed meets the guidelines set out in the Energy Technology Criteria List. As the exact LED bulbs will vary based on your

current fixtures and preferences, we recommend consulting the list of products that meet ECA requirements when considering this solution. An outline of the benefits of the ECA program can be found at http://www.eca.gov.uk. Specific guidelines on LED criteria is located in the PDF found here: http://www.eca.gov.uk/etl/find/_P_Lighting/105.htm?tab=CriteriaPanel

How to Implement

We recommend further investigating this solution after considering the types of halogen lights present throughout the eating area. As LED lights are produced in varying color temperatures and varying brightness levels, we recommend experimenting with these lights on a small scale to determine the exact solution that will create the same level of lighting currently present throughout your shop.

Final Analysis

Overall, our walkthrough audit observed that your building was already quite energy efficient. We were impressed to find an efficient use of heating as well as lights turned off in the office when not in use. We have recommended three inexpensive solutions that could help reduce your building's energy usage. By simply replacing your incandescent lights, using an infrared sensor to control lighting in the basement, and taking advantage of available natural light, we estimate you could reduce your building's energy usage by 6.067kWh annually.

In addition, we also recommend considering LED lighting as a solution to replacing your existing halogen lighting throughout the main retail area. While LED lighting solutions are expensive, they are a quickly evolving technology that will become less costly in the future.

We would greatly appreciate your feedback so that we can better conduct future audits. We ask that you fill out the following survey located at: http://tinyurl.com/reigateaudit

If you have any questions or would like any additional information, feel free to contact our team at reigateiqp@wpi.edu.

Appendix Q – Gerrard's Audit Report

Overview

We conducted an energy audit of your business and the table below outlines the energy saving methods we recommend. It is followed by an in-depth explanation and analysis of each recommendation.

Priority	Item	Summary	Expense	Time to Implement	Estimated Savings			Expected Payback Period	Eligible for ECA	More Information
					£/yr	Tonnes CO_2/yr	kWh/yr			
1	Replace T-12 Bulbs	Use T-8 bulbs instead of T-12 as they are more efficient	£8	Less than an hour	£36.07	.15	292	3 months	N/A	Page 4
2	Replace backroom Incandescent Lights	Use CFL's because they last far longer and use less energy than incandescent bulbs	£12	15 minutes	£46.82	.2	379	4 months	Not worth the time	Page 5
3	Add occupancy sensors in fitting rooms	Use a PIR sensor to automatically turn the lights on and off	£140	One day	£46.61	.2	377	3 years	N/A	Page 6
4	Replace recessed Halogen spot lights	Use LED's because they last far longer and use less energy than incandescent bulbs	£325	1 week	£190.73	.8	1,544	1.7 years	Several Options	Page 7

5	Replace ceiling mounted Halogen Down Lights	Use LED's because they last far longer and use less energy than incandescent bulbs	£324	1 Week	£280.90	1.2	2,274	1.2 years	Several Options	Page 8
6	Replace Halogen flood lights	Think about replacing halogen flood lights with LEDs for their long life span and energy efficency	£600	One Week	£166.46	.75	1348	3.5 years	Several Options	Page 9
Total			£1409	~ One Week	£768	3.3	6215	3 months to 3.5 years		

Priority 1	Replace T-12 Fluorescent Tubes with T-8 Tubes			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
£8	36.07	.15	292	3 months

Observations

The middle two tubes used to illuminate the merchandise on the wall were T-12 fluorescent tubes.

Analysis

T-8 fluorescent tubes can provide the same amount of light as T-12 tubes while using 40% less energy. In addition, T-8 tubes cost roughly the same and are compatible with fixtures designed for T-12 tubes. As a result, replacing T-12 tubes with T-8 tubes provides a simple method to reduce your energy usage by 292 kWh/yr.

For additional information, please see the spread sheet in the calculations section below.

How to Implement

Purchase 5ft (150cm) 58W T-8 fluorescent tubes to replace the T-12 tubes. Note that the T-8 tubes will have a lower wattage than T-12 tubes however they will provide the same amount of light.

Priority 2	Replace incandescent bulbs with CFL's			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2	kWh	
£12	46.82	0.2	379	4 months

Observations

We noticed one standard incandescent and you reported two more, all standard 60W bulbs. Incandescent lighting is one of the most inefficient lighting types there is so we recommend replacing these bulbs with CFL's.

Analysis

Compact fluorescent bulbs last about 10 times longer, use a quarter of the energy, and produce 90% less heat then incandescent bulbs of the same illumination. Replacing these bulbs is an easy solution to reduce your facility's energy usage.

See the spreadsheet in the calculations section for more information on our assumptions.

How to Implement

Examine existing incandescent bulbs to determine their wattage. Using the table to the right as a guide, purchase CFLs with an equivalent wattage to provide the same amount of light as the previous bulbs. (The wattage should be 60 and therefore you'll be looking for 15W bulbs)

(http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12060)

Table 1. Comparable Wattage of CFLs and Incandescents

Incandescent Wattage	CFL Wattage
25	5
50	9
60	15
75	20
100	25
120	28
150	39

Priority 3	Add Occupancy Sensors in Fitting Rooms			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
£140	46.61	.2	377	3 years

Observations

We noticed that the fitting rooms located on the first and second floors were lit even when not occupied.

Analysis

Equipping the fitting rooms with infrared sensors that turn on the lights only when the room is occupied, can reduce your energy use. These sensors can detect the heat emitted by an occupant to switch on the lights when someone is present and keep the room lit when it is occupied and for a configurable period of time after the occupant has left the room.

If the fitting rooms are only occupied for 20% of operating hours, adding PIR sensors to control the light fixtures could reduce their energy usage by up to 80% compared to leaving the lights on during the entire day.

Note: as PIR sensors will vary the energy usage of the lights based on the occupancy of the room, our calculations can only estimate the possible energy savings for this solution. Our calculations conservatively assume that the sensor turns on the lights for 20% of your facility's operating hours, your actual results may vary. For more information, see the attached calculations spreadsheets. All calculations assume 36W CFL bulbs.

How to Implement

These sensors usually use passive infrared sensors (PIR) to detect the heat of a human body entering a room. Once triggered, the sensor contains a timer, which keeps the light on for a configurable duration in order to prevent the need for quick retriggering. Such sensors can be installed in the ceiling or mounted in wall switches for easy retrofitting to existing systems.

Priority 4	Replace Recessed Halogen Spotlights With LED's			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£325	190	.8	1544	**1.7 years**

Observations

We noticed many small halogen spotlights in ceiling of the lower level as well as some other areas. We estimate there to be around 25 of these lights in either single,double, or triple fittings

Analysis

While LED lights are more expensive than halogen lighting, they have a lifespan of around 50,000 hours or 25-30 years of normal use and produce less heat then other types of lighting. Despite the initial expense, LED lighting solutions will promise excellent returns over their lifetime. Given that LED lights last 20 times as long as most halogen lights it is usual that despite the higher cost per bulb the LED light will save money over the long term even if it didn't use less energy.

For our calculations we assumed we estimated each lamp used 25W, if this is inaccurate and the estimate is too high more savings will ensure while if it is two low the savings will be less.

Note: Exact estimates for the efficiency of this solution will vary based on the type of fixtures installed in your restaurant. LED lighting is a quickly evolving technology; more efficient and less expensive fixtures may be available in the future

Enhanced Capital Allowance

There is an opportunity to subtract the cost of a new lighting system from the business's taxable profit as long as the lighting installed meets the guidelines set out in the Energy Technology Criteria List. An outline of the benefits of the ECA program can be found at http://www.eca.gov.uk. Specific guidelines on LED criteria is located in the PDF found here: http://www.eca.gov.uk/etl/find/_P_Lighting/105.htm?tab=CriteriaPanel

How to Implement

Look at the bulbs you have to determine their wattage to insure that it is the same as our estimated amount, then if so look at the spread sheet to determine what our research indicates to be an equivalent watt LED and either purchase online or go to a lighting store

Priority 5	Replace Halogen Down Lighting With LED's			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
£324	280	1.2	2274	**1.2 years**

Observations

We noticed approximately eighteen halogen lights on the main ceiling and upper floor. As above halogen lights are relatively inefficient and therefore we recommend their replacement.

Analysis

While LED lights are more expensive than halogen lighting, they have a lifespan of around 50,000 hours or 25-30 years of normal use and produce less heat then other types of lighting. Despite the initial expense, LED lighting solutions will promise excellent returns over their lifetime. Given that LED lights last 20 times as long as most halogen lights it is usual that despite the higher cost per bulb the LED light will save money over the long term even if it didn't use less energy.

For our calculations we assumed we estimated each lamp used 50W, if this is inaccurate and the estimate is too high more savings will ensure while if it is two low the savings will be less.

Note: Exact estimates for the efficiency of this solution will vary based on the type of fixtures installed in your restaurant. LED lighting is a quickly evolving technology; more efficient and less expensive fixtures may be available in the future

Enhanced Capital Allowance

There is an opportunity to subtract the cost of a new lighting system from the business's taxable profit as long as the lighting installed meets the guidelines set out in the Energy Technology Criteria List. An outline of the benefits of the ECA program can be found at http://www.eca.gov.uk. Specific guidelines on LED criteria is located in the PDF found here: http://www.eca.gov.uk/etl/find/_P_Lighting/105.htm?tab=CriteriaPanel

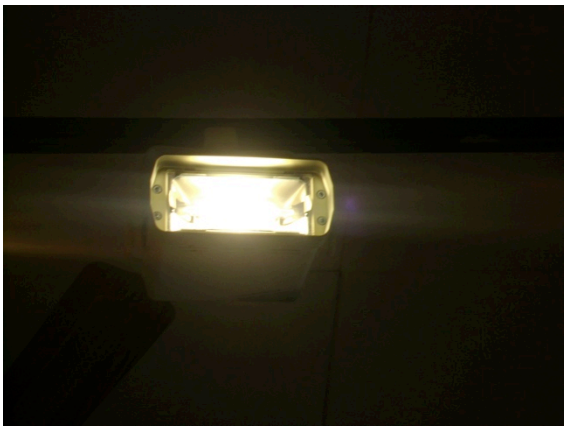
How to Implement

Look at the bulbs you have to determine their wattage to insure that it is the same as our estimated amount, then if so look at the spread sheet to determine what our research indicates to be an equivalent watt LED and either purchase online or lighting store

Priority 6	Replace Halogen Flood Lights			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£600	166	.75	1384	**3.5 years**

Observations

We noticed around eight halogen flood lights on the main ceiling and lower floor ceiling. As above halogen lights are relatively inefficient and therefore we recommend their replacement. In this case due to the high cost of LED flood lights it may be worth it to wait.



Analysis

While LED lights are more expensive than halogen lighting, they have a lifespan of around 50,000 hours or 25-30 years of normal use and produce less heat then other types of lighting. Despite the initial expense, LED lighting solutions will promise excellent returns over their lifetime. Given that LED lights last 20 times as long as most halogen lights it is usual that despite the higher cost per bulb the LED light will save money over the long term even if it didn't use less energy.

Note: Exact estimates for the efficiency of this solution will vary based on the type of fixtures installed in your restaurant. LED lighting is a quickly evolving technology; more efficient and less expensive fixtures may be available in the future

Enhanced Capital Allowance

There is an opportunity to subtract the cost of a new lighting system from the business's taxable profit as long as the lighting installed meets the guidelines set out in the Energy Technology Criteria List. An outline of the benefits of the ECA program can be found at http://www.eca.gov.uk. Specific guidelines on LED criteria is located in the PDF found here: http://www.eca.gov.uk/etl/find/_P_Lighting/105.htm?tab=CriteriaPanel

How to Implement

We included the name of a model of LED flood light that we believe to be equivalent; you are encouraged to do your own research to be sure of this before investing money.

Final Analysis

Overall in our walkthrough we noticed that your major energy usage was in lighting. We have suggested six ways to reduce your lighting costs for a total monetary savings of 764.89 pounds and electric savings of 6250 KWh per year. Of these, replacing your T-12 flourescent and standard incandescent bulbs are the least expensive and still save significant energy. Installing LED bulbs will have a high intial cost but will pay for its self overtime. Of the Halogen lightes to replace replacing the floodlights is the least urgent due to the high initial cost per bulb, and LEDs are a quickly evolving technology that will become less costly in the future especially for large lighting applications.

We would greatly appreciate your feedback so that we can better conduct future audits. We ask that you fill out the following survey located at: http://tinyurl.com/reigateaudit

If you have any questions or would like any additional information, feel free to contact our team at reigateiqp@wpi.edu.

Appendix R – Frankie & Benny's Audit Report

Overview

We conducted an energy audit of your business and the table below outlines the energy saving methods we recommend. It is followed by an in-depth explanation and analysis of each recommendation.

Priority	Item	Summary	Expense	Time to Implement	Estimated Savings			Expected Payback Period	Eligible for ECA	More Information
					£/yr	Tonnes CO_2/yr	kWh/yr			
1	Replace incandescent light bulbs	Use CFL's because they last far longer and use less energy than incandescent bulbs	£120	One Day	296	0.248	460	~5 Months	N/A	Pages 3 & 4
2	Add an occupancy sensor in bathroom and storage rooms	Use a PIR sensor to automatically turn the bathroom lights on and off	£175-225	One Day	208	1.33	2460	~ 1 year	N/A	Pages 5 & 6
3	Turn off computers and registers at the end of the day	Reduces energy consumption during the night and at times when not in use	*None*	About a week to develop routine	22	0.14	263	*Immediate*	N/A	Page 7
Total			**£345**	**Two weeks**	**526**	**1.71**	**3183**	**< 1 year**		
Additional Solutions										
4	Replace halogen lighting with LED bulbs	LED lighting offers significant energy savings over halogen lighting	£562	Two weeks	338	2.15	3986	~ 2 years	Yes	Page 8

Priority 1	Replace Incandescent Bulbs with CFLs			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£120	296	0.248	460	**~ 5 months**

Observations

We noticed many hanging lighting fixtures that utilize amber-tinted incandescent light bulbs in the dining area.

Analysis

Compact fluorescent bulbs (CFLs) last about 10 times longer, use a quarter of the energy, and produce 90% less heat then incandescent bulbs of the same illumination. Replacing these bulbs is an easy method to reduce your restaurant's energy usage, returning on the initial expense in around five months of operation.

We have listed this item as a high priority because due to the large number of lighting fixtures that use the amber-tinted incandescent bulbs; it will be easy and inexpensive to implement generating great energy and cost savings.

CFLs are available in the preferred amber-tinted color used throughout the restaurant, they can be found online and in specialty lighting stores for around £8 each.

How to Implement

Examine existing incandescent bulbs in the bathrooms to determine their wattage. Using the table to the right as a guide, purchase CFLs with an equivalent wattage to provide the same amount of light as the previous bulbs.

(http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12060)

Table 1. Comparable Wattage of CFLs and Incandescents

Incandescent Wattage	CFL Wattage
25	5
50	9
60	15
75	20
100	25
120	28
150	39

Priority 2	Install PIR Sensors in Storage Rooms and Restrooms			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£175-225	208	1.33	2460	**~ 1 year**

Observations

The storage rooms located in the back of the restaurant and the restrooms were illuminated even when individuals were not in those locations.

Storage Room

Ladies Restroom

Analysis

Fitting the storage rooms and bathrooms with infrared sensors that turn on the lights only when the room is occupied can reduce your energy usage and remove the need for occupants to bother controlling these lights with switches while providing the same energy savings.

These sensors can detect the heat emitted by an occupant to switch on the lights when someone is present and keep the room lit when it is occupied and for a configurable period of time after the occupant has left the room.

If the bathroom and kitchen areas are only occupied for 20% of operating hours, adding PIR sensors to control the three T-8 fluorescent fixtures in the bathroom and kitchen areas could reduce their energy usage by up to 80% compared to leaving the lights on during the entire day.

These sensors usually use passive infrared sensors (PIR) to detect the heat of a human body entering a room. Once triggered, the sensor contains a timer, which keeps the light on for a configurable duration in order to prevent the need for quick retriggering. Such sensors can be installed in the ceiling of the hallway or mounted in wall switches for easy retrofitting to existing systems.

Note: as PIR sensors will vary the energy usage of the lights based on the occupancy of the room, our calculations can only estimate the possible energy savings for this solution. Our calculations conservatively assume that the sensor turns on the lights for 20% of our facility's operating hours, your actual results may vary. For more information, see the attached calculations spreadsheets.

Additionally, we have recommended replacing your halogen lights in the bathrooms and eating area with LED lighting solutions. Due to the high cost of LED lighting, these calculations are based on the existing halogen lighting, as simply installing PIR sensors is far more cost efficient.
How to Implement Purchase PIR sensors for the storage room, changing room, and bathroom foyer, and each bathroom. Many options exist for differing installation types, from ceiling mounted sensors to options that can be retrofitted into existing wall switches. To minimize installation time, we recommend investigating switch-mounted sensors.

Priority 3	Turn Off Computers and Registers			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
None	22	0.14	263	*Immediate*

Observations

It was found that a computer and several registers located throughout the restaurant were turned on, but not in active use.

Analysis

Simply turning off or hibernating the computers when not in use and turning off the registers outside operating hours can easily decrease their energy consumption. If the computer and registers are shut off for 20% of your operating hours, such as before customers arrive in the morning could result in an energy savings of 263kWh/yr.

Note: Our calculations assume three standard 100W computers that are inactive for 20% of your operating hours. As these calculations depend on our estimates of your computers' and registers' inactivity, your results may vary.

How to Implement

Only turn on the computer when it is in active use. If the computer will be used throughout the day, consider placing the computer in standby or hibernation mode, which will allow it to be resumed quickly. We recommend investigating both standby and hibernate modes to determine which best suits your needs.

In addition, develop a timetable for the registers that allows the correct time for them to warm-up for use and ensure they are shut down before closing each night.

Priority 4	Replace halogen lighting with LED bulbs			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£562	338	2.15	3986	**~ 2 years**

Observations

We noticed a large number of halogen lights present throughout the eating area and bathrooms.

Analysis

While we understand that your restaurant uses halogen lights in order to maintain an ambiance throughout the eating area, we recommend investigating replacing these lights with LED lighting solutions to significantly reduce your energy usage.

While LED lights are more expensive than halogen lighting, they have a lifespan of around 30,000 hours or 25-30 years of normal use and produces less heat then other types of lighting. Despite the initial expense, LED lighting solutions will promise excellent returns over their lifetime.

Note: Exact estimates for the efficiency and pricing of this solution will vary based on the type of fixtures installed in your restaurant. In addition, LED lighting is a quickly evolving technology; more efficient and less expensive fixtures may be available in the future.

Enhanced Capital Allowance

There is an opportunity to subtract the cost of a new lighting system from yout business' taxable profit as long as the lighting installed meets the guidelines set out in the Energy Technology Criteria List. As the exact LED bulbs will vary based on your current fixtures and preferences, we recommend consulting the list of products that meet ECA requirements when considering this solution. An outline of the benefits of the ECA program can be found at http://www.eca.gov.uk. Specific guidelines on LED criteria is located in the PDF found here: http://www.eca.gov.uk/etl/find/_P_Lighting/105.htm?tab=CriteriaPanel

How to Implement

We recommend further investigating this solution after considering the types of halogen lights present throughout the eating area. As LED lights are produced in varying color temperatures and varying brightness levels, we recommend experimenting with these lights on a small scale to determine the exact solution that will create the same ambiance throughout the restaurant.

Final Analysis

Your establishment was fairly energy efficient overall. By simply replacing your incandescent bulbs and controlling the usage of your lighting, we estimate that you could reduce your energy usage by 3183kWh annually. In addition, we also recommend considering LED lighting as a solution to replacing your existing halogen lighting throughout the eating area. While LED lighting solutions are expensive, they are a quickly evolving technology that will become less costly in the future.

We encourage you to make sure the posters that have been provided to you listing the warming times and suggestions for employees to be more conscious of their energy habits, be made visible and enforced. Simply altering the behaviors of your employees can lead to remarkable savings on your energy bills.

We would greatly appreciate your feedback so that we can better conduct future audits. We ask that you fill out the following survey located at: http://tinyurl.com/reigateaudit

If you have any questions or would like any additional information, feel free to contact our team at reigateiqp@wpi.edu.

Appendix S – Poilce Station Report

Overview

We conducted an energy audit of your business and the table below outlines the energy saving methods we recommend. It is followed by a in depth explanation and analysis of each recommendation.

Priority	Item	Summary	Expense	Time to Implement	Estimated Savings			Expected Payback Period	More Information
					£/yr	Tonnes CO_2/yr	kWh/yr		
1	Skylights	The current skylights are inefficient and poor insulators.	Get Estimate	*Get Estimate*	Get Estimate	Get Estimate	Get Estimate	Get Estimate	Page 4
2	Thermostatic Radiator Valves (TRVs)	TRVs can help save energy costs by regulating the radiators.	£180	*Minimal*	--	--	Estimate 5% of heating bill	--	Page 5
3	Install LED lights in 24/7 areas	LED lighting is more effective than T-5 and T-8 bulbs for high traffic areas	£3,350	*A Few Weeks*	£2,561	13.9	25,613	1.3 years	Page 6
4	Improve Energy Awareness	Educate employees on using natural light and keeping the lights off during the day when not needed.	Minimal	*On-going*	--	--	1% of energy bill	Instant	Page 7

5	PIR Sensors	PIR sensors on the external lighting would reduce electricity usage.	£35 per sensor £580 total	*1-3 days*	£1,511	8.2	15,116	*4 months*	Page 8
6	Insulate heating pipes	Insulating the un-insulated heating pipes would reduce the overall energy usage.	£2 per meter	*2 weeks*	--	--	--	*1-10 years*	Page 9
Total			£4,110		£4,072	22.1	40,729		

Priority 1	Replace Skylights			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
Get Estimate	Get Estimate	Get Estimate	Get Estimate	Get Estimate

Observations

The current skylights are dirty, inefficient, and poor insulators. They cause the building to be too hot in the summer and too cold in the winter. There are many radiators located in the hallways, approximately 2 feet below the plastic skylights. The complaints about freezing temperatures in the winter suggest that a significant portion of the heat provided by the radiator is wasted and exits the building through the thin skylight rather than heating the building, as they are intended to.

Analysis

Glass windows would be a great alternative to the plastic skylights. They would reduce the amount of energy lost through the ceiling. Windows that open would also provide the hallway with ventilation to alleviate the heat in the summer. Windows would provide even more sunlight than the current skylights, which would reduce the need for lights to be turned on during the day.

The exact savings and cost cannot be estimated appropriately. However, we are certain that installing new windows would significantly improve the efficiency of the corridors in the building.

How to Implement

The first step is to determine the extent of changes the Police Station is willing to invest in. If replacing the skylights with windows is feasible, it is possible that the Council can provide a recommendation on a supplier, and the Police Station can get an estimate through the supplier.

An alternative to replacing the skylights with glass windows is to discontinue heating the hallways with the plastic skylights. According to employees, the corridor remains at uncomfortably cold temperatures regardless, so discontinuing the ineffective heating, could save the Police Station a significant amount of money

Priority 2	Install Thermostatic Radiator Valves on Radiators			
Estimated Expense	Savings			Payback Period
	£/yr	Tonnes CO_2/yr	kWh/yr	
15* x 8 = £120	--	--	5%	--

Observations

It was estimated that there were 15* radiators that need Thermostatic Radiator Valves.
*Actual value may vary.

Some radiators in the building had TRVs while other did not. Based on the complaints of some employees on the stifling heat in certain part of the building and freezing temperatures in others, TRVs would be a great solution to this.

Note: Make sure not to install TRV's in rooms that have a thermostat as they will fight each other

Analysis

A Thermostatic Radiator Valve (TRV) controls the temperature of a room by regulating the flow of hot water to the radiator. Thermostatic radiator valves (air vent valves) also exist for steam radiators. A TRV will turn on and off the radiator based on the temperature of the room. It is ideal for rooms that tend to be over heated.

The BBC estimates installing TRVs on all radiator can save 17% of a heating bill since half of your radiators already have TRVs we will conservatively estimate around 5%

Priority 3	Install LED lights in 24/7 areas			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£3,350	2,561	13.9	25,613	1.3 years

Observations:
The majority of lighting in the police station is mostly either T-8 or T-5 bulbs which are energy efficient enough. However we recommend replacing T-8 and T-5 bulbs with LEDs in the areas of the police station that are active 24/7 due to the large number of operating hours.

Analysis
LED lighting provides similar lighting levels at much higher efficiency than fluorescent lights. They last 50,000 hours which is around 5 times longer than a conventional fluorescent lamp. Replacing current lighting with LED solutions will have a high initial cost, but will save on energy bills after the payback period is completed.

The calculations for energy savings are in the attached spread sheet and based off replacing 16 5ft T-8 double fixtures and 24 2ft T-5 quad fixtures which is our estimate for the number of lights in 24/7 zones. The instillation costs are estimations and you would need to get a quote to get a solid number.

Note: no calculations were made for lights in the custody section of the station because were are not sure what special rules exist for lighting in those areas, there are LED versions of all lights used in the custody section and they should give a similar pay back period.

How to Implement

- There is a guide on how to replace T-8 light bulbs by a lighting business at this link: http://www.paulbubb.com/Install_t8_t10_guide.pdf.
- And one for T-5 bulbs at this link: http://www.netledlighting.co.uk/Install_t5_guide.pdf

Priority 4	Improve Energy Awareness			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
Minimal	--	--	1% of energy	Near Immediate

Observations

In some areas of the building employees took advantage of the abundance of natural sunlight in the room and left the lights switched off. In other rooms, the room was bright enough without turning the lights on, but still, all the lights in the room were turned on. Also, in another room the door to a room with air-conditioning was left open.

Analysis

Utilizing the skylights and natural sunlight provided by the prevalence of windows located along most of the walls of the building can produce more than enough light for employees to work during the day.

By educating employees to reduce their dependency on artificial light, the Police Station can save approximately 1% of their energy bills per year.

How to Implement

In order to raise energy awareness small notes, posters and sticky notes near light switches or doors may be necessary. It is also important to talk to the staff about what to do to save energy and energy awareness in general.

Priority 5	Installing PIR Sensors on External Lights			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£560	1,511	8.2	15,116	4 months
Observations There are approximately 16 external halogen lights, that we presume to be 250 watt, that turn on when the sun sets and turn off when it is light out again. We feel that these lights are on more than necessary and could benefit from a PIR sensor so that the lights only turn on when motion is detected.				
Analysis PIR Sensors are a good option because they would help reduce the amount of time the lights are on. PIRs use infrared light to detect movement in a room and trigger the lights accordingly. PIR sensors are limited to line of sight but rarely false trigger. There are around 4724 night time hours in the United Kingdom per year 16 lights * 250W/1000 * 4724 hours=18896 kwh per year used *.8 =15116 kwh saved per year				
Note: As PIR sensors will vary the energy usage of the lights based on the occupancy of the area, our calculations can only estimate the possible energy savings for this solution. Our calculations assume that the sensor turns on the lights for 20% of the night time hours; your actual results may vary depending on outside activity.				

Priority 6	Installing Insulation on Heating Pipes			
Estimated Expense	**Savings**			**Payback Period**
	£/yr	**Tonnes CO_2/yr**	**kWh/yr**	
£1 per meter	--	--	--	1-10 years depending on pipe

Observations

Most of the hot water pipes were not insulated and therefore, as the water runs through the pipes it drops in temperature, requiring more energy from the heating system. We recommend adding insulation to heating pipes on the following priority:

1. Primary pipe from water heaters
2. Any large pipes
3. Any pipes through unheated areas
4. All others

Analysis

Insulating the pipes would help increase the efficiency of the pipes and radiator, therefore saving the energy required by the radiator. The cost of insulating piping varies on the type of pipe to be insulated. The energy saving trust estimates £10 for installing insulation on primary pipe with a payback of around a year.

How to Implement

1. Measure pipe thickness and length of pipe
2. Determine the best insulation, our research suggests 2.5 cm insulation
3. Make sure insulation meets all safety codes
4. Follow manufactures instillation instructions

Final Analysis

Overall, our walkthrough audit observed that the Police Station was already fairly energy efficient. We were impressed to find that a majority of the lighting was already very efficient. In addition, we have recommended six possible solutions that could help reduce your building's energy usage by an additional 40,729 kWh and save you around £4,072 per year. By implementing these solutions and maintaining your already energy-conscious attitude toward lighting and heating, the Police Station can continue to reduce its energy consumption in the future.

If you have any questions or would like any additional information, feel free to contact our team at reigateiqp@wpi.edu.

Appendix T - Case Study Compiled Information

Name	**Type of Industry**	Cost of Investment:	**£/year**	**Tonnes CO_s/ year**	**kWh/year**	**Payback Period**	**Typical Problems:**	**Typical Changes Recommended:**
Printmates	Printing	£152 (without solar panels)	£337.2 (without solar panels)	2.13 (without solar panels)	3,965 (without solar panels)	10 Months	- Lights on when not needed - Computers on more than needed - Inefficient lighting - Enterances not sealed	- Lighting – use T-8 instead of T-12 - Computer settings - CFLs instead of incandescent - PIR sensors - Seal doors at enterance - Use natural light when sufficient - Improve energy awareness
Summit Print	Printing	£8,012	£2,378	10.2	20,352	3.7 years	- Lights on when not needed - Unused computers, using screensavers instead of on standby - Overheated area - Machines Left on when not in use	- Lighting - Turn off lighting when natural light is sufficient - Adjust settings so computers go into standby - Adjust temperature settings - Increase energy awareness with staff - Ask staff to turn off machines when not in use
Printing AVERAGES:		**£4,082**	**£1,357.6**	**6.165**	**12,158.5**	**2.3 years**	- **Lights on when not needed** - **Computers on more than needed**	- **Lighting – use T-8 instead of T-12** - **Adjust settings so computers go into**

							- **Inefficient lighting** - **Employees uneducated about energy efficiency**	**standby** - **CFLs instead of incandescent** - **PIR sensors** - **Turn off lighting when natural light is sufficient** - **Improve energy awareness**
Frankie and Benny's	Restaurant	£345	£526	1.71	3,183	2 years	- Inefficient lighting - Lights on when not needed - Computers on longer than necessary	- Turn off lighting when natural light is sufficient - Lighting – use T-8 instead of T-12 - Adjust settings so computers go into standby
La Barbe	Restaurant	£815	£386	1.8	3,220	2.1. years	- Lighting	- Lighting
Restaurants AVERAGES:		**£580**	**£456**	**1.755**	**3,201.5**	**2 year**	- **Lighting** - **Employees not educated on energy efficiency**	- **Lighting** - **Educate staff to turn off lights after they leave a room, and to leave lights off if natural light is sufficient**
Risbridger Ltd	Manufacturing	£17,139	£3,233	8	75,576	6.1 years	- Hot water tank on longer than needed - Boiler on longer than needed	- Lighting - Adjust running hours of the calorifier and boiler - Install VSDs on boiler pumps
Manufacturing AVERAGES:		**£17,139**	**£3,233**	**8**	**75,576**	**6.1 years**	- **Hot water tank on longer than needed** - **Boiler on longer**	- **Lighting** - **Adjust running hours of the calorifier and boiler** - **Install VSDs on boiler**

							than needed	**pumps**
Gerrard's	Retail	£1,409	£768	3.3	6,215	1.9 years	- Inefficient lighting - Lights on when not necessary	- Lighting - Replace halogen lighting with LEDs, incandescents with CFls, use T-8's instead of t-12 - Take advantage of natural light when sufficient - Install PIR sensors
Greensleeves	Retail	£57	£213	1.35	2,502	6 months	- Lights on when not needed - Inefficient lighting	- Lighting – replace incandescents with CFLs - Install PIR sensors - Take advantage of natural light when sufficient
Retail AVERAGES:		**£733**	**£490.5**	**2.325**	**4,358.5**	**1.2 years**	- **Inefficient lighting** - **Lights on when not necessary**	- **Lighting** - **Replace halogen lighting with LEDs, incandescents with CFls, use T-8's instead of t-12** - **Take advantage of natural light when sufficient** - **Install PIR sensors**
Armatool	Ware house	£7,583	£3,270	10.6	30,631	3.5 years	- Over lit areas - Unused computers are using screen savers instead of standby mode - Skylights are dirty - Low traffic areas lit at all times	- Lighting - Reduce number of lights - Adjust computer settings - Clean skylights - Ask staff to turn off lights when leaving the area

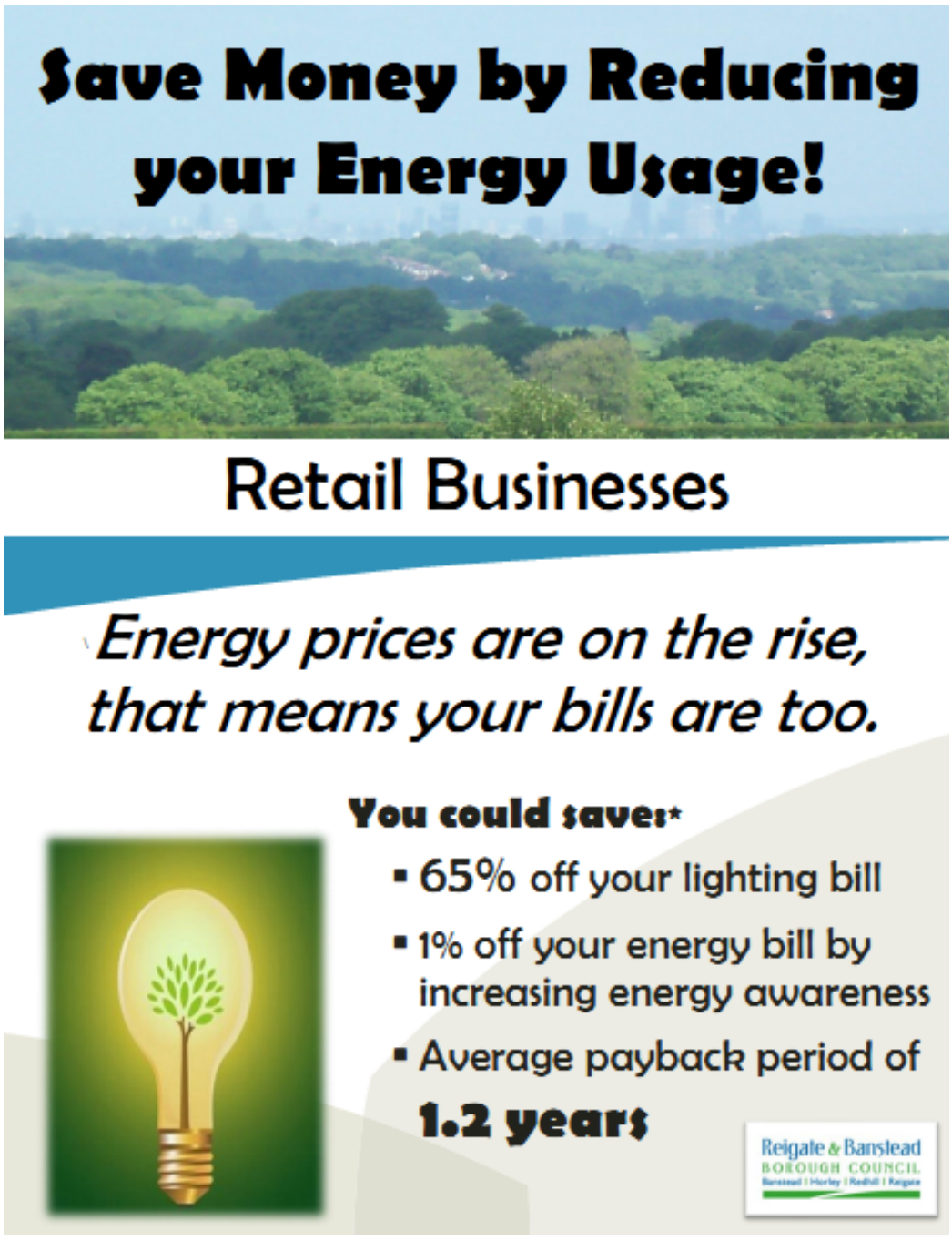
Craftstone Europe	Ware house	£4,000	£3,117	--	--	1.3 years	- Radiators are blocked by display shelves	- Rearrange shelves so that radiators are not blocked
Commercial Distibutor AVERAGES:		**£5,791**	**£3,193 .5**	**10.6**	**30,631**	**2.4 years**	- **Over lit areas** - **Unused computers are using screen savers instead of standby mode** - **Skylights are dirty** - **Low traffic areas lit at all times** - **Radiators are blocked by display shelves**	- **Lighting** - **Reduce number of lights** - **Adjust computer settings** - **Clean skylights** - **Ask staff to turn off lights when leaving the area** - **Rearrange shelves so that radiators are not blocked**
Salvation Army	Publi c /Com munit y Servi ce	£38	£41.37	2.11	584	2 years	- Boiler running more than needed - 80W T-12 bulbs - Lights on when not needed	- Lighting - Turn off heat before end of day - Replace T-12 with T-8 bulbs - Add occupancy sensors
Reigate Library	Publi c /Com munit y Servi	£6,871	£10,76 9.12	10	43,589	2.1 years	- Lights on when not needed - Building too warm in winter	- Turn off lights when natural light is sufficient - Adjust thermostat - Install TRVs - Lighting

	ce							
Police Station	Public /Community Service	£4,110	£4,072	22.1	40,729	10 months	- Skylights - Radiator pipes not insulated - External lights on all night - Inefficient lighting in 24 hour area - Too hot in certain areas	- Lighting - TRVs - PIR sensors - Insulate heating pipes - Replace skylights
Wray Common Primary School	Public /Community Service	£28,100	£2,598	12.5	27,243.41	4 years	- Lights on when not needed - Radiators blocked by furniture - Underused areas are air conditions and computers are on	- Lighting - Turn off lights when natural light is sufficient - Rearrange furniture so it is not blocking radiator - Adjust temp settings in the building - Turn off computers
Wray Park Fire Complex	Public /Community Service	£4,797	£21,344	4.3	928,544	2 years	- Lights on when not needed - Radiator not functioning at most efficient - Temperatures too hot - Windows open - More hot water being heated than necessary	- Lighting - Improve energy awareness - Turn lights off when natural light is sufficient - Rearrange furniture so it is not blocking radiator - Shut down one of the two hot water calorifiers - Zone building

							- Building being heated when no necessary	
Public/Community Service AVERAGES:		**£8,783.20**	**£7,764.90**	**10.20**	**208,137.88**	**2.2 years**	- **Lights on when not needed** - **Radiator not functioning at most efficient** - **Extreme temperatures**	- **Lighting** - **Turn off lights when natural light is sufficient** - **Rearrange furniture so it is not blocking radiator** - **Consider installing TRVs** - **Adjust temperature settings**
YMCA Prince's Rd	Recreational Facility	£14,653	£6,034	26.6	82,622	3.3 years	- Space heaters are being used throughout building - Over lit - Boilers are on during all occupancy hours - Radiators blocked by furniture	- Lighting - Remove space heaters - Remove one bulb per fixture - Adjust running hours of boiler - Rearrange furniture
YMCA Hillbrook	Recreational Facility	£22,955	£7,829	19.1	49,489	3.8 years	- Over lit - Lights left on in rooms no one is using - Overheat rooms - Heating left on overnight	- Lighting - Reduce number of lights - Educate staff - Use heaters as needed, turn off when not needed - Turn off/down heaters overnight
Recreational Facility AVERAGES:		**£18,804**	**£6,931.5**	**22.85**	**66,055.5**	**3.6 years**	- **Over lit areas** - **Lights on when not needed** - **Boilers on more**	- **Reduce number of light / remove bulbs** - **Turn light off when natural light is sufficient**

							than needed	- **Turn heaters off overnight** - **Adjust running hours of boiler**

Appendix U – Retail Case Study

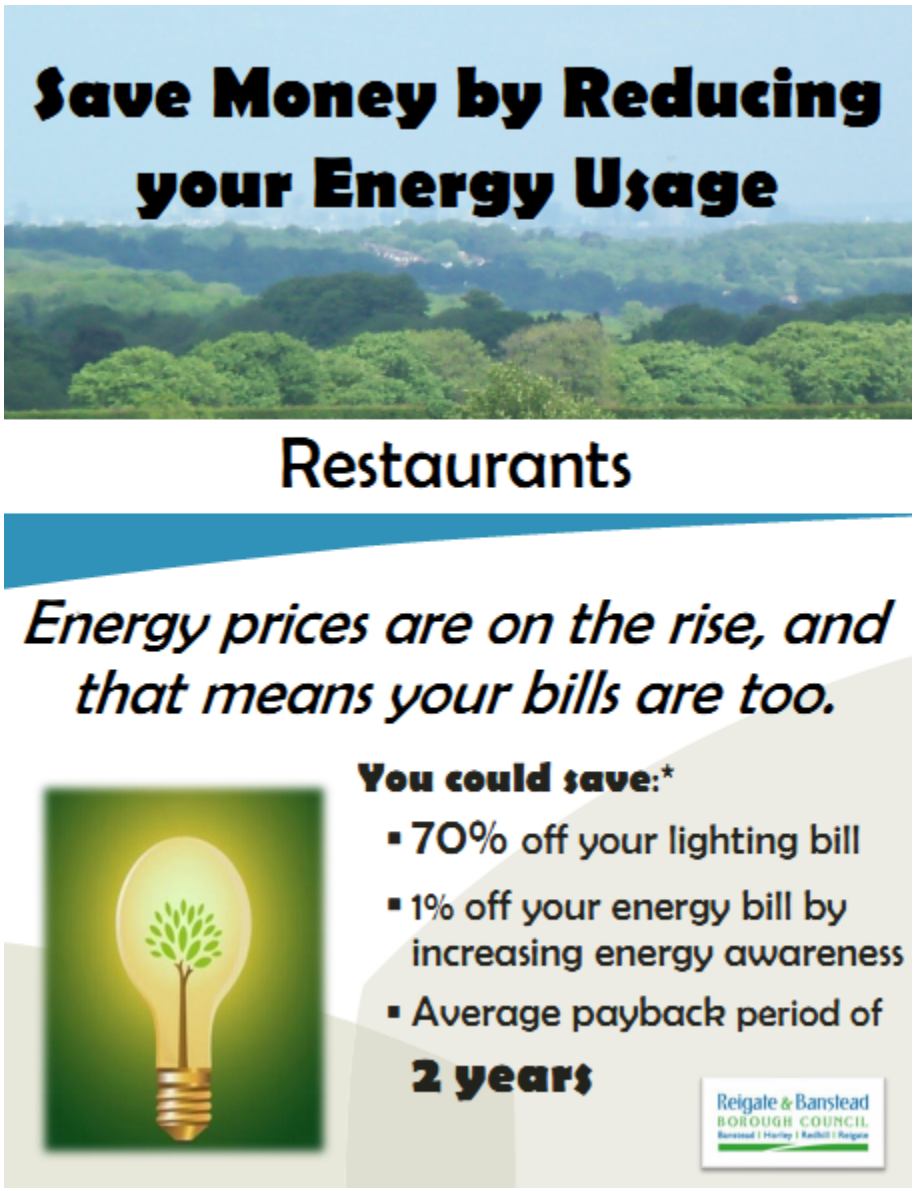


Common Problems & Recommended Solutions

Problem	Solution	Benefits
Lights on when not needed	• Turn off lights when natural light is sufficient • Improve employee education – educate staff to turn off lights when they leave an area	Increasing energy awareness can save ~1% off of your energy bill
Inefficient lighting	• Replace T-12 fluorescent bulbs with T-8 or T-5 bulbs • Replace halogen lighting with Compact Fluorescent Lights or LEDs where possible • Install occupancy sensors to automatically control lights	Could save 65% off of your lighting bill

For more information please contact:
Raymond Dill, Reigate and Banstead Borough Council, 01737 276211

Appendix V – Restaurant Case Study



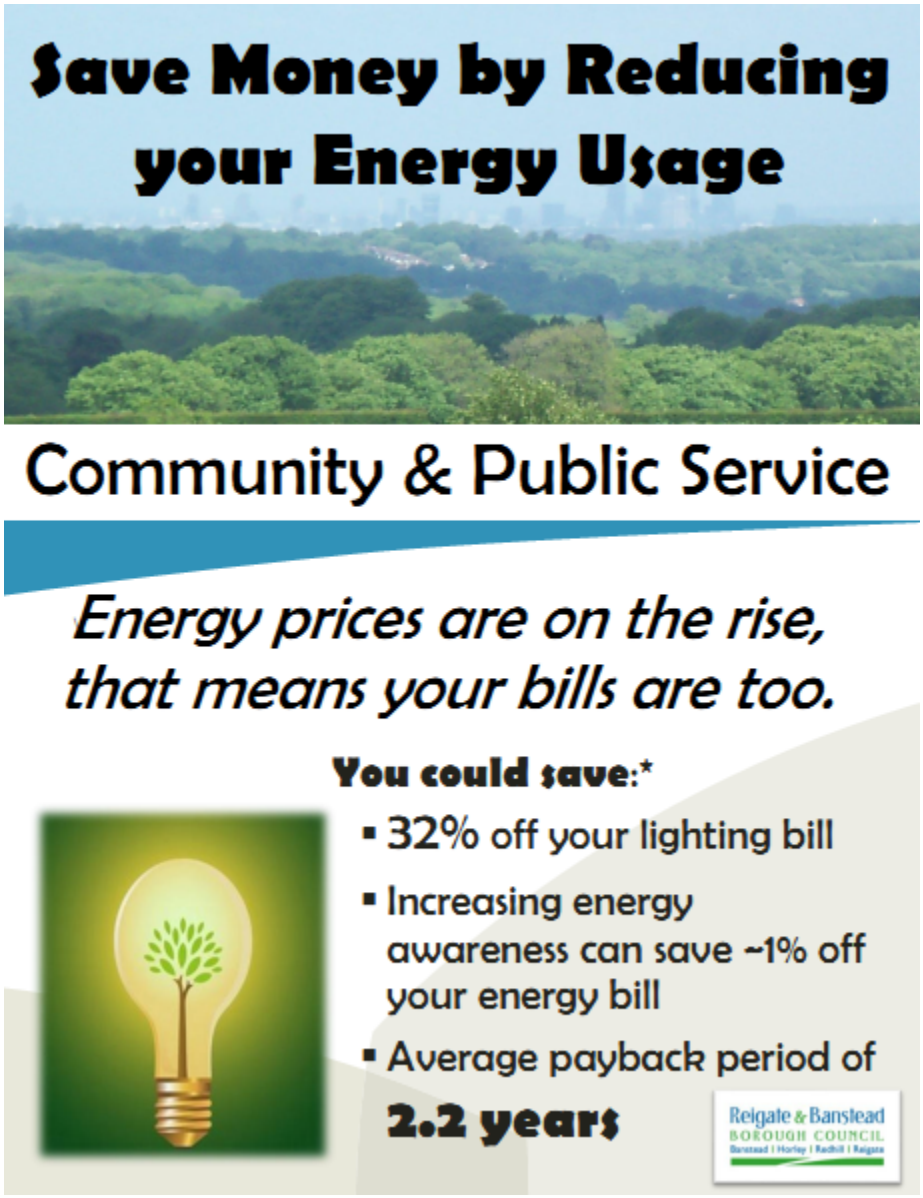
Common Problems & Recommended Solutions

Problem	Solution	Benefits
Employees not educated in energy efficiency	• Promote employee energy awareness	Increasing energy awareness can save ~ 1% off of your energy bill
Inefficient lighting & lights on when not needed	• Replace T-12 fluorescent bulbs with T-8 or T-5 bulbs • Replace halogen lighting with Compact Fluorescent Lights or LEDS where possible • Add occupancy sensors to automatically control lights	Could save 70% off of your lighting bill
Computers and registers on longer than needed	• Adjust computer settings to power off after a period of not being used • Turn registers on/off at the appropriate times with minimal lag time	Can lower energy consumption of the computers up to 90%

For more information please contact:
Raymond Dill, Reigate and Banstead Borough Council, 01737 276211

* Numbers are based on average values, individual results may vary

Appendix W – Community & Public Service Case Study



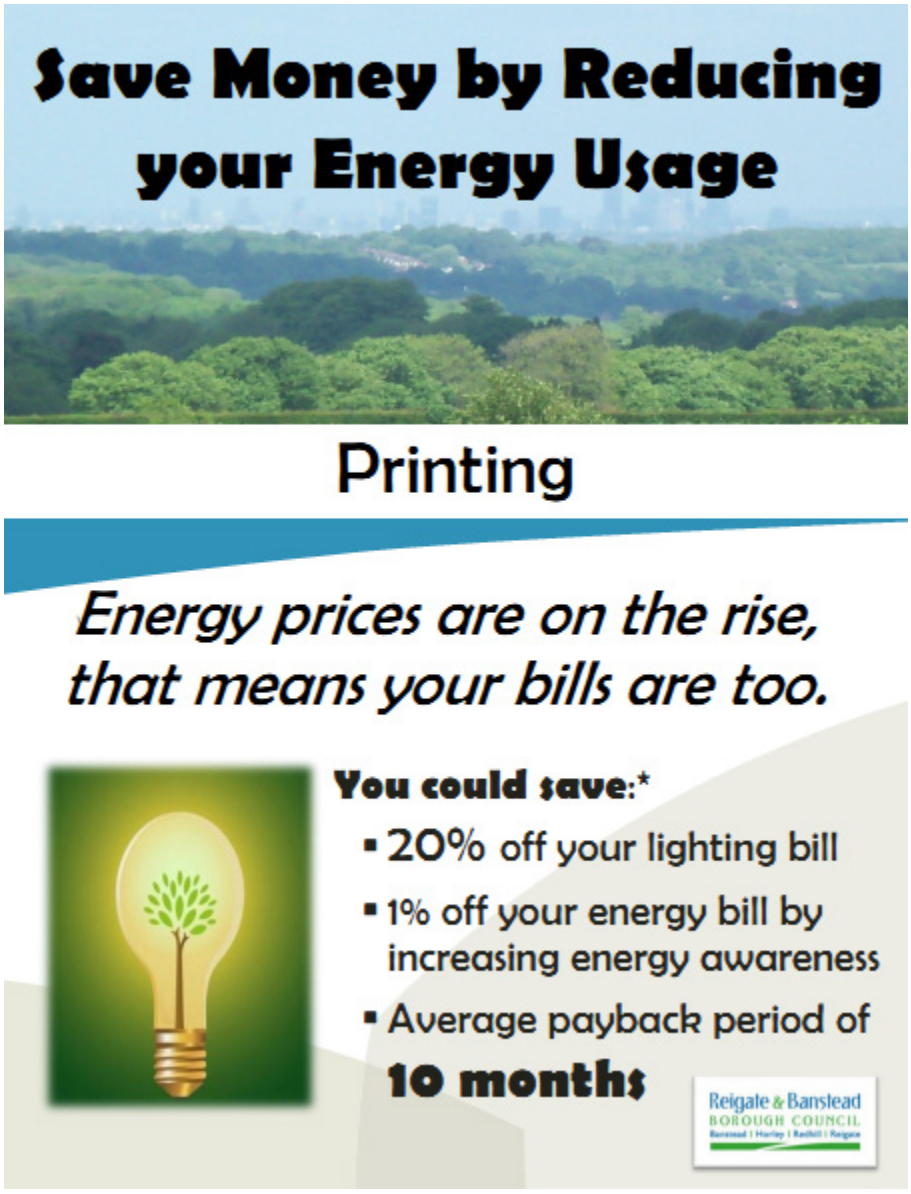
Common Problems & Recommended Solutions

Problem	Solution	Benefits
Lights on when not needed	• Turn off lights when natural light is sufficient • Add occupancy sensors to automatically control lights	Increasing energy awareness can save ~1% off of your energy bill
Inefficient lighting	• Replace T-12 fluorescent bulbs with T-8 or T-5 bulbs • Replace halogen lighting with Compact Fluorescent Lights or LEDs where possible	Could save 32% off of your lighting bill
Building too warm in winter	• Adjust thermostat settings for the building • Turn heating off when building is not occupied • Install Thermostatic Radiator Valves	Could save 17% off of your heating bills
Radiator not functioning as efficiently as possible	• Rearrange furniture so it is not blocking radiator	Could save 1% off of your heating bills

For more information please contact:
Raymond Dill, Reigate and Banstead Borough Council, 01737

* Numbers are based on average values, individual results may vary

Appendix X – Printing Case Study



Common Problems & Recommended Solutions

Problem	Solution	Benefits
Lights on when not needed	• Turn off lights when natural light is sufficient • Add occupancy sensors to automatically control lights	Increasing energy awareness can save ~ 1% off of your energy bill
Inefficient lighting	• Replace T-12 fluorescent bulbs with T-8 or T-5 bulbs • Replace halogen lighting with Compact Fluorescent Lights or LEDs where possible	Could save 20 % off of your lighting bill
Unused computers remain on	• Adjust computer settings to power off after a period of not being used	Can lower energy consumption of the computers up to 90%

For more information please contact:
Raymond Dill, Reigate and Banstead Borough Council, 01737 276211

* Numbers are based on average values, individual results may vary