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Carbon Reduction Tools for Municipal Buildings

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Carbon Reduction Tools for Municipal Buildings

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Abstract

In an effort to reduce carbon emissions in the UK, the London Borough of Merton began work with Worcester Polytechnic Institute (WPI) researching carbon reduction methods. This project furthers this general goal by developing a replicable model which municipalities can use to map out energy usage of their buildings; as well as constructing a Combined Heat and Power (CHP) financial feasibility toolkit to help municipalities plan and implement District Heat and Power using CHPs.

Executive Summary

The United Kingdom is currently at the forefront of worldwide green energy and carbon reduction measures. They signed the Kyoto protocol pledging to lower their carbon emissions 8% (from 1990 levels) by 2012, and quickly met this goal. Keeping with their reputation, the UK has pledged to continue surpassing the Kyoto Protocol's goals, meeting a 20% reduction by 2010 and a 60% reduction by 2080. To begin working towards these noble goals, the UK has appointed certain boroughs as 'Energy Action Areas': These areas have been assigned the job of pioneering carbon reduction methods. The Borough of Merton, located in London, is one of these appointed 'Energy Action Areas'. As such, they have been researching and testing possible ways to reduce carbon emissions. Their most notable carbon reduction method is their research into a District Heat and Power scheme utilizing a Combined Heat and Power (CHP) plant.

CHP plants generate heat and electricity simultaneously. In a normal electric power plant, fossil fuels are burned to create electricity and the excess heat produced from the combustion is vented out of smokestacks. CHPs capture this excess heat and utilize it to produce hot water. Through this technique, CHPs attain twice the efficiency of a normal power plant; requiring less overall fuel to produce a similar amount of electricity and heat. CHPs, however, have a notable disadvantage over normal power plants; a change in their output would result in a large loss of efficiency. A CHP plant, to utilize maximum efficiency, should only be on, producing 100% of its possible heat and electricity, or off, producing none. So in order to implement a CHP power plant a strong understanding of an area's electric and heating needs must be attained.

Thus there were two main goals which our team wanted this project to address. First was to help Merton attain a strong understanding of the energy needs in the focus area of Mitcham, as well as aid in the CHP feasibility assessment in the area. Second was to document the methods used to attain this understanding, so it can stand as a template for other boroughs who wish to implement similar carbon reduction measures.

To accomplish these goals and meet Merton's needs, our project produced four main deliverables. The first was a database of energy information on the Mitcham regeneration area. This was necessary for Merton, as they are planning on implementing CHPs in the Mitcham area in the near future which requires a solid understanding of its energy needs. The second was a set of recommendations on how to automate the data collection process. This will prove invaluable for Merton if they wish to implement CHPs in other areas, as this will allow them to gather the information they need quickly and easily on their own. The third was a programme entitled FATCAT (Financial Analysis Targeting and CHP Assessment Toolkit), which assists in feasibility analysis of CHP systems. This program allows a municipality to begin appropriately sizing and understanding the financial implications of CHPs. The final deliverable was the ChAsER (CHP Assessment and Energy Reduction) guide, which contains all of our methodologies we utilized, expressed in general terms. ChAsER is meant to inform other municipalities on the methodologies used in Merton, so they can reproduce the work that was done.

To accomplish the first deliverable, the database of energy information, we began by assessing the feasibility of connecting buildings in the Mitcham regeneration area to a CHP plant. While performing this assessment, we discovered that the best buildings to focus on were municipal owned buildings. This is due to their ability to be contracted for long-term energy consumption from CHP. Businesses came in second, since they were also large energy users and could be signed on for 15-year contracts. However, gathering information on the energy usage of businesses proved troublesome. Private and social housing came last on the list for this same reason; it proved nearly impossible to collect reliable energy information. Private and social housing had another downside as well; the costs outweighed the benefits of beginning a district heat and power scheme by focusing on these buildings.

Collecting energy data on the municipal buildings proved much more feasible than the other buildings identified. We identified four solid methods to retrieve this data, listed below in order of precedence:

- Retrieving energy data from LASER, an energy management company which acquires energy for a large amount of Merton's Buildings
- Retrieving energy data from previous reports done by PB Power, a consulting company
- Retrieving energy data from actual bills retrieved from the building
- Energy information from Internal audits conducted by the Finance department

LASER provided us with the most useful and trustworthy information: monthly readings or estimations from the meters themselves. PB also provided fairly accurate estimations. Actual energy bills from the buildings are much more accurate than estimates from PB's reports, however they were also much harder to attain. In most cases it required the team to call the building in question, and then trace the paper trail upwards to locate the person who directly handled the bills. The internal audits were potentially a strong information source, but we found that there was a lack of consistency within the audits. Some buildings had only monetary figures reported, while others had reading in ambiguous units, or completely erroneous readings.

Our second deliverable, recommendations for automation, was drawn from our experiences while gathering information on municipal buildings. While collecting this data, we discovered that there was potential to automate this collection process in numerous places. This would effectively make the data collection occur seamlessly everyday, and allow the information to be constantly updated and ready for use whenever it was needed. The two areas which we thought had the most potential for automation were LASER, and the officials who handled the energy bills for specific municipal buildings.

LASER was more than happy to provide us with information on all of the buildings which it supplied in the Borough of Merton. If the borough set up a system whereby each month they received the data from LASER in spreadsheet format, it could be inserted into the energy database allowing up-to-date information to regularly be gathered. An alternate idea would be to make it LASER's responsibility to send the data in a format which could be easily imported into a database (through the contract they have with LASER). Our team created a prototype database and front-end for this idea and presented it to Merton, which received favorable feedback.

As for the officials who handle each building's energy bills, it could be written into their job description that they must also report each month's energy usage to a central location. If this were done, then Merton could seamlessly collect this data on a monthly basis. Our team created a working prototype for this as well, consisting of a database and a simple front end webpage which would allow users to enter data into the database. This idea was again received favorably by Merton.

The third deliverable, FATCAT, was created using our knowledge of financial analysis and computer programming. We created a user-friendly program which allows a user to enter an electric and heat demand, and from this data produces a list of possible CHP choices to cover this demand. The user can then choose a CHP machine and the program will then automatically perform the financial analysis calculations for that particular machine, calculating: carbon reduction, yearly profit, excess (or shortage) of heat/electricity from the machine, and total profit. All of these calculations are done for 1, 3, 5, 10, 15, and 20 years into the future. FATCAT also takes into account increases in fuel prices, costs of implementing a new infrastructure (district heat and power system) and inflation. The most useful part of FATCAT though, is in the user's ability to change certain variables within the program, such as the inflation rate, the price of fuels, the annual increase in fuel price, and numerous others. This allows a user to run scenarios, seeing what the best, worst, and average cases are for implementing a CHP system for a specific heat and electric load.

The final deliverable, ChAsER, was a compilation of all of our methodologies which we found effective in the Mitcham area. This was created from our experiences in gathering the municipal data, as well as what we learned from our research on CHPs and upcoming green technologies. This guide also discusses two of our previous deliverables, the energy database and FATCAT, providing user guides and tutorials for both of them to facilitate their construction and use in other municipalities.

From what we learned while working on this project, our team recommends that Merton begins the process of implementing a district heat and power scheme using CHP. This would, of course, entail a deeper analysis of installation and infrastructure costs, but with the knowledge of the energy loads from our energy database, this next step can be taken confidently.

We also recommend that Merton begin testing the automation prototypes we produced. By creating a fully working model of these databases and utilizing a website front-end, they can test the feasibility of our automation suggestions. If they prove feasible, they can then move to the implementation of our prototypes on their intranet.

Looking forward, Merton should also begin exploring ways to collect data on business and residential energy usage, since these are the next steps after connecting Municipal buildings to CHPs. We recommend that Merton contact and work with Croyden Energy Network (CEN), whom we had some contact with during the project. By working with them, Merton could produce surveys/energy audits which could help gather forensic data on business and residential energy usage.

Hopefully, by leaving Merton with our deliverables, they can begin assessing and implementing CHPs throughout the borough. If Merton can even make a small impact in reducing carbon emissions through these findings, it could set an example for the UK and even the world. This example could then ripple out and begin the changes needed to reduce carbon emissions and stop global warming.

Authorship Page

The final report was written through the combined effort of all four members of the Merton Carbon Team. However, since each team member had their own focus area during the project, each was given a primary area to hold responsibility over.

John DeMello focused on the development of the FATCAT program, the ChAsER guide, and performed research involving policies, CHPs, and private wire networks. He also acted as our second liaison to businesses and departments within Merton; building up needed relationships and gathering required data. John also wrote a large part of the methodology and background of our paper, and did some minor editing throughout.

Joe Guzman focused on the power point presentations, which were presented to the Merton Council and representatives of University College of London and De Montford. Joe also developed our business advertisement and acted as our main liaison to businesses and other departments within Merton. In the paper itself, Joe focused on writing the results and conclusion sections and portions of the background.

Chung (Alex) Luk focused on raw data collection, including both gathering the data, and translating it into a usable and understandable format. Alex also acted as a liaison between our group and businesses as well, informing them of our project and gathering needed information. Most of the graphics in this report, as well as some of the appendixes, were also created by Alex.

Michael Robert focused on the databases, prototyping, and any programming required by the project. This includes creating and maintaining the energy database, as well as all programming required by FATCAT. He also wrote the GIS Tutorial and portions of the background, methodology, and results (pertaining to the GIS and databases). Aside from these sections, he was also in charge of final editing and formatting of the paper, to give it "one voice".

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1 Introduction

Near the end of the 20th century, global warming began being recognized by researchers and media alike as a possible problem facing the world. Research conducted since the initial recognition of global warming has done nothing but support these claims; the amounts of greenhouse gasses in the atmosphere have risen in the past years due to the unabated emissions caused by mankind, with the largest offender being carbon dioxide. It has been estimated that if trends continue as they are, the world would experience a 2-6°C increase in surface temperature by 2100 (Houghton, 2004). To most people this figure initially sounds harmless; it is not uncommon in the fall and spring to experience successive days with a larger variance in temperature than that, so what is the harm? However, even a single degree rise in average surface temperature would cause drastic changes to the world's climates and ecosystems: oceans would rise due to a melting of the polar ice caps, extreme weather conditions would become more frequent, and biodiversity could be adversely affected (Houghton, 2004).

The United Kingdom has found itself in an especially precarious situation in regards to global warming and climate change. As would all life on earth, the UK would find itself experiencing generally warmer weather in both summer and winter (UK Climate Impacts Programme). However what makes global warming particularly dangerous for the UK is the affects on the sea level and extreme weather conditions. Since the UK is an island, rising sea levels coupled with increased flooding would cause massive damage to its cities and towns, at best effecting "68 underground stations, 400 schools …16 hospitals [as well as] the homes of 1.25 million people and property worth £80bn" (Aldred, 2005).

It is with these issues in mind that the UK has pressed forward with policies and attempts to reduce greenhouse gas emissions, with a focus on carbon dioxide since it is the most excessively produced and has a long latency period in the atmosphere. In 2004, the UK signed the Kyoto Protocol; calling for a global attempt to reduce carbon emissions, and in 2005 ratified it. The Kyoto Protocol calls for the UK to make an 8% reduction, compared to emissions in 1990, by 2012 (Manne, 1998). In an effort to lead the world in reducing carbon emissions, the UK has aimed to surpass this goal; they have pledged to meet a 20% reduction by 2010, and are hoping to meet a 60% reduction by 2080 (Energy White Paper, 2003).

However, to reach these goals much more will have to be done than just signing policies and making plans, efforts will have to be made to implement these strategies, including at the forefront local government efforts and involvement. The Borough of Merton in London has been chosen to spearhead this movement, acting as a sort of testing ground for strategies and a scheme for others to follow. Merton, with the aid of project groups based out of Worcester Polytechnic Institute, has started down this path of implementing carbon reduction strategies. They already had project teams explore how municipal government can reduce carbon emissions: both directly, through better practices by the municipality itself, and through policies that influence buildings and citizens of the borough (Jahnke et al, 2006). Parallel to this, they conducted research on measuring energy usage and carbon emissions in the Borough, including both what methodology to use to measure these effectively, and what information would be needed to implement said methodology (Gagne et al., 2006). This information is very important to the Borough of Merton for planning and implementing their district heat and power scheme through the application of numerous Combined Heat and Power (CHP) plants. These CHP plants and a district heat and power scheme are what Merton has been pursuing to reduce their carbon emissions.

These are both important steps towards the goal of carbon reduction in the Borough of Merton; an understanding of basic municipal structure and effective power, as well as a way to measure energy usage and carbon emissions will both help Merton effectively implement efficient carbon reduction strategies. However, this research has neither touched on how Merton will effectively collect the information needed to begin implementing CHP plants, nor how they can assess the feasibility of the CHP plants in a given area. Thus, the primary goal of this project was to assist in taking this next step by collecting baseline data on the energy usage of Merton, as well as exploring and recommending an automated data collection methodology that will allow Merton to continually gather information needed on energy usage over the course of its regular municipal affairs. After this, our secondary goal was to produce a generalized guide for other municipalities to follow in implementing our data collection methodologies, as well as a detailed feasibility analysis program to assist in assessing CHPs for a target area.

To accomplish these goals first we gathered data on the energy usage of buildings and located "information farming points" for this data: points where the Borough of Merton could collect the data through everyday affairs relatively easily. Second we established a database of energy data for the regeneration area of the Borough of Merton, to provide a solid basis for our recommendations. Next we used the “farming points” we identified from data collection and developed recommendations and notes for an automated method to collect and store this data in a centralized location, allowing Merton easy access to the data needed to plan and implement carbon reduction strategies such as CHP plants. Finally, we created a program for CHP feasibility analysis called FATCAT (Financial Analysis Targeting and CHP Assessment Toolkit), and also combined all of what we learned into a guidebook for other municipalities entitled the ChAsER (CHP Assessment and Energy Reduction) guide.

2 Background

Throughout the past few decades an increasing amount of research has been done on the world's ecosystems; more specifically on climate change. The global community has realized that in the past, preventative measures were not taken to preserve the delicate balance of the world. As a result of this, the man-made industry has produced greenhouse gasses for many years with no worry of regulations or repercussions. As technology and science have progressed, extensive knowledge has been gained of the detrimental effects man-made industry has had and continues to have on the earth. With such environmental forecasts, a grim future is on the horizon for the planet; a future that the world is now trying to prevent. Various countries have realized that the earth's climate is very fragile and have begun to take measures to prevent total disaster. These counties have taken preventative measures through the implementation of policies mandating the reduction of emissions. These policies have resulted in careful study of greenhouse gasses, particularly carbon dioxide, and the development of both reduction and measurement methodologies.

2.1 Greenhouse Gasses

Due to the seriousness of these gasses, a database of knowledge has been collected about the effects of greenhouse gasses. Basically, naturally occurring and man-made gasses in the Earth's atmosphere act as insulation between the world and space. These gasses include: Carbon dioxide, methane, nitrous oxide, perfluorocarbons and sulphur hexafluoride (IEA). This layer of insulation allows the sun's rays to enter the atmosphere; then these rays strike the Earth's surface where they are reflected back towards outer space in the form of infrared radiation. Greenhouse gasses prevent some of this radiation from leaving the atmosphere, resulting in a raise in the temperature of the Earth. Without this insulation, the Earth's temperature would plummet; however, with the excess production of carbon and other greenhouse gasses from man-made industry, the temperature continues to rise, resulting in the potential destabilization of the environment. As of right now the future of the environment is well within saving, however this will soon not be the case. The increase of the earth's temperature causes the melting of ice caps and permafrost in the Arctic Region, resulting in an increase in the release of greenhouse gases, mainly methane, which only compounds the global warming. The melting also results in the exposure of darker underlying ground that absorbs heat and adds to the melting process. The outcome is a vicious and possibly unstoppable cycle resulting after the carbon breaking point (modest estimates put at about 500 parts per million) of which we are currently at around 380 ppm.

2.2 Effects of Carbon

As the building block of life, carbon is a simple element found everywhere in nature, and is part of every living thing on the planet. Carbon is also found in the atmosphere, however not in its simplest form; it is found in the molecule Carbon Dioxide, a resultant of decomposition and combustion. Carbon dioxide is one of the main greenhouse gasses affecting the Earth's temperature due to its long latency period in the upper atmosphere and excess production from humans. Of course the effect greenhouse gasses have on the regulation of temperature is a natural process that keeps the climate bearable. However problems arise when too much carbon dioxide is released into the air causing more radiation to be trapped and in turn causing an increase in temperature.

Carbon dioxide is by far the most abundantly produced greenhouse gas; it is a waste product of many different commercial and non-commercial processes. Due to this fact, it is also the greenhouse gas, which is most easily regulated and reduced. Therefore, countries all over the world have taken steps to reduce their carbon emissions.

2.3 Effects of Global Warming on the World

The world's climate is very fragile and important. Throughout the entire world there are ecosystems which contain specific qualities that allow them to survive in their given climate. With global warming, all organisms would have to deal with an increase in temperature, and this increase could cause drastic results which would hinder survival, or at the very least result in a restructuring of the ecosystem.

With the changing climate brought about by greenhouse gasses, all aspects of life would be affected. Agriculture is the backbone of the world's food supply and is greatly dependant on understanding the climate. Every farmer understands that his or her crop is tailored to a specific climate and is susceptible to changes in temperature and climate. They recognize global warming as a direct threat to their way of life and to society's well being.

Based solely on complexity and the ability for countries to adapt, third world countries will be affected the most by climate change. As stated before, global warming results in the appearance of more extreme climate conditions. In general most third world countries have an economy based heavily on agriculture, and for this reason they stand to lose the most. Such extreme climate conditions would include an increase in flooding and droughts, which are both vastly detrimental to farming. These floods and droughts could result in a huge loss of crop and severe damage to the country, in turn resulting in the loss of human life.

The warmer climate will also result in a general increase in diseases throughout the world. Insects, such as mosquitoes, which transmit numerous diseases, are kept in check by cold winters, and they generally stay in warmer climates. However, with an increase in temperature, climates all over the world would warm; this would allow insects to spread their diseases much more readily. This trend would result in millions of deaths due to diseases such as malaria becoming more common.

2.4 Effects on the United Kingdom

As the previous section displayed, greenhouse gasses could lead to a multitude of disastrous effects on the global ecosystem and climate. The overall temperature of the Earth would warm, causing warmer summers and milder winters; but at the same time causing a larger frequency of extreme events to occur including: heavy rainfalls, dry spells, flooding, and other weather related conditions.

If the current trends in greenhouse gas production and climate change continue, the UK could be in grave danger. The changing climate could have detrimental effects on the land, climate, and health conditions, as well as the economic standing of the United Kingdom; assuming, of course, that no preventative measures are taken to limit greenhouse gas production.

For the United Kingdom, the effect which climate change could have on the land is a very important issue. This is due to the fact that the United Kingdom is comprised of nations spread across the British Isles; the land and seas are important for both industry and residences, and thus changes to them could prove disastrous.

Rising sea levels is a large factor brought about by the climate changes taking place, but the dangers are doubled for the United Kingdom. In the last century, measurements have shown that the ocean has been slowly encroaching on the land of the United Kingdom, at a rate of 1.5 mm a year; this is even after taking into account the continental drift causing the island to rise to the north, and sink to the south and east (DEFRA, 2004). If this trend continued unchecked, flooding would become more and more frequent, as well as more devastating; potentially causing damage to "68 underground stations, 400 schools …16 hospitals [as well as] the homes of 1.25 million people and property worth £80bn" (Aldred, 2005).

2.5 Effects on the United Kingdom Economy

Aside from the costs incurred to adapt to the changing climate, there would also be an effect on the United Kingdom's economy, in general, if carbon emissions trends were allowed to continue. These changes would be most pronounced on the tourism industry, which currently produces nearly 1.7 million jobs and earns about 100 million pounds per day from all visitors (Viner and Agnew, 1999). However, if climate changes continue, this industry will be adversely affected. With milder winters and warmer summers, United Kingdom residents could be less inclined to travel. With less snowfall due to milder winters, ski resorts in Scotland (which is especially important to the local economy) would also experience a decline in business (Viner and Agnew, 1999). And on a larger scale, the rising water levels of the ocean could adversely affect tourism and tourist activity in coastal regions of the United Kingdom (Viner and Agnew, 1999).

Contrasting this, if the United Kingdom were to implement preventive measures against the climate change, it would actually improve their economy. It is true that the measures currently being researched would cause an initial loss of about 1% GDP (gross domestic product), however this is a very small detriment, and it would be offset by the improvements that could accompany it (Energy White Paper, 2003). For example, reducing carbon emissions and improving energy efficiency would lead to cheaper energy bills, creating more disposable income to infuse into the economy (McEvoy et al, 2000). The construction of renewable energy power plants would also produce more jobs, and the power plants themselves have the potential to generate more jobs than conventional fossil fuel power plants (McEvoy et al., 2000).

It is clear that there are adverse effects that can come from an increase in greenhouse gasses. These include a rise in global temperatures, changes to climates and ecosystems, and even effects on human health and economy.

It is apparent from this research that steps needs to be taken to reduce the detrimental effects that could occur from greenhouse gasses. The simplest way to do this is by limiting carbon dioxide emissions, which are produced in the creation of energy for cities, and in nearly all-industrial processes. This limitation cannot come just from voluntary action since it will cost money and reduce profits by some margin, therefore the international and local communities must establish policy to ensure more is not lost in the future.

2.6 Policy Initiatives to Reduce Carbon Emissions

Worldwide efforts have been made to reduce carbon emissions and greenhouse gasses to deter global warming and its potential devastating effects. A large endeavour has been undertaken by the international community to develop programmes and treaties through multinational conferences with the aim of combating global warming.

2.6.1 The Kyoto Protocol

The Kyoto Protocol was created through international discussions as a climate policy that would be used to prevent the growing carbon emissions levels in both developed and developing countries. This treaty addresses concern over a country's obligation to stop increasing the level of carbon dioxide equivalent emissions and to further reduce it to 5 percent below 1990 levels between the years 2008 and 2012 (Manne, 1998).

By reaching and sustaining the levels, which the Kyoto Protocol has established, the world can reach a good basis to continue reducing carbon emissions. This strong international agreement, though only requiring a small reduction that will see very little empirical results, provides the necessary infrastructure and commitment in the global community to seriously combat global warming.

2.6.2 Energy White Paper

The United Kingdom's Energy White Paper establishes a policy through which the British government plans to implement programmes and fuel research and innovation to reduce carbon dioxide emissions by 60 percent no later than the year 2050. Though the Kyoto Protocol and the UNFCCC both have created a criteria the UK must meet, the White Paper brings that criteria further to bolster a higher standard not only in the UK but worldwide. This Paper not only addresses a plan to achieve these methods, they also express the need for research and development to create more advanced technologies to achieve a 60 percent reduction, this figure being the amount of reduction necessary to stabilize the carbon dioxide levels (Energy White Paper, 2003).

Even with such high standards, the White Paper acknowledges that much damage has occurred and will occur due to climate change and global warming, but the majority of major future destruction can be avoided by acting now. The UK also has the foresight to realize only 2 percent of global carbon dioxide emissions originate from the UK and without international action there is very little impact the 60 percent reduction would have. The White Paper lays out a framework for not only the UK, but for the entire world and hopes to inspire the global community to take action (Energy White Paper, 2003).

Consumer and individual action must be taken in addition to government incentives and regulations of the energy industry in order to achieve such a significant reduction. By conserving more energy through energy saving techniques and instituting methods such as Combined Heat and Power (CHP), individuals can reduce energy demand thereby reducing carbon emissions further. New buildings can also be built with energy saving techniques already constructed into the house and comply with newer regulations on energy reduction. By becoming a more energy efficient society, renewable energy sources will be able to provide a larger percentage of the power resulting in a more optimal situation.

The White Paper addresses multiple areas of concern in reducing carbon emissions as well as meeting the criteria set forth in the Kyoto Protocol. Through this multiplicity of policies and methods to reduce emissions, the UK has set an exceptional example for other countries to follow in order to stabilize carbon dioxide levels. However, this is not enough to combat global warming. There must be local action, which coincides with national and international policy in order to see a real reduction in carbon emissions and the threat of global warming.

2.6.3 Merton Policy Initiatives

Much of the policy passed by the Merton Council is due to the United Kingdom's participation in the Kyoto Protocol, and the necessity for local participation in order to accomplish its goals. Since cities such as London produce the largest amount of carbon dioxide, the United Kingdom has chosen to implement and test carbon reduction policies and strategies in London's boroughs; these boroughs are labelled "energy action areas". Merton is one of these energy action areas, and as such they have begun taking significant steps to try to lower their carbon emissions, including the Climate Change Strategy, consisting of the five major goals displayed in table 1 below.

1	To cut CO_2 emissions in Merton by 15% by 2015
2	To generate 10% of Merton's energy needs from renewable sources by 2015.
3	To recycle 33% of Merton's household waste by 2013
4	To compost and sustainably treat from 67% of Merton's biodegradable waste by 2015
5	To promote and extend sustainable travel options across the borough

Figure 1: Merton's Climate Change Strategy

(Hewitt et al., 2005)

The first goal listed is the core of the climate change strategy; this is their desired end product, and the other goals listed all indirectly support this one. For this reason they have passed legislation to accomplish the first core goal; knowing full well that the other goals will most likely be implemented to accomplish the first. The legislation passed includes Merton's Community Plan, which concentrates on reducing carbon emissions associated with its municipal buildings by sixty percent. They have also passed both the Climate Change policy and the Unitary Development Plan, which deal with overall carbon reduction and an increase in renewable energy use (Hewitt et al., 2005).

Many of the large buildings responsible for carbon emissions in the borough are government owned municipal buildings. The local participation for these policies has concentrated on these municipal buildings, since by virtue of being government owned, information needed to calculate carbon emissions is easily obtainable and privacy issues are not a factor.

2.7 Sources of Carbon Emissions

Measuring the carbon emissions of even a single building in its entirety is not a trivial task. Although there are only a few processes within each building which directly cause carbon emissions (the main one being heat generation), there are numerous processes which indirectly cause them, such as: internal processes which use fuel or electricity, waste production, vehicles use by employees in the building, and other building specific processes. Measuring all of these processes in detail would be a challenging task, if not impossible. However, measuring carbon emissions can be simplified by looking at the four encompassing emissions processes which can be found in any building: electricity usage, heat generation and fuel usage, waste production and waste handling (landfilling, recycling, combusting, and so forth), and transportation of employees. Since the focus here is on municipal buildings and processes most directly related to the buildings, transportation can be left out of the measurements, leaving the other three sections for evaluation.

2.7.1 Measuring Carbon Emissions by Electricity Usage

Since the invention of electricity, people who live in developed countries have been depending on electrical energy to power everything from lights to personal computers. With today's technology, there are numerous ways in which this electrical energy could be produced without emitting carbon dioxide, including: nuclear, hydropower, fuel cell energy, and solar power. Although this is true and these zero carbon emissions methods are available, 80% of the world's electricity is still being produced by burning fossil fuels (ExxonMobil, 2005).

The amount of carbon dioxide released into the atmosphere due to electricity usage is directly proportional to the amount of carbon dioxide generated by the power plants when power is being produced. According to recent research, a natural gas fired combined cycle power plant will emit about 294 tons of carbon dioxide per hour while producing 800 megawatts of electricity; an ultra supercritical pulverized coal fire power plant will emit about 738 tons of carbon dioxide per hour while producing 830 megawatts of electricity (Roberts et al., n.d.).

Thus, to measure the carbon emissions from municipal building by electricity usage, one could collect the amount of electricity used by that specific building, and then utilize simple calculations to relate the amount of carbon emissions with the amount of electrical power supplied to the building.

2.7.2 Measuring Carbon Emissions by Heat Generation

Heat generation is one of the essentials of daily life; buildings around the United Kingdom require heating to keep the internal environment at a comfortable level for its residents. The two most widely used practices to generate heat in the UK are either by burning natural gas or by burning oil.

To calculate how much carbon emissions are being produced through the generation of heat, one could use a basic chemical molecular calculation. Using the coefficient that is related to the heat generation chemical reaction, one can estimate, for example, that burning one cubic foot of natural gas will generate around 12 pounds of CO_2, and burning one gallon of oil will generate around 22 pounds of CO_2 (The Earth Organization). So once a building's fuel usage is known, as well as the type of fuel they use, the carbon emissions caused by the building through the burning of fossil fuel can be estimated.

2.8 Standardized Systems for Measuring Emissions and Efficiency

In order for the Borough of Merton to efficiently understand and measure the effects their steps have had on overall carbon production, they have begun to take steps to monitor their emissions. These measurements should also allow Merton to determine their biggest carbon emitters. There are many different sources of carbon dioxide, and at this point in time it is impossible to address them all. For this reason the Borough of Merton has decided to concentrate its effort on measuring and reducing carbon emissions from buildings, focusing on their municipal buildings. These buildings have been targeted for two reasons: because they are stationary, and because they account for almost four times the emissions of the transportation system. On top of this, data on the structural qualities and processes of the building can be easily measured and are fairly static, due to the fact that many of these buildings are governmentally owned. These following sections will explore the various methods that countries, companies, and organizations have used to measure and estimate carbon emissions and efficiency.

2.8.1 National Calculation Method

One approach to measuring energy consumption and carbon emissions is NCM, the National Calculation Method. This particular method was outlined by the Office of the Deputy Prime Minister in a document released in July of 2004 (Building Research Establishment, 2005). This method is a comparative one, comparing the energy use of a proposed building with that of a national, or control, building. The calculations are done by using construction data collected when the building goes through the various registration processes. These calculations also take into account data collected on the activities and internal processes taking place in the buildings. After all of this data is collected, the calculations are made through the use of a computer programme. This programme, Simplified Building Energy Model (SBEM), provides in-depth analysis of the energy usage and carbon dioxide production of the building (Building Research Establishment, 2005).

Specifically the programme uses the geometrical characteristics, construction, refrigeration use and the lighting system throughout the building to estimate the building's monthly energy use and carbon dioxide emissions. All of these characteristics play a crucial part in energy usage, and thus carbon dioxide emissions. With this information, governments, companies and organizations can determine the effectiveness of new policies and reduction strategies.

2.8.2 Standardized Assessment Procedure (SAP)

Another approach to carbon emissions measurement is SAP, the Standardized Assessment Procedure. With this approach a building is monitored and rated based on extensive criteria: including a Carbon Index (a generalized rating of the amount of carbon emissions), and an energy rating for each building. These measurements are calculated through data collected on each building being rated, including:

- Materials used for construction of the dwelling
- Thermal insulation of the building fabric
- Ventilation characteristics of the dwelling and ventilation equipment
- Efficiency and control of the heating system(s)
- Solar gains through openings of the dwelling
- The fuel used to provide space and water heating, ventilation and lighting
- Renewable energy technologies used in the building

(Garston, 2005)

This system is quite in-depth and can determine the energy efficiency of a building from a structural standpoint, as well as the amount of carbon emissions likely to be produced. However, no method is perfect. Since this method is based solely on the physical characteristics of the building, it cannot take into account the energy profile of occupants. For example, one building could house a person who travels all the time and an identical building could house a family of five. These two buildings, although physically identical, would have vastly different energy usages; SAP would not capture this in its Carbon Index and energy ratings.

2.8.3 Energy Assessment and Reporting Methodology (EARM)

This particular approach to carbon emissions measurement was developed to be simple, using only a spreadsheet to perform the assessment. It was originally developed to target hotels, industrial buildings, factory-offices, and banks. However, it can also be adapted to schools and other buildings if the necessary benchmarking system has been developed. The main use of this method is to identify poor performing buildings and systems, determine the reason for the poor performance, and to create a benchmarking system. There are three main stages to this approach:

- Stage 1: This stage provides a quick assessment in terms of energy use per unit floor area, which can be carried out by in-house resources.
- Stage 2: If the building has special energy uses or occupancy, the second stage is likely to be required, which can also in most cases be carried out in-house.
- Stage 3: For a full understanding of the performance of the building and its systems, a Stage 3 assessment is carried out; requiring specialist capabilities.

(TJL Associates, 2000)

This system allows the assessment team to reduce the completion time required by completing as many steps as the building requires, as well as gain an understanding of the building and system efficiency. A large amount of data is also collected on each building, which is crucial to effective carbon emissions assessment.

2.8.4 Carbon Trust's Baseline and Targeting Tool

This approach is built off of the idea that by simply measuring electricity usage and heating fuel usage, a very elementary conclusion on a building's equivalent carbon emissions can be determined. This process can be found in many spreadsheets and web-based applications, such as on the Clean Air Cool Planet website. These methods provide minimal data that can be used to reduce energy consumption and therefore equivalent carbon emissions; however more comprehensive tools have been created to further the understanding of a building's energy usage and the corresponding carbon output. These spreadsheets and programs take into account the area of the building in question, transportation, water usage, waste management as well as other carbon-producing processes.

The advantage of these comprehensive tools is that benchmarks can be established, such as with the Carbon Trust's Baseline and Targeting Tool (CTBTT). "Typical" and "Good-Practice" values are determined by samples that were taken by the Carbon Trust and are used to red flag actual building values that exceed those benchmarks. Using these red flags, buildings can be further examined to determine the best way to reduce energy consumption. By using the CTBTT, a free carbon accounting tool, standards for carbon equivalencies can be established throughout the UK and comparisons made between different municipalities. This allows for a greater base of knowledge to be both collected and standardized for examination by higher authorities, such as the Mayor of London or UK environmental agencies.

The CTBTT is an Excel sheet divided into 11 tabs: Intro, Buildings, Transport, Streetlights, Waste & Water, Commuting, Data, Building Graphs, Transportation Graphs, Commuter Graphs, and Summary. These sectors calculate their corresponding carbon emissions as described by their tab names, while the Summary provides graphs from the corresponding data entered. The calculations executed by this worksheet are very simple, however the most important data are the benchmarks referenced in the worksheet. Images of the CTBTT can be seen in Appendix A with a further explanation of its use.

2.9 City Knowledge

City Knowledge is the idea that local governments can create a large central database of information to aid in decision and policymaking. As explained in the dissertation on City Knowledge written by Fabio Carrera, a city can essentially function as a large corporation with the ability to track and control the locality's funds and implementation of policy. With a centralized local GIS (geographic information system), each branch of the municipality can properly coordinate with one another and share data that they have collected. City Knowledge approaches the problem not through forcing data collection on the local governments, but rather aims to integrate data collection into everyday life.

City Knowledge begins with a middle-out approach by examining municipal structure and expanding local knowledge from this middle point. A municipal government can generically be divided up into the following areas:

- Political and executive branches

- Internal Services
- Public Health and Safety
- Culture and Leisure
- Education
- Physical Services

By using the middle-out approach, each of these areas can concentrate on the data they need to collect for their own use. This method eliminates the collection of superfluous data which would only result in increased costs and time wasted. Each of these departments would then be able to use a bottom-up approach to data collection and a top-down approach to policy making (Carrera, 2004).

The bottom-up data collection approach is an extension of the department's needs. A complete infrastructure for data collection cannot be instituted overnight, so a gradual change must first be made by collecting data for "low hanging fruit." This allows for governments to collect data that is most profitable to them and thus will have a more immediate impact. By focusing on these data areas, a general infrastructure may also be created to lay a foundation for further collection. Through the creation of a foundation through the bottom-up approach, finer data can be gathered which allows policy makers to better tailor their policies and decisions to a given situation. This information can be collected through multiple methods. Individuals may be given the task of data collection while performing their daily tasks. This can be as simple as town tree cutters taking measurements of the trees they are cutting and providing those measurements to the town arborist. Third parties that specialize in data collection can also be used to collect this data, but may result in more expenses than are necessary.

The finer data compiled by the local departments at the smallest scale possible is then used for a top-down policy making approach. Data collected from the bottom is filtered through to the top so departments and executives are able to make decisions based upon the data; which are then implemented and affect the lower departments. This information when collected on an automated, regular basis provides city officials with the essence of how the city is doing at all times and any anomalies can be pointed out immediately before the problem becomes too large.

2.9.1 "Corporate Knowledge"

City Knowledge very closely mimics the way larger corporations are organized and run. Data is collected either by contractual agreements with third parties or through internal processes. This data is usually filtered from the bottom to the top and a synopsis of the data can be given to the company's executives; for example a town manager, a mayor, or a city council. The executives can then make decisions based upon this information with the guidance of the finance and legal departments which cities also have. By using this full "corporate knowledge," better decisions are made that allow the government to function more effectively and efficiently. Cities may not possess the comprehensive knowledge that companies are able to produce due to the infrastructure they have already put in place and the ease of companies to monitor their employees. These cities will have to expend more funds on building an information collection infrastructure and determine a way to collect information about private citizens without violating laws in place. "Corporate knowledge," however, mirrors city knowledge and proves that this idea can be extremely useful.

British Telecommunication (BT) serves as a good example of the feasibility and usefulness of the idea of "corporate knowledge". They have used their power as a corporation to establish an infrastructure that would allow them to reduce carbon emissions and lead the way in greener energy. This follows very closely with the ideals of the UK and Merton in their own reduction of carbon emissions. Steps were taken first to monitor their data collection services in order to properly determine what areas they needed to work on and to see how much progress has been made.

2.9.2 British Telecommunications Data Collection Programme

According to Chris Wade, British Telecomm's Group Environmental Manager, BT had a Management Information System (MIS) since 1991 that measured energy usage and transportation in the company. Their most recent advancement was to upgrade the electrical meters to measure all buildings on half hour intervals and collect the information in a database. They also had knowledge of information such as what heaters were being used in buildings and were able to make the conversion from oil to gas heating which reduced carbon emissions greatly. Contracts with the waste disposal companies allow for the collection of data on the energy usage and carbon emissions associated with the disposal of waste and allows for new agreements to be drafted, which can allow for reductions in emissions. Another third-party that supplies data is the power company that provides green energy through BT's contract with them. The data supplied includes the breakdown of where the electricity is produced and through which processes along with the associated carbon emissions. All of this data has allowed British Telecomm to have knowledge of its carbon emissions output and take steps to reduce emissions by 53% since 1996 (BT, 2005).

Without BT's data collection programme, the necessary information would not have been passed to the executives and the environmental team that would have allowed for the proper action to be taken. Though Merton is much smaller and has less money to expend than BT, a comparison can be made by the successfulness of BT due to their data collection and "corporate knowledge" which could result in the same success for Merton using the "city knowledge" approach.

2.10 "Farming" Teams

The vast project of determining how in the normal course of business the London Borough of Merton can continually gather necessary data on carbon emissions and efficiency is far too large for a single WPI team to accomplish. For this reason the Borough of Merton has employed the skills of numerous WPI teams. The main goal of our portion of the project is thus to integrate the work of the two previous teams in the "farming phase" of the City Knowledge approach to gathering information. The first team has concentrated its work on identifying municipal activities that result in carbon dioxide emissions, as well as evaluating policies which could be implemented by the Merton government to reduce carbon emissions, which includes: determining the success rate of a particular policy, as well as determining if the policy is financially possible. The other team has concentrated their work on determining what data needs to be collected in order to assist the Borough of Merton in assessing their carbon reduction policies. They also focused on developing a centralized database for the collected data. This section will focus on discussing each of the two previous team's projects, since their work will be directly integrated with ours.

2.10.1 Urban Approach to CO_2 Reduction

This team concentrated their work on cataloguing all of the processes, which produced carbon dioxide emissions. However, due to the fact that the carbon emissions are produced by so many different processes, this team was forced to limit themselves to municipal buildings of Merton's five major departments: Children, Schools and Families Department, the Chief Executive, the Community and Housing Department, Corporate services, and the Environment and Regeneration Department (Jahnke et al, 2006). Through close examination of these departments the team was able to determine the processes responsible for emitting carbon within each department, and from this they were able to determine where reduction policies would be most effective. Finally, to allow the collected data to be utilized efficiently by the Borough of Merton, the team developed a centralized database so that all the various departments would have access to the information.

2.10.2 Building Energy Estimation

The second group focused their work on furthering Merton's plan to install combined heat and power plants in various areas of the Borough. They did this by characterizing some of the buildings throughout the Mitcham regeneration area based on their functionality. Then from this they were able to determine where certain building types are located. This information was then put in a Geographic Information System, allowing them to then estimate and validate the energy use of public buildings. Once the team gathered the information, they were then able to use the GIS system to determine some of the buildings, which used the largest amount of energy, as well as the areas where there is a constant energy usage (Gagne et al, 2006). Both of these abilities would prove invaluable for the Borough of Merton in deciding locations for district heating CHP plants.

3 Methodology

At this point in time the Borough of Merton is planning on developing a district heat and power scheme through the implementation of numerous combined heat and power plants. Much of the research for such a DHP scheme has been and will be conducted by WPI teams. Our individual project only tackles a portion of the knowledge Merton needs, however, we are building upon two previous teams' research as well as working closely with the other WPI team working here. In addition, a summer team will further the research that has not been completed in order to complete the recommendations and working models that Merton is seeking.

With the Borough concentrating on collecting data to support a combined heat and power feasibility study, the purpose of our project was to create a replicable method by which the London Borough of Merton could map energy usage of buildings within a given target area. This included both the mapping of actual energy usage and estimated energy usage when forensic data was unavailable, as well as recommendations for the automation of this data collection process. To do this we integrated our research of past projects, discussed in sections 2.10.1 and 2.10.2, with the City Knowledge approach and came to the conclusions that creating a GIS Energy Database was the best way to store and map energy data. Doing this would give Merton a useful tool for CHP planning, estimating carbon emissions of the borough, identifying high energy users, and numerous other tasks. The GIS database is most useful for CHP feasibility studies, since it allows for the CHP planning team to see the geographical layout of the proposed routes, as well as to easily display and evaluate energy usage data for all the buildings in the area. To create the database and collect the necessary data on buildings, our team completed the following steps:

- Modified the current Merton Energy GIS (MEGIS) database to support our research and data entry needs
- Gathered data on building energy consumption and located areas where data can be easily obtained, to provide Merton with concrete energy information.
- Gathered data on building characteristics which were used to develop estimations for buildings where forensic data was not available

- Inserted both estimated and real energy data into the GIS, providing Merton with a centralized energy database.
- Produced a list of our data collection points and developed recommendations/prototypes for seamless automated data collection.

Our team concentrated on gathering energy data from buildings found in the Mitcham regeneration area, located in the southeast of Merton. A graphical display of our methodology can be seen in Figure 2.

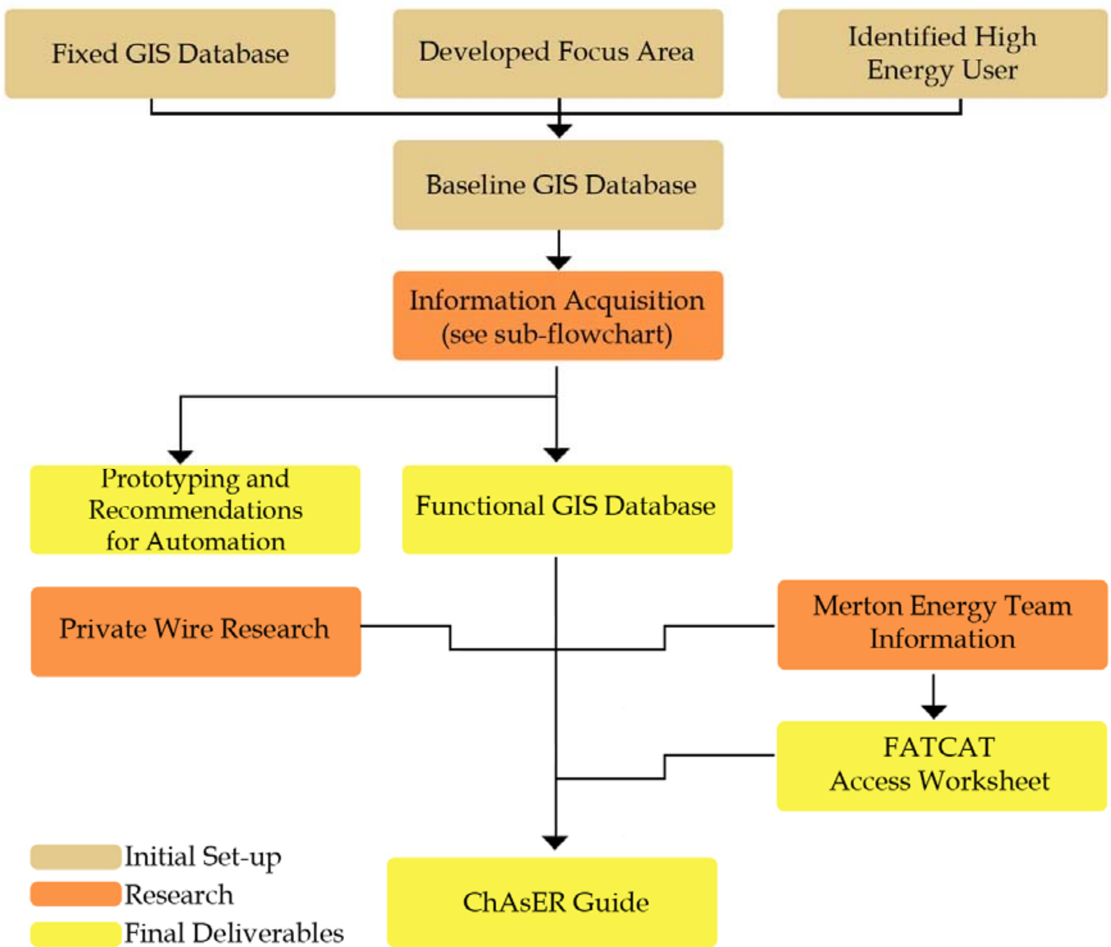

Figure 2: Methodology Flowchart

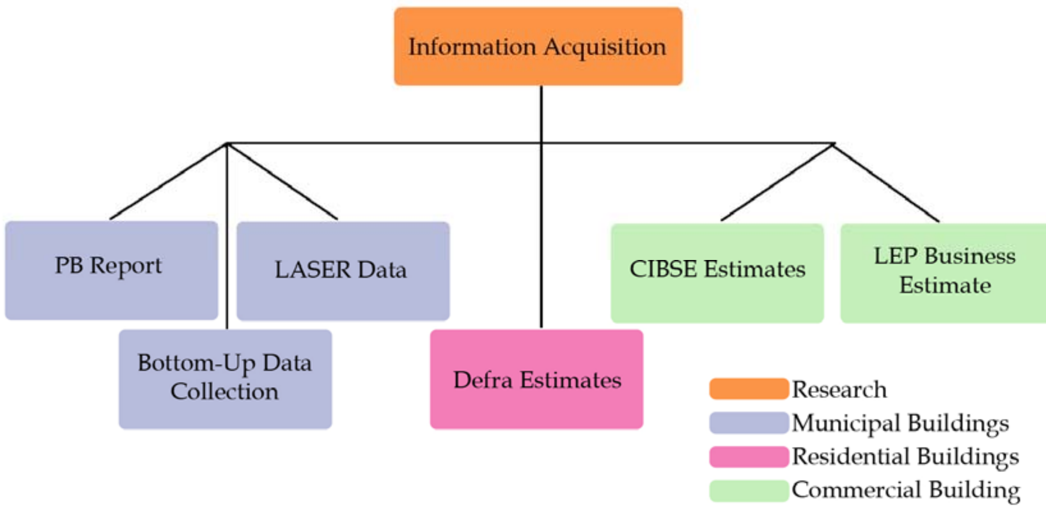

Figure 3: Data Collection Flowchart

3.1 GIS Maintenance and Modification

Our focus area was chosen and roughly mapped by one of the WPI teams previously working with Merton (Gagne et al., 2006). The previous IQP team also worked with the MEGIS database, and created a simple access database to aid in entering data into the MEGIS map. However, the database was quite ad hoc, and required significant modifications to produce a suitable database for use by our team and Merton.

The database contained almost no internal documentation, thus our first goal was to appropriately document and group the fields. Next we double checked the information in the database and corrected any erroneous information found within it. Once we were sure the basis of the database was in working order, we expanded on the data contained in the database, adding five new fields to hold information we gathered: average annual heat fuel usage (in kWh), average annual electricity usage (in kWh), source of heat fuel usage data, source of electricity usage data, and a field for a hyperlink to any external documentation on the building (e.g. a spreadsheet of energy usage over previous years). This feature of hyper-linking provides easy access and manipulation of the database for those not familiar with Microsoft Access or the MEGIS and can allow for more seamless updates of the MEGIS. Once this was done, we expanded upon the focus area the previous team had inputted into the database, adding 738 new buildings, and nearly doubling the contents of the database. Finally, we optimized the database making it take up nearly 60% less memory on the computer, as well as making it more user-friendly.

Actual data entry into the access database and MEGIS was handled in one of two ways: either the data was painstakingly entered by hand, or through the use of access update queries. Manual data entry was accomplished by searching through the access database to find the appropriate building and UPRN, then entering the colleted data. As can be imagined, this is a tedious and time consuming task, so whenever possible access update queries were used. These however, were only possible when the data we collected was in electronic form and contained within it the UPRN of the building. If this was the case, then access update queries were used to match the UPRNs and insert the information into the appropriate field.

Most of the data entry on council buildings had to be entered manually since the data was generally either non-electronic, or did not contain a UPRN or means to link it with the database automatically. However, for energy estimations based on building classification, we automated the process, having Access utilize a certain value for energy usage based on the building classification, and possibly building size.

3.2 Determining Actual Energy Use

With the MEGIS database now updated, understandable, and presentable, we were able to begin data collection. The data collected, whether actual or estimated, covered numerous types of buildings within our target area, including: businesses, social housing, school buildings, civic centres, police and fire stations, and private housing. Since there was such a multitude of different buildings in the area, we split the buildings into three major areas based upon usage, which ultimately dictated how we gathered data from each; these three major areas were Municipal buildings, Commercial buildings, and Residential Buildings.

The main concentration of this study was to determine a variety of CHP plant sizes needed by a specific area or building. However, since to determine a CHP plant size all that is needed are general ballpark figures, a certain amount of leeway on the data could be allowed. With this in mind, our team concentrated on obtaining actual data where we could and where it was most appropriate, and provided the best possible estimates for the other buildings in the area. We experimented with many different data collection methods; some of which were unsuccessful, but documented to support the LEAA goal of learning from our mistakes and successes. The methods that were utilized for data collection can be seen below in Figures 4 and 5, broken up by data type and building type.

Data Collection Methods		
Building Type	Actual Data (Gas and Electric)	Estimated Data (Gas and Electric)
Municipal	[1]Follow the paper trail (Energy Bills) [1]LASER Data	[1]CTTBT Worksheet [2]CIBSE Guides, [3]PB Power Report [4]Internal Audit
Commercial	[4]Actual building Surveying	[1]CTTBT Worksheet [2]CIBSE and ECON Benchmarks
Residential	[4]Surveying of Residences in conjunction with CEN	[1]Defra Worksheet
1-4 Scale Best to Worst -- based on accuracy		

Figure 4: Accuracy of Methods for Data collection

Data Collection Methods		
Building Type	Actual Data (Gas and Electric)	Estimated Data (Gas and Electric)
Municipal	[1]LASER Data [3]Follow the paper trail (Energy Bills)	[1]PB Power Report [1]Internal Audit [2]CTTBT Worksheet [2]CIBSE Guides
Commercial	[4]Actual building Surveying	[2]CTTBT Worksheet [2]CIBSE and ECON Benchmarks
Residential	[4]Surveying of Residences in conjunction with CEN	[2]Defra Worksheet
1-4 Scale Best to Worst -- based on availability		

Figure 5: Availability of Data for Data collection Methods

3.2.1 Municipal and Council Owned Buildings

Collecting accurate energy information on municipal buildings became the focus of our project once the initial breakdowns of building types were evaluated. The reasoning behind this is simple, municipal buildings:

- Are high-energy users
- Can sign its own buildings up to its CHP scheme and contracted for 15 years
- Have readily available forensic energy data

The first source of data that we came across for these municipal buildings was a report done by Parsons Brinkeroff (PB), a private energy-auditing company. This report contained energy information on only twenty-four buildings in total, however much of the information turned out to be estimations. Upon further inspection we also discovered that even some of the "actual" data PB had collected was erroneous, thus PB's report was used sparingly at best.

Since our focus was to collect actual energy data for municipal buildings, we began exploring other areas aside from PB to gather this data. Our first attempt at locating energy data for municipal buildings was to contact the departments which controlled the buildings, and work our way down to the actual person who controlled and handled the bills. After attempting this we quickly discovered that searching for energy bills from department heads was not successful in our particular situation. Higher-level employees did not specifically deal with the energy bills and did not know whose jurisdiction it fell under, which made locating the bills challenging, if not impossible. We soon discovered that it was much more fruitful to trace the paper trail up from a single building, since they know where they send their energy bills. First we would contact a specific building manager, and then followed the chain of command up, until we discovered the final resting place of the building's energy bills. From here we could then branch out, inquiring if this person/department handled the bills for other municipal buildings of the same type, for example all of the schools or civic centres. In most cases they did handle more than just the bill for the specific building we started with, and if they did not handle all of the bills for that type of building, they could point us in the right direction to find the other bills.

While utilizing this search methodology, we came into contact with the Merton property manager who informed us that a large amount of Merton's buildings purchased their gas through contracts with LASER, an energy acquisition company run through the Kent County Council. Municipalities use these energy acquisition companies to reduce their energy costs by entering into contracts with other boroughs, allowing for energy to be purchased in bulk. We proceeded to contact LASER directly, and inquired if it was possible to receive a breakdown of energy usage of all of the buildings Merton had under contract. This turned out to be possible, and when requested LASER provided us with a monthly breakdown of their energy billing of all of the buildings under contract in Merton. This data mainly pertained to the gas usage of buildings, in kilowatt hours (kWh). Though the information was obtained directly from LASER, monthly energy data was unreliable because some months were estimated and then corrected after an actual meter reading. In some cases, this resulted in a month having negative energy consumption, due to so many credits being built up. The yearly data for each building still proved to be useful though, providing us with the most accurate numbers attainable without actually reading the meters.

The property manager also provided our team with an internal audit carried out by the Corporate Services branch. This audit contained information on how much each department's building spent on energy for the year. After obtaining this data we compared it with our collected data from LASER and actual energy bills, realizing that there was a significant discrepancy between the two. Even though the data from the internal audit proved to be very inaccurate, it provided us with a substantial list containing municipal owned buildings throughout the borough.

Using the internal audit we were able to determine which municipal buildings in Merton were using the largest amount of energy, and which were using little to no energy. This gave us a prioritized list to help focus our efforts. Using the same approach described above, starting with the building manager and tracing the bill upwards, we gathered actual energy data on these large energy users. Thus we were able to quickly gather accurate information on these large consumers, which greatly aided the CHP group's study.

3.2.2 Commercial Buildings

Our team's secondary objective was to collect information on commercial buildings, since after evaluation they were almost as desirable as municipal buildings. Commercial buildings fit much of the same criteria required by CHP power plants: they are large energy users, they can be signed up on 15 year energy contracts, and in general businesses should be supportive of the idea of CHPs since it would save them money.

Our initial plan was to estimate the energy usage of businesses using some of the estimation methods discussed in the background of this report, since energy data on businesses was not as readily available as municipal buildings. However, while doing this, we discovered that an issue could arise if there were certain circumstances which modified a businesses energy use greatly. For example, a large business building would normally be assigned a large energy usage through the estimations, however if this building was used as warehouse storage, it would not use nearly as much energy as estimated. As a contrast, a small retail business would be given a low energy usage from estimation, but if it dealt in consumer electronics, and constantly had electronics running on display, it would use a great deal more energy than estimated.

For this reason we decided to try to attain actual energy data. This proved much more difficult than municipal buildings; we did not have direct access to a business's energy bills or to an audit of their spending on energy for a given year. With these facts in mind we undertook the difficult task of obtaining actual energy data from commercial buildings through fieldwork.

Our fieldwork consisted of a personal surveying of about 40 businesses in the area. We visited each business, identifying ourselves as a college project group working with the Borough of Merton, and asked if the owner or manager of the business was free to talk with us for a few minutes. When we could, we then presented the manager or owner with a short pamphlet giving a brief description of our project and its goals, which can be found in Appendix B. With this we described how CHP's could help reduce costs for them as well as help the environment, and enquired if they would be willing to help our study by supplying us with energy usage data. We were unable to attain energy data from this fieldwork; we discovered that the large businesses who were interested in CHPs sent their bills to corporate headquarters to be taken care of, and smaller businesses tended to be uninterested.
However, the fieldwork was not a complete loss. While surveying these 40 businesses we noted any large energy consumption equipment they had, and classified the building as retail, service, manufacturing, office, etc. Using these classifications, as well as the rough square footage of the building attained from the MEGIS maps, we were able to systematically estimate the energy usage of the businesses using CIBSE and ECON, and taking into account the special cases where straight estimations would have been grossly erroneous.

Another area we attempted to explore for obtaining the business type for estimation purposes was the business rate tax data. This data currently is considered "protected" and cannot be used for any other purpose than its original intention. However, through working with Simon Guild, the data protection officer, Local Government Act 2000 (LGA2000) may provide a way to obtain the addresses and business types to aid in estimation. This will require complete transparency on what the data will be used for and what benefits it will have in accordance with LGA2000. Without this data, however, we were able to obtain the business type data and estimates as seen in appendix A of the ChAsER guide (see attachment to this paper). The actual benchmarks can be found in appendix B of the ChAsER guide.

3.2.3 Social Housing and Private Housing

Social and private housing, upon inspection, proved to be the least important to collect energy data on. Far too many individual houses are needed to justify a CHP plant, and even if it could be justified, the buildings' owners cannot be contracted for long periods of time so there is a risk of them changing energy providers.

Although this is true, we felt that since residential houses are collectively a significant energy user, our database should strive to include their information as well to create a complete energy profile. Because these buildings were not as integral to the project, we began by assessing each house in a generalized manner, identifying them as one of the following: flat, mid-terraced, end-terraced, semi-detached, and detached, with 1, 2, or 3 bedrooms. This classification was done based on observations of satellite photographs and personal observations by the team. From these classifications we then entered in estimate data from the Defra worksheet, which can be found in Appendix C. This worksheet is one of the most widely known and accurate worksheets for estimations of housing energy use.

Since our estimations were not exact, we wanted to strive to gather actual energy data for these buildings. We originally planned on obtaining this information through a survey, similar to our commercial survey, however it would also include a free energy audit as an incentive. Given that these buildings are not conducive to CHP planning, as well as the negative response we received from businesses, we decided not to follow through with our survey.

Even though we decided this, we still included it in our recommendations as a viable source of information and automation. We had already built up relations with Croyden Energy Network, which offers free energy audits if a resident fills out their energy audit questionnaire. The CEN audit survey, which can be seen in Appendix D, asks for information about the state of the house, types of windows and boiler, as well as other SAP-like items that help assess a home's energy use. Unlike the SAP questionnaire, the CEN questionnaire is far less detailed, and provided us with a questionnaire that was more likely to be filled out and submitted by Merton's citizens. This questionnaire was also web-based which provides a possible capture point to automate the collection of the data; on top of this, since it is web-based Merton could create their own version which includes questions about yearly energy usage, and then simply pass the information on to CEN for the free survey.

3.2.4 "Off-peak period" Energy Usage

During our study on collecting actual energy usage from buildings, we realized that energy demand is significantly different comparing the daytime and night time electricity usage. This is mainly because during the day, people are working and using devices within their home which require electricity. As the day progresses into evening and businesses close, the electricity use decreases. This is an even more drastic decrease as people go to sleep at night (see appendix I). To keep the electricity demand at an even balance and maintain the load on the CHP, other sources are needed to consume the electricity.

One of the solutions that we looked into was to supply electricity to streetlights around the CHP plant. This helps balance the curve since as the evening approaches and the sun sets, the lights within the borough turn on and consume a large amount of night time electricity. Each year, Merton Council pays to the tune of £350,000 to power all the streetlight within the borough. We have collected information on electricity usage around our focus area (see Appendix E), and found out that during wintertime, when there is less sunlight, streetlights use around 900 kW of electricity per day around the focus area. More accurate modelling needs to be accomplished in this area before more concrete conclusions can be made, however streetlights are one area to look into to balance the electricity load.

3.3 Development of Farming Point List and Automation Recommendations

In order to apply the City Knowledge approach to the Borough of Merton, the previous WPI/Merton team began constructing a matrix which mapped out information farming points based on Merton's specific departments and processes. This matrix serves as a starting point for Merton to look into automation and seamless data collection, as such one of the main goals of our project was to help augment and update this matrix.

During the project we constantly kept in mind the goal of automation, and as such took steps to facilitate augmentation of this matrix. We documented and kept track of the source of all of the data we gathered (this can be seen in abridged format in Appendix F), as well as took notes on any automation ideas which came to light during the project. Every source of information was then analyzed to identify possible locations of new farming points. With the help from a city knowledge expert from Venice, Daniela Pavan, we analyzed and added a good deal of information to the matrix, including the identification of three promising farming points: the internal Merton audits, the LASER data, and the surveys for businesses and residential housing.

Parallel to augmenting the previous research team's matrix, as we identified farming points we also explored the idea of automation of each one. This process was fairly fluid in nature. Each farming point, once identified, was first evaluated to see if it could be completely automated so that no real labour had to be done. This was hardly the case however, since there was usually little which could automatically link the data with the MEGIS database. If it could not be completely automated, then it was evaluated for partial automation, for example by creating a webpage on Merton's intranet where someone could enter the information into MEGIS. Any farming points which where identified in this way for automation were recorded, and two were later chosen to be prototyped to prove that the automation was possible.

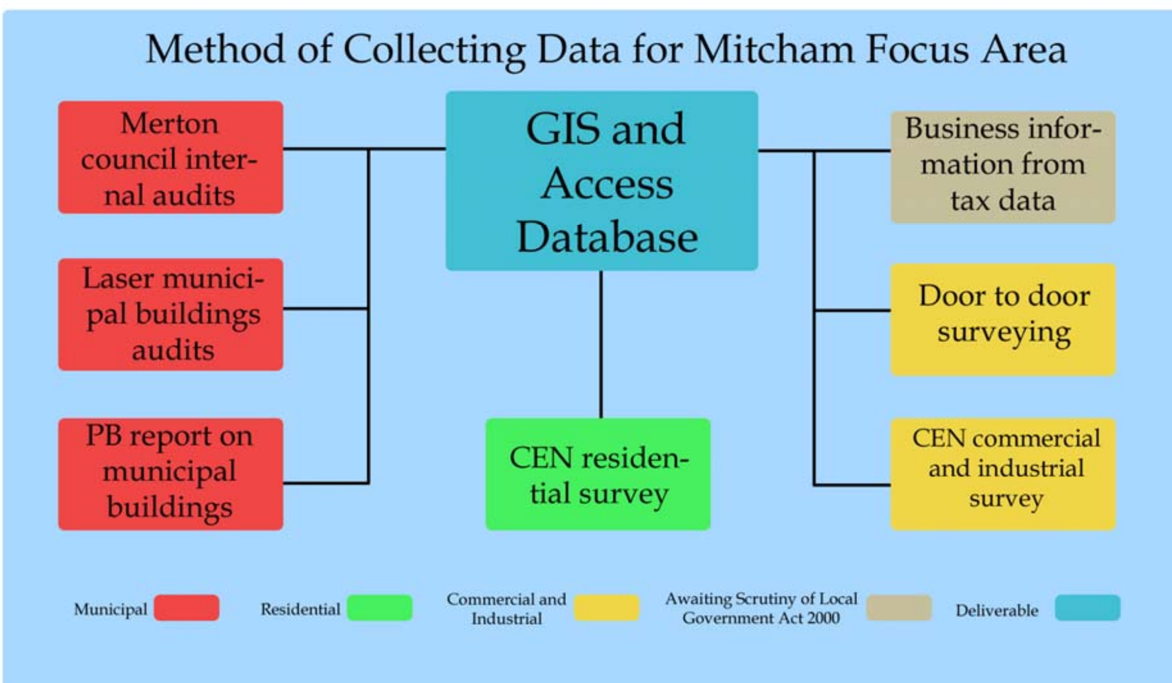

Figure 6: Collection Methods

4 Results

The purpose of our project was to gather data for use in a combined heat and power (CHP) and district heat and power (DHP) feasibility scheme, as well as keep in mind automation and the fact that what we do should be replicable by other boroughs. We did just this. We collected the necessary data for a CHP and DHP feasibility study (a breakdown of this data can be seen below in Figure 7) and inputted it into MEGIS, produced a list of recommendations and automation prototypes. Beyond this, we produced two tools for use by Merton and other boroughs in duplicating our work: the CHP Assessment and Energy Reduction (ChAsER) guide, and the Financial Analysis Targeting and CHP Assessment Toolkit (FATCAT).

<table>
<tr><th colspan="7"><u>Data Collection Summary</u></th></tr>
<tr><th colspan="2"></th><th>Source</th><th># Of buildings</th><th>% Of Buildings in Area</th><th>% Of total Gas in Area</th><th>% Of total Electricity in area</th></tr>
<tr><td rowspan="3">Municipal</td><td rowspan="3">Actual</td><td>LASER</td><td>7</td><td>0.40</td><td rowspan="3">21.3</td><td rowspan="3">16.7</td></tr>
<tr><td>PB Power</td><td>8</td><td>0.47</td></tr>
<tr><td>Team Data Collection</td><td>4</td><td>0.23</td></tr>
<tr><td>Residential</td><td>Estimates</td><td>Defra</td><td>1605</td><td>92.1</td><td>47.1</td><td>70</td></tr>
<tr><td>Commercial</td><td>Estimates</td><td>ECON & CIBSE</td><td>119</td><td>6.8</td><td>31.6</td><td>13.3</td></tr>
</table>

Figure 7: Building Data Collection Summary

4.1 ChAsER Guide

In order to help accomplish the goal of a replicable project, our team developed the CHP Assessment and Energy Reduction (ChAsER) guide, seen in the attachment to this paper. This guide provides a step-by-step process for implementing a district heat and power scheme through the use of multiple CHPs in a borough. ChAsER catalogues the steps we took to examine Merton's infrastructure and locate the energy usage of its municipal buildings in a generalized manner, allowing it to be applied to any municipality. This guide also provides municipalities with concrete methods for estimating buildings when actual energy data is difficult to gather. Since a requirement of our process of collecting and analyzing energy data involves MEGIS, the guide also contains a tutorial explaining how to accomplish this using a Geographical Information System (which every borough utilizes). The tutorial also explains some of the more interesting capabilities of the MEGIS database, including: hyper-linking, updating via an access database, capture areas, drawing and estimating pipelines, and much more. The guide closes by suggesting future implementation schemes for alternate energy technology which boroughs could look into after CHPs and DHPs to reduce carbon emissions.

4.2 FATCAT Worksheet

The next step for municipalities after gathering the appropriate energy data would then be to start analyzing their energy needs and begin preliminary CHP sizing. If a municipality did not do this, then they would not know if CHPs could prove financially feasible for their areas, and indeed, they would have a hard time convincing anyone to begin the CHP and DHP schemes. It is for this reason that we built the Financial Analysis Targeting and CHP Assessment Toolkit (FATCAT) and included it with ChAsER.

FATCAT assists in sizing CHPs and performing basic financial analysis. It works on top of an Access database, created by the other WPI research team working parallel to ours. This database contains around 40 CHPs, including information such as: manufacturer, installation cost, maintenance cost, efficiency, output, engine type, fuel type, size, and numerous other details (for a complete list refer to the section of the ChAsER guide on FATCAT in Appendix F). The worksheet allows the user to take into account numerous variables, such as fuel prices, the price you sell produced electricity and gas at, fluctuations in these prices, etc. (again, for a full list refer to ChAsER). Thus, a borough could use FATCAT to compare CHP units, as well as CHP schemes involving multiple units, and then see what their annual profit would be, what the payback period would be, as well as how much CO_2 they would be saving by using a CHP.

4.3 Recommendations for a Seamless Data Collection System

After collecting data on energy usage in the borough, as well as documenting the sources and farming points of the data, we went on to produce recommendations of ways to seamlessly collect the needed data. We considered many different automation techniques, and from these and our notes from the project, were able to develop two sets of recommendations: one for municipal buildings, and another for commercial and residential buildings.

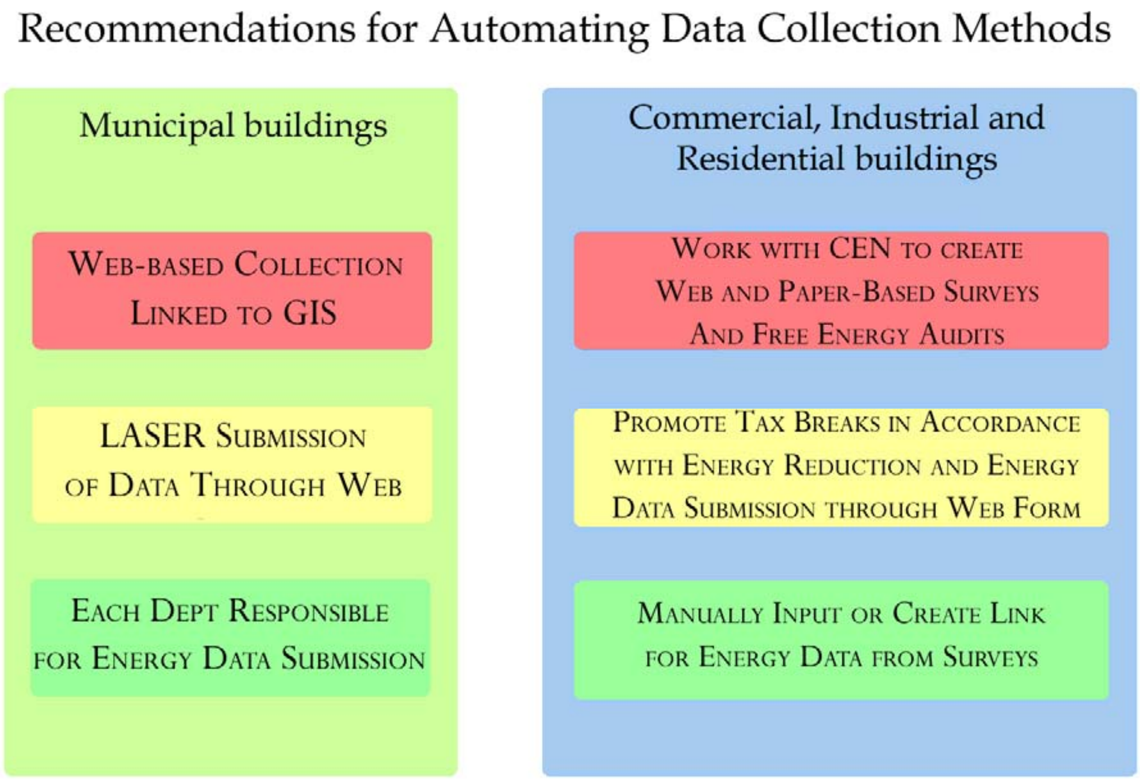

Figure 8: Automation Recommendations

4.3.1 Recommendations for Municipal Building Automation

Through our study of the municipal structure we were able to find three valuable farming points (LASER, Individual Building Accountants and Internal Audits) that provided much of the basic information needed for municipal buildings and their energy consumption. This provides other Boroughs with a very systematic data collection scheme while also offering the next Merton team specific areas of automation. This is the basis for our automation recommendations for municipal buildings.

To take advantage of the fact that energy data is collected somewhere in the infrastructure of the municipality a web-based collection system could be developed. For example, Merton could host a simple form on their intranet allowing someone to select a building based on what department controls it, and then enter the month and year and its electricity and heating usage for that month. Then it can be deemed the responsibility of those who collect and control the energy bills for each building to log onto this intranet webpage and enter the data as they receive it month by month. This would allow Merton to collect the data in a centralized location and enter it into MEGIS through the course of everyday affairs.

Multiple systems exist for this process, including web-based, java-based, Adobe PDFs and other custom-made forms. It would be up the IT department of the municipality to determine which system they prefer or deem best. To illustrate how this sort of system could look and work though, we created two prototypes: one for the entering of energy bills for use within the Merton intranet, and one for the entering of LASER gas data, for use by LASER or by a data entry worker within Merton. These prototypes can be found in Appendix G.

There are a few alternatives to this set up as well, a data-entry worker could be used to enter this information into the database manually, or each department could be given a layer in the database and allowed editing rights to said layer. In the latter case, Merton could also take into account security risks by only allowing access to the layers to certain people and only under certain circumstances, for example through password protection. This would allow for seamless automation without the risk of unauthorized viewing of specific information. Again, this could be an added responsibility to those that already work in the building or to the municipal workers that are in charge of energy bills for said building. Using this methodology, jurisdiction of the MEGIS database would be split up between departments, each department then being responsible for keeping their portion up-to-date.

4.3.2 Recommendations for Commercial and Residential Buildings

Since we were unable to obtain actual energy data on commercial and residential buildings, the automation process will be essential for Merton and its continuance of the CHP project. However, Merton has very little control over commercial and residential buildings, and as such, they can not force the collection of energy data as they can with their own buildings. For this reason, incentives must be included so as to persuade businesses and residents to cooperate with Merton and provide energy information.

For residential buildings we recommend that Merton modify and utilize Croydon Energy Network's (CEN) free energy audit survey. The survey could be modified to also request the residents electric and gas usage over the past year, from energy bills. This information could then be electronically collected and entered into the MEGIS database. The rest of the survey's information could also be stored, and passed on to CEN to provide the resident with a free energy audit, including information on how to save money by using less energy. This would provide a sufficient initial incentive for the survey. In order to annually collect this data Merton council could employ tax breaks for residences that are lowering their energy usage by sufficient amounts; this tax break could possibly be subsidized by heating companies, since they have been offering boroughs monetary incentives if they lower heating consumption.

To collect energy data from commercial buildings we again recommend that a survey be utilized. However, this could only be successfully employed if the municipality can present a working example of a stable CHP system which resulted in reduced energy cost for buildings connected to it. If after the CHPs are installed for municipal buildings and working, they then begin to survey businesses notifying them of this and proving its benefits while asking for energy bills, they have a strong potential to persuade business owners to release energy information. This could then provide Merton council with the initial data on commercial buildings. To extend this to a replicable yearly process however, some incentive will have to be given for businesses, possibly a small tax break for efficient energy usage by their buildings, in the same manner as private residences could be given.

If however, Merton wishes to collect information on businesses not pertaining directly to energy usage, there are numerous "farming points" within the municipal's policies and departments. We recommend that Merton also explore these farming points to locate alternate information on businesses which could be used to estimate energy data if data can not be attained from the survey. A brief listing of farming points we believe should be explored for this purpose can be seen in Appendix H.

5. Conclusion

The final outcome of this project was the production of an updatable database containing energy information on each building in the Mitcham regeneration area, as well as farming point locations and recommendations for automation. We also produced a guide for CHP implementation, ChAsER, and a financial analysis worksheet, FATCAT. These tools, along with the updated MEGIS database, can act as an energy map for the regeneration area in Mitcham and provide the Merton council with viable candidates for CHP systems.

The work of the two previous teams, the Merton/WPI energy team, the MEGIS system, work from PB power, and the ECON, CIBSE and Defra worksheets, were all integrated with our work. Doing this, we managed to produce a single database containing energy information of the Mitcham focus area, along with complex tools for assessing CHP feasibility. The applications of these tools can aid in targeting high-energy users who could greatly benefit from a CHP plant. Other alternative energy sources can also be implemented from the data provided by the energy map, which provides the data needed for the calculation figures such as break-even points and cost effectiveness. All of these deliverables combined provide the Borough of Merton with the data needed to appropriately review and implement strategies to reach their goal of 60% reductions in carbon emissions by 2050.

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Appendix A: Carbon Trust Baseline and Target Tool

The Introduction tab provides a general overview of the spreadsheet and information on its uses. The Carbon Trust developed this programme to provide a free tool to municipalities that would measure their municipal building's carbon emissions equivalents and allow them to determine where reductions were needed.

The Buildings tab is divided into two sections. The first section is a worksheet that provides both "Typical" and "Best Practice" values for categories of municipal buildings. Some values are provided in the worksheet, but can also be referenced and updated on the Action Energy Website. This allows for a continual update of these benchmark values and provides more categories of buildings should some of Merton's municipal buildings not fall under any category provided on the worksheet. The first section also provides CO_2 factors which will be updated according to data from the electricity and fuel companies that supply Merton's buildings. The factors currently in place give a good estimate of the corresponding kgCO_2 per kWh as well as the actual cost of energy sources such as coal and electricity. However, not all fuels are expressed in kWh which is the standard used by the CTBTT, so in the worksheet a conversion table is also provided to convert standard units of energy sources that would be seen on an energy bill into kWh.

Buildings Worksheet

o expand or contract all the grouped cells

Energy type (Keep alphabetical)	CO_2 Factors $kgCO_2$ /kWh	Typical Cost (pence / kWh)
Coal	0.30	0.62
Electricity	0.43	4.50
Gas	0.19	1.00
LPG	0.214	1.50
Oil	0.26	1.40

Conversion Assistant		
Energy Cost: £	-> kWh	
	0	Coal
	0	Electricity
	0	Gas
	0	LPG
	0	Oil
LPG/propane: kg	-> kWh	
	0	
Gas: m³	-> kWh	
	0	
Oil: litres	-> kWh	
	0	
Coal: tonnes	-> kWh	
	0	
Area: ft²	-> m²	
	0	

Building Type List (Must be in alphabetical order)	Electricity (kWh / m2)		Gas or Oil (kWh / m2)		Category List
	Typical	Good Practice	Typical	Good Practice	
Car Park - enclosed	15	15			Region 1
Council - Care Homes	75	59	555	492	Region 2
Council - Libraries	46	32	210	133	Region 3
Council - Museums	70	57	142	96	Region 4
Council - Special housing	68	46	432	314	
Council - Town Halls	111	84	205	138	
Leisure Centre (Dry)	105	64	343	158	
Leisure Centre (Lrg Pool)	258	164	1321	573	
Leisure Centre (Sml Pool)	237	152	1336	573	
Office - AirCon Prestige type	304	199	171	91	
Office - AirCon Standard type	203	115	160	87	
Office - No AirCon Cellular ty	51	31	143	75	
Office - No AirCon OpenPlan	81	51	143	75	
Other					
School - Primary (no pool)	32	22	164	113	
School - Secondary (no pool	33	25	144	108	
School - Secondary (with poo	36	29	187	142	
Warehse - Light Large 8x5	-	-	103	92	
Warehse - Light Small 8x5	-	-	107	96	
Warehse - Medium Large 8x5	-	-	140	125	
Warehse - Medium Small 8x5	-	-	145	130	

Figure 9: Building Worksheet Section One

In the second section of the Buildings Tab, multiple years can be accounted for with the bulk of data entered into these sections. After expanding one of the years, multiple boxes are shaded grey; these are provided for data entry. The actual building, corresponding building type (taken from the first section) and category can be entered to describe the actual building and specify a user defined region (such a specific area or department of Merton). Collected data must then be entered into the worksheet. The worksheet takes in energy usage determined from Merton's energy bills as well as the area of the building which can be determined through building records. These two pieces of data provide an important baseline that covers the majority of a building's carbon emissions equivalencies.

Buildings Worksheet

← Click "+" to show introduction (click "-" to hide it)

Year:	2002
Number of employees	17500
Target 5 Year % CO_2 reduction	30%

← *This target overwrites any year on year targets entered below*

Building or Site	Building Type (only required for benchmark comparison)	Category (only required for breakdown pie chart)	Gross Int. Area m² (required for benchmark comparison)	Electricity Total kWh per year	Cost (Based on typical p / kWh table above)	% of Renewable Electricity	Gas Total kWh per year	Cost (Based on typical p / kWh table above)	Oil Total kWh per year	Cost (Based on typical p / kWh table above)	Coal Total kWh per year	Cost (Based on typical p / kWh table above)	LPG Total kWh per year	Cost (Based on typical p / kWh table above)	Actual Degree Days for benchmark comparison
Town Hall	Council - Town Halls	Region 1	7100	912,000	£41,040	0%	1,190,000	£11,900		£0		£0		£0	2240
Civic office	Office - AirCon Standard typ	Region 2	4300	890,000	£40,050	0%	998,088	£9,981		£0		£0		£0	2240
Library	Council - Libraries	Region 3	1100	43,200	£1,944	0%	163,200	£1,632		£0		£0		£0	2240
Museum	Council - Museums	Region 4	1200	63,200	£2,844	0%	103,600	£1,036		£0		£0		£0	2240
Other buildings				37,659,855	£1,694,693	1%	134,135,953	£1,341,360	13,267,297	£185,742	2,781,850	£17,247		£0	2000
					£0			£0		£0		£0		£0	
					£0			£0		£0		£0		£0	
TOTAL				39,568 MWh			136,591 MWh		13,267 MWh		2,782 MWh		0 MWh		

2002	Total Tonnes of CO_2	47089	tCO_2 / employee	2.69	Target reductn / empl.	NA	Actual reduction	NA
2003	Total Tonnes of CO_2	46082	tCO_2 / employee	2.63	Target reductn / empl.	6%	Actual reduction	2%
2004	Total Tonnes of CO_2	45905	tCO_2 / employee	2.62	Target reductn / empl.	6%	Actual reduction	0%
2005	Total Tonnes of CO_2	45732	tCO_2 / employee	2.61	Target reductn / empl.	6%	Actual reduction	0%
2006	Total Tonnes of CO_2	0	tCO_2 / employee	0.00	Target reductn / empl.	6%	Actual reduction	%

This spreadsheet tool was developed by The Carbon Trust (www.thecarbontrust.co.uk)

Figure 10: Building Worksheet Section Two

The worksheet also divides the energy sources into separate sections (i.e. coal, gas, oil) and takes into account any renewable energy sources that may be used (as a percentage). "Degree days" are also taken into account using a separate worksheet provided by The Carbon Trust which accounts for warmer and colder days that will require more energy use due to weather. From this data entered into the grey areas, values such as CO_2 emitted, energy costs, best practice benchmarks and potential savings by attaining best practice benchmarks are displayed in the white areas. These figures are automatically calculated from the data entered. Red and Yellow flags highlight energy usage (in kWh/m²) that is above the "Typical" (Red) and "Best Practice" (yellow) benchmarks. With just these sections discussed, a good idea of a building's carbon emissions from energy could be realized. However, there are more factors covered in the worksheet, which refines this number.

Red cells below are **above the 'typical'** benchmark

Yellow cells below are **above 'best practice'**

Energy - KWh						CO_2 emissions								Costs					
Electricity		Fossil Fuel			Total	Electricity			Fossil Fuel		Total			Electricity		Fossil Fuel		Total	
kWh/m²	Good Practice bench-mark kWh/m²	Weather Corrected kWh	kWh/m²	Good Practice bench-mark kWh/m²	Weather Corrected Total kWh	CO_2 tonnes	CO_2 tonnes saved (Renew. Electr.)	Pot'l tCO_2 savings (vs good practice)	CO_2 tonnes	Pot'l tCO_2 savings (vs good practice)	Total CO_2 tonnes	Pot'l tCO_2 savings (vs good practice)	CO_2 kg/m² no weather correction	Cost	Pot'l Cost savings (vs good practice)	Cost	Pot'l Cost savings (vs good practice)	Total Cost	Pot'l Cost savings (vs good practice)
128.5	84	1,307,938	184.2	138	2,219,938	392.2	0.0	135.7	226.1	56.7	618.3	192.4	87.1	£41,040	£14,202	£11,900	£2,985	£52,940	£17,187
207.0	115	1,097,006	255.1	87	1,987,006	382.7	0.0	169.7	189.6	124.7	572.3	294.4	133.1	£40,050	£17,759	£9,981	£6,565	£50,031	£24,324
39.3	32	179,374	163.1	133	222,574	18.6	0.0	3.4	31.0	5.7	49.6	9.2	45.1	£1,944	£360	£1,632	£301	£3,576	£661
52.7	57	113,868	94.9	96	177,068	27.2	0.0	0.0	19.7	0.0	46.9	0.0	39.1	£2,844	£0	£1,036	£0	£3,880	£0
0.0	-	184,877,858	0.0	-	222,537,713	16031.8	161.9	0.0	29769.9	0.0	45801.7	0.0	-	£1,694,693	£0	£1,544,349	£0	£3,239,043	£0
0.0	-	0	0.0	-	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	£0	£0	£0	£0	£0	£0
0.0	-	0	0.0	-	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	£0	£0	£0	£0	£0	£0
MWh:		187576			227144	16852	162	309	30236	187	47089	496		£1,780,571	£32,321	£1,568,898	£9,852	£3,349,470	£42,173

Figure 11: Buildings Worksheet Section Two cont.

Streetlight data is examined in the fourth tab of the CTBTT and can be obtained easily through the Merton's transportation and maintenance departments. By accounting for street and traffic lights in the municipality, electricity usage may better be examined. These values are important due to traffic lights being run non-stop and streetlights powered throughout the night. These contribute a significant amount of carbon equivalent emissions that can easily be reduced by energy-efficient bulbs.

Street Lighting Worksheet

↑ *Click on boxes in top left to expand or contract all the grouped cells*

Introduction	Emission Type	CO2 Factor	CO2 units	Typical Cost (pence / kWh)
Data Entry cells are shaded Grey. In the tables below, either enter one value for all streetlights or values for each group of lights (e.g. roadsigns, footpath lights, etc.)	Streetlights (kWh)	0.43	kgCO2/kWh	4.50

← *Click "+" to show introduction (click "-" to hide it)*

Year	2002
Target 5 Year % CO_2e reduction	

← *This target overwrites any year on year targets entered below*

Description	Electricity kWh / year	Cost (Based on p / kWh table above)	% of Renewable Electricity	Number of units (optional)	Hours of operation (optional)	Tonnes CO2	kWh / unit / year	Average Watts / unit	Cost / unit / year
Streetlights	20,000,000	£900,000	2%	32,000	11	8428.0	625	156	£28.13
Bollards & Signs	2,000,000	£90,000	0%	7,000	24	860.0	286	33	£12.86
Housing streetlights	900,000	£40,500	0%	1,500	11	387.0	600	149	£27.00
		£0	0%			0.0	-	-	-
TOTAL		£1,030,500				**9675.0**			

2002	Tonnes of CO_2	9675	Target reduction	NA	Actual reduction	NA
2003	Tonnes of CO_2	9503	Target reduction	0%	Actual reduction	2%
2004	Tonnes of CO_2	9331	Target reduction	0%	Actual reduction	2%
2005	Tonnes of CO_2	9159	Target reduction	0%	Actual reduction	2%
2006	Tonnes of CO_2	0	Target reduction	0%	Actual reduction	%

Figure 12: Street Lighting Worksheet

The Waste and Water Emissions Worksheet (5th tab) allows for the evaluation of energy usage due to water and CO_2 emissions due to waste. Water data can easily be collected from monthly water bills and then input to the worksheet to determine the carbon equivalence from every m^3 of water used. These carbon emissions are due to the energy required to pump and process clean water. Waste is much more difficult to quantify due to the fact that most buildings do not have an infrastructure in place to measure the amount of waste produced. The only way to obtain this data would be to consult the waste management companies who would be able to measure the tonnes of waste produced and processed. This may be feasible since Merton ships its waste outside of the borough to be placed into landfills there, so it might be possible to estimate waste production through their bills, or the waste company may already measure the amount of waste in tonnes.

Waste and Water Emissions Work

† Click on boxes in top left to expand or contract all the grouped cells

Introduction	Emission Type (keep alphabetical)	CO2 Factor	CO2 units
	Waste - Landfill (tCO2e)	1000	kgCO2e
	Waste collected (tonnes)	310.5	kgCO2e/tonne
	Water consumed (m3)	0.40	kgCO2/m3

← Click "+" to show introduction (click "-" to hide it)

Year	2002
Target 5 Year % CO_2e reduction	

← This target overwrites any year on g

Description	Emission Type	Amount	CO2 Factor	Tonnes CO2
Landfill sites	Waste - Landfill (tCO2e)	5,000	1000.00	5000.0
Waste from council buildings	Waste collected (tonnes)	1,000	310.50	310.5
Water used in council buildings	Water consumed (m3)	494,239	0.40	199.7
			-	0.0

Figure 13: Waste and Water Emission Worksheet

Transportation and Commuting are the focus of the third and sixth tabs within the CTBTT. According to UK Department for Transport, transportation accounts for about 25% of the total UK carbon emissions. Though this is not conclusive with respect to Merton, the collection of this data would require surveys of every Merton employee as well as recording of all business travelling and municipal vehicle travel in Merton. This does not relate to the municipal building's carbon equivalents and would be too time consuming of a process to accomplish with the other data collection during this seven-week period. This should be addressed in the future as it does contribute to carbon emissions from municipal processes; however this data would not be as valuable as data on the actual buildings.

The final five tabs of the CTBTT provide data from the previous worksheets as well as graphs and pie charts, which break down the data into their respective areas for comparison. Total CO_2 emissions as well as a breakdown of CO_2 emissions per employee in the areas of transportation, commuting and buildings are provided to help visualize the difference in emissions between each building. In these final tabs, the graphs are automatically generated from the data entered and show the areas of greatest carbon emissions equivalencies.

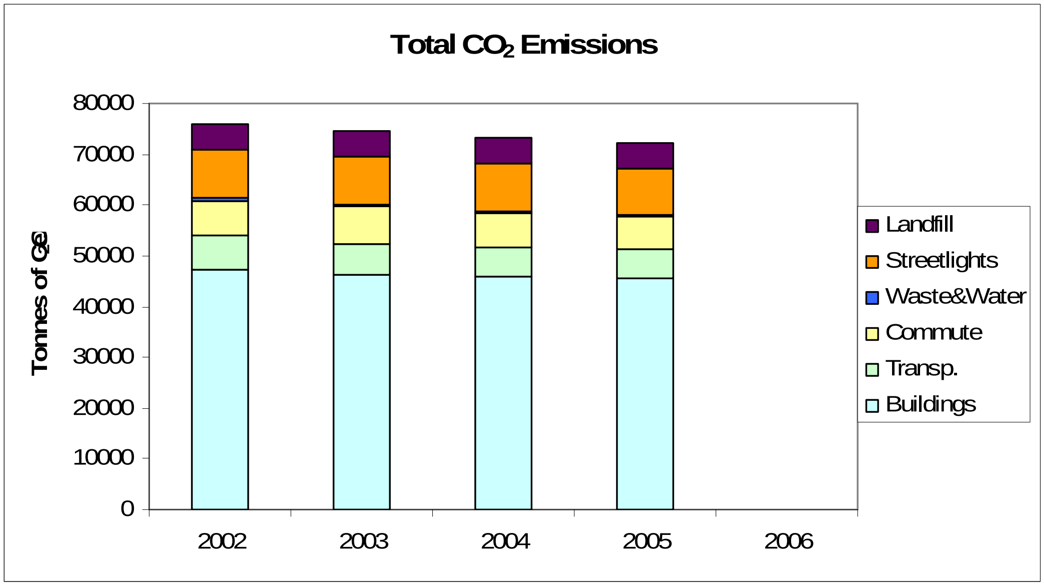
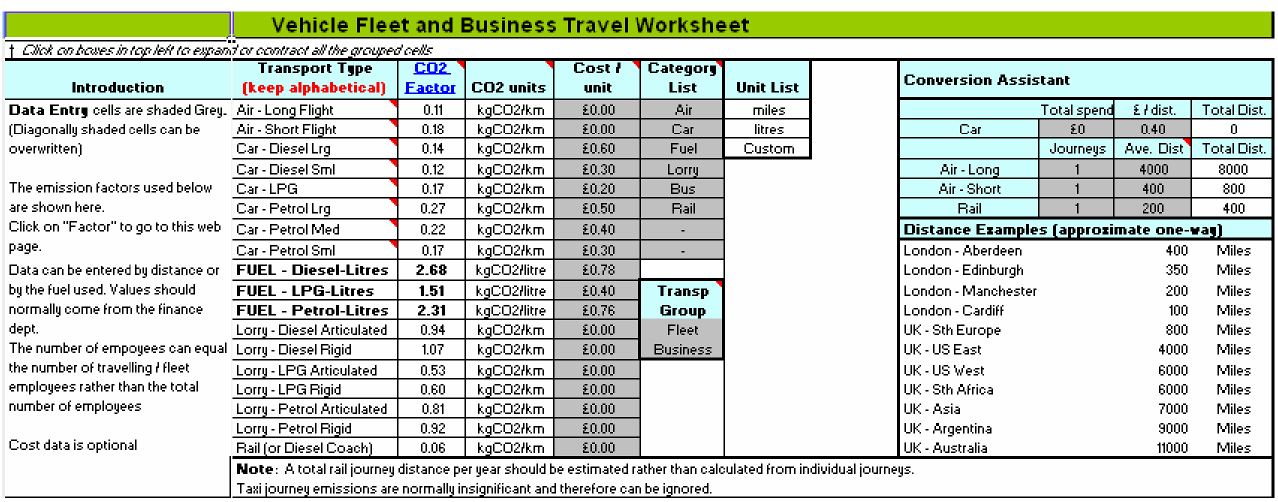


Figure 14: Total CO_2 Emissions Data Graph

Vehicle Fleet and Business Travel Worksheet



Vehicle Fleet and Business Travel Worksheet

† *Click on boxes in top left to expand or contract all the grouped cells*

Introduction

Data Entry cells are shaded Grey. (Diagonally shaded cells can be overwritten)

The emission factors used below are shown here.
Click on "Factor" to go to this web page.
Data can be entered by distance or by the fuel used. Values should normally come from the finance dept.
The number of empoyees can equal the number of travelling / fleet employees rather than the total number of employees

Cost data is optional

Transport Type (keep alphabetical)	CO2 Factor	CO2 units	Cost / unit	Category List	Unit List
Air - Long Flight	0.11	kgCO2/km	£0.00	Air	miles
Air - Short Flight	0.18	kgCO2/km	£0.00	Car	litres
Car - Diesel Lrg	0.14	kgCO2/km	£0.60	Fuel	Custom
Car - Diesel Sml	0.12	kgCO2/km	£0.30	Lorry	
Car - LPG	0.17	kgCO2/km	£0.20	Bus	
Car - Petrol Lrg	0.27	kgCO2/km	£0.50	Rail	
Car - Petrol Med	0.22	kgCO2/km	£0.40	-	
Car - Petrol Sml	0.17	kgCO2/km	£0.30	-	
FUEL - Diesel-Litres	**2.68**	kgCO2/litre	£0.78		
FUEL - LPG-Litres	**1.51**	kgCO2/litre	£0.40	**Transp**	
FUEL - Petrol-Litres	**2.31**	kgCO2/litre	£0.76	**Group**	
Lorry - Diesel Articulated	0.94	kgCO2/km	£0.00	Fleet	
Lorry - Diesel Rigid	1.07	kgCO2/km	£0.00	Business	
Lorry - LPG Articulated	0.53	kgCO2/km	£0.00		
Lorry - LPG Rigid	0.60	kgCO2/km	£0.00		
Lorry - Petrol Articulated	0.81	kgCO2/km	£0.00		
Lorry - Petrol Rigid	0.92	kgCO2/km	£0.00		
Rail (or Diesel Coach)	0.06	kgCO2/km	£0.00		

Conversion Assistant

	Total spend	£ / dist.	Total Dist.
Car	£0	0.40	0
	Journeys	Ave. Dist	Total Dist.
Air - Long	1	4000	8000
Air - Short	1	400	800
Rail	1	200	400

Distance Examples (approximate one-way)

London - Aberdeen	400	Miles
London - Edinburgh	350	Miles
London - Manchester	200	Miles
London - Cardiff	100	Miles
UK - Sth Europe	800	Miles
UK - US East	4000	Miles
UK - US West	6000	Miles
UK - Sth Africa	6000	Miles
UK - Asia	7000	Miles
UK - Argentina	9000	Miles
UK - Australia	11000	Miles

Note: A total rail journey distance per year should be estimated rather than calculated from individual journeys.
Taxi journey emissions are normally insignificant and therefore can be ignored.

Figure 15: Vehicle Fleet and Business Travel Worksheet

Year	2002
Number of employees	17500
Target 5 Year % CO_2e reduction	

← This target overwrites any year on year targets entered below

Site / Group	Transport Type (by dist or fuel)	Trans. Group	Category (required for pie chart)	Amount	Unit	Cost / unit	Cost (£)	Pot'l Alternative Transport Type	Fuel Reduction %	CO2 Factor	Tonnes CO2	Pot'l tCO_2 savings	Pot'l Cost savings
Person 1	Car - Petrol Med	Business	Car	35,000	miles	£0.40	£14,000	Car - Petrol Med	10%	0.35	12.4	1.2	£1,400
Person 1	Rail (or Diesel Coach)	Business	Rail	60,000	miles	£0.00	£0			0.10	5.8	-	-
Department A	FUEL - Petrol-Litres	Fleet	Lorry	5,000	litres	£0.76	£3,800			2.31	11.6	-	-
Other Business travel		Business	Car			-	-			-	728.0	-	-
Other Fleet travel	FUEL - Diesel-Litres	Fleet	Lorry	2,300,000	litres	£0.78	£1,794,000			2.68	6164.0	-	-
						-	-			-	0.0	-	-
TOTAL							£1,811,800				6921.7	1.2	£1,400
2002	Total Tonnes of CO_2		6922	/ employee	0.40	Target reductn / empl.		NA	Actual reduction		NA		
2003	Total Tonnes of CO_2		6386	/ employee	0.36	Target reductn / empl.		10%	Actual reduction		8%		
2004	Total Tonnes of CO_2		5850	/ employee	0.33	Target reductn / empl.		5%	Actual reduction		8%		
2005	Total Tonnes of CO_2		5582	/ employee	0.32	Target reductn / empl.		2%	Actual reduction		5%		
2006	Total Tonnes of CO_2		0	/ employee	0.00	Target reductn / empl.		1%	Actual reduction		%		

This spreadsheet tool was developed by The Carbon Trust (www.thecarbontrust.co.uk)

Figure 16: Vehicle Fleet and Business Travel Worksheet cont.

Commuting Worksheet

Commuting Worksheet (Optional)

or contract all the grouped cells

Miles					
Transport Category (keep alphabetical)	**Type**	**Factor kgCO2/km**	**Department**	**Type List**	**Unit List**
Bus - Diesel	Bus	0.06	Dept 1	Bus	Miles
Car - Diesel Lrg	Car	0.14	Dept 2	Car	Kms
Car - Diesel Sml	Car	0.12	Dept 3	Rail	
Car - LPG	Car	0.17	Dept 4	Walk/Bike	
Car - Petrol Lrg	Car	0.27	Dept 5		
Car - Petrol Med	Car	0.22	Dept 6		
Car - Petrol Sml	Car	0.17			
Motorbike	Car	0.09			
Rail	Rail	0.06			
Walk / Bike	Walk/Bike	0.00			

Year	**2002**
Total No. of Employees	**4000**
Target 5 Year % CO_2e reduction	

← *This target overwrites any year on year targets entered below*

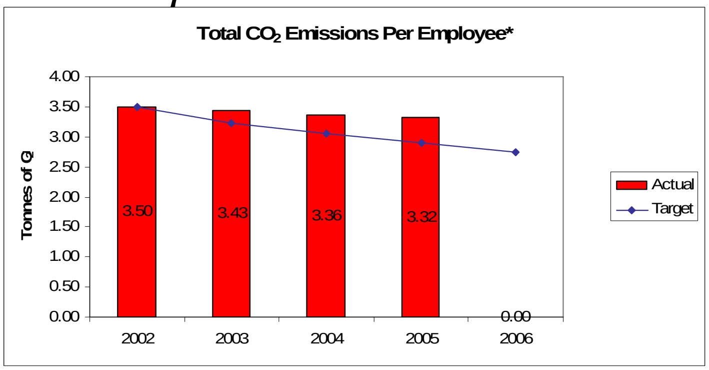
Name	Dept	1st leg (one way)	Miles	2nd leg (one way)	Miles	3rd leg (one way)	Miles	# / car	Days / wk	Wks / yr	Total tCO2 / year
Person 1	Dept 1	Rail	1	Rail	2	Car - Petrol Med	10	1	5	45	1.72
Person 2	Dept 1	Rail	58.2			Car - Petrol Med	9.4	1	5	45	4.03
Person 3	Dept 1	Rail	89					1	5	45	3.87
Person 4	Dept 2	Rail	55	Rail	4	Car - Petrol Med	8	1	5	45	3.84
Person 5	Dept 4	Rail	70					1	5	45	3.04
Person 6	Dept 2			Rail	4			1	5	45	0.17
Person 7	Dept 1			Rail	3.9			1	5	45	0.17
Person 8	Dept 2			Rail	1.875			1	5	45	0.08
Person 9	Dept 1			Rail	0.3			1	5	45	0.01
Person 10	Dept 5	Walk / Bike	2					1	5	45	0.00
								1	5	45	0.00
										Total	16.93

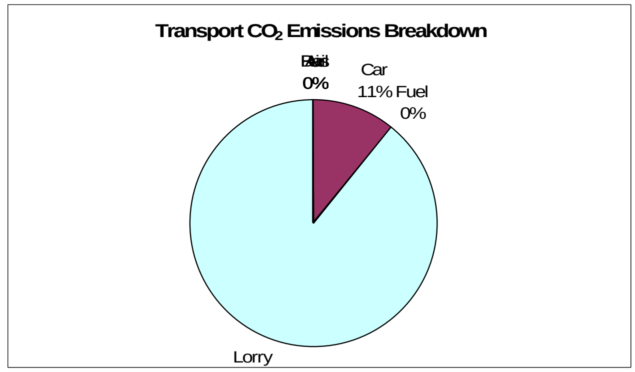
No. of Employees (above):	10
Sample ratio:	400.00

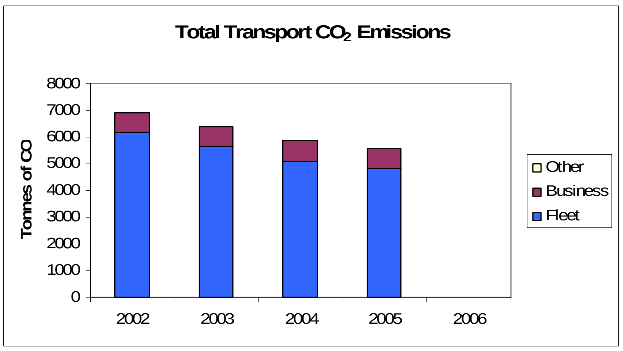
Department	tCO2 / yr / person	Dept. size
Dept 1	1.96	5
Dept 2	1.36	3
Dept 3		0
Dept 4	3.04	1
Dept 5	0.00	1
Dept 6		0
		0
		0
		0
		0

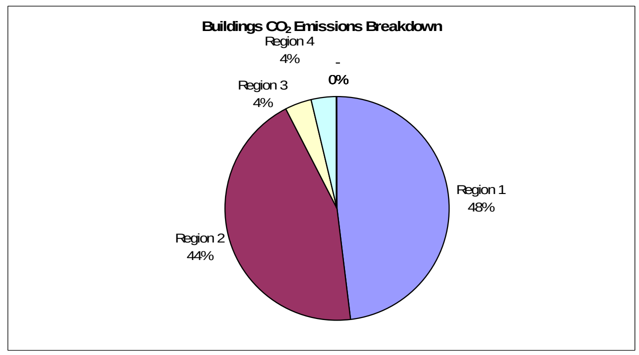
Figure 17: Commuting Worksheet

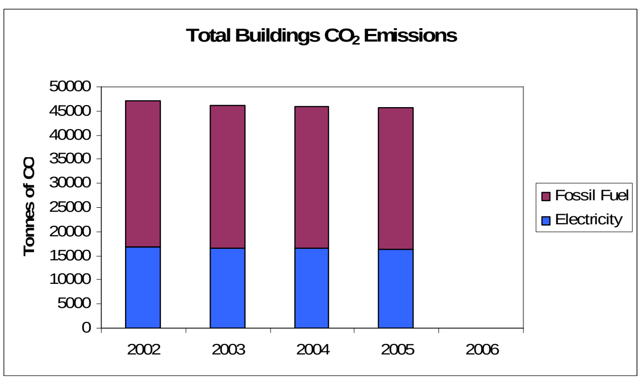
Data Graphs











Total Costs & Emissions

	2002	2003	2004	2005	2006
tCO_2 Emissions	**75,970**	**74,603**	**73,208**	**72,341**	**0**
tCO_2 saved (green elect.)	334	668	1,002	1,336	0
Potential Savings* tCO_2	497	486	471	461	0
Pot'l % Savings* tCO_2	1%	1%	1%	1%	%
Total Costs	£ 6,191,770	£ 6,017,469	£ 5,859,894	£ 5,780,769	£ -
Potential Savings* £	£ 43,573	£ 42,439	£ 40,873	£ 39,739	£ -
Pot'l % Savings* £	1%	1%	1%	1%	%

* Annual savings (without setup costs or buying green electr.) based on achieving 'good practice' & alternative transport options.

Appendix B: Business Advertisement

Where your Information goes

- The information collected from you will be used by the Worcester Polytechnic Institute team in collaboration with the University College of London, Oxford University, Merton Council and Croyden Energy Networks, a non-profit organization.
- The research conducted with this information will be used to help make a combined heat and power system possible in your community

With All this How can you say no to CHP

MERTON ENERGY TEAM

WORCESTER POLYTECHNIC INSTITUTE

- We are the Merton Carbon Team from Worcester Polytechnic Institute, one of the top Engineering Schools in the United States.
- We are working with the Merton Council in their effort to reduce energy use and carbon emissions in the borough
- We are looking into a new energy system, using combined heat and power plants, that will cut both carbon emissions and your energy bills

HELP US HELP YOU

COMBINED HEAT POWER

THE WAY OF THE FUTURE

- Merton Council is planning on implementing a Combined Heat and Power system in your area
- This is very positive for both your business and th
environment
- This system has many benefits which include:
  - Lower energy bills, most companies save 10% annually on their energy bills
  - More stable energy rates, providing you with protection from rate hikes
  - Increased reliability. No more worrying about blackouts or brownouts, CHP sys
tems experience very few outages
  - Improved energy quality, surges will no longer wreak havoc on your computers a
hinder performance.
  - Improved indoor air quality through im
proved control of humidity and air cond
tioning, making your area more comfo
able for both employees and customers. This can only increase profitability.

Provide a few energy bills and all of this could be you

Appendix C: Defra Spreadsheet

		Gas Central Heating						Electric Stor		
		Heating		Lights & Appliances		Cooking		Heating		Lights & A
Property Type	Bedrooms	kWh/yr	kgCO2/yr	kWh/yr	kgCO2/yr	kWh/yr	kgCO2/yr	kWh/yr	kgCO2/yr	kWh/yr
Flat	1	7,865	1,494	1,466	630	807	153	5,939	2,554	1,401
Flat	2	11,423	2,170	2,129	916	1,173	223	8,626	3,709	2,036
Flat	3	16,666	3,167	3,107	1,336	1,711	325	12,586	5,412	2,970
Mid Terraced House	2	11,693	2,222	2,109	907	1,008	192	9,057	3,895	2,027
Mid Terraced House	3	14,663	2,786	2,645	1,137	1,264	240	11,357	4,884	2,542
End Terraced House	2	15,138	2,876	2,117	910	1,008	192	12,222	5,255	2,027
End Terraced House	3	18,983	3,607	2,655	1,142	1,264	240	15,325	6,590	2,542
Semi-Detached House	2	18,373	3,491	2,589	1,113	1,136	216	14,886	6,401	2,485
Semi-Detached House	3	21,236	4,035	2,992	1,287	1,314	250	17,206	7,399	2,872
Semi-Detached House	4	24,338	4,624	3,429	1,475	1,505	286	19,720	8,479	3,292
Detached House	2	24,412	4,638	3,091	1,329	1,199	228	20,092	8,639	2,973
Detached House	3	28,209	5,360	3,572	1,536	1,386	263	23,217	9,983	3,435
Detached House	4	32,549	6,184	4,121	1,772	1,599	304	26,789	11,519	3,964

Energy consumption includes Space and Water heating, Cooking, Lighting and Appliances.
Energy use modelled using BREDEM-12 and assumes stock average dwelling characteristics, standard heating pattern and occupancy.

Grey shading indicates base case dwelling.

Appendix D: CEN Survey

The Home Energy Survey:

Every home is different, so by letting us know as much as possible about your home, we can tell you how you can save energy and reduce your fuel bills while helping to save the environment.

Simply fill out this survey by completeing you name and address and clicking the appropriate mark for each of your answers and we will send you a personalised report with recommendations for your home, their cost and details of the savings you could make. We will also include details of any grants which you may be able to claim.

The South West London Energy Efficiency Advice Centre is a not-for-profit organisation working in partnership with your Local Authority and the Energy Saving Trust.

If you have any questions or would simply like more information, please call free on 0800 512 012.

Your Details:

Title:
First Name or Initials:
Surname:
Your Address:
Your Postcode:
Daytime telephone:
e-mail address:

Your Home:

When was your home built?

- Since 1996
- 1991 - 1995
- 1982 - 1990
- 1981
- 1977 - 1980
- 1976
- 1966 - 1975
- 1965
- 1950 - 1964
- 1945 - 1949
- 1930 - 1944
- 1919 - 1929
- 1900 - 1918
- Before 1900

What type of home do you live in?

- Detached
- Semi-detached
- End terrace
- Mid terrace
- Mid terrace with passage
- Top floor Flat
- Middle floor Flat
- Ground floor Flat

Do you own or rent your home?

- Own or buying on a mortgage
- Renting from Council
- Renting from Housing Association
- Renting privately
- Tied house / other

Does your home have a loft?

- Yes
- No

- If so, do you have a heated room that's in regular use in the loft?

- Yes
- No

How many floors does your home have?

(excluding loft rooms or cellars)

- 1
- 2
- 3
- 4
- 5
- More than 5

How many bedrooms does your home have?

- 1
- 2
- 3
- 4
- 5
- 6
- More than 6

How many living, dining, study or play rooms does your home have?

(Please use none if your home is a bedsit)

- None
- 1
- 2
- 3
- 4
- More than 4

Is your building listed or in a conservation area?

- No
- Yes, conservation area
- Yes, listed

Insulation:

How much loft insulation does your home have?

If this is going to prove difficult to find the answer,please take an educated guess.

- None
- 25mm (1 inch)
- 50mm (2 inches)
- 75mm (3 inches)
- 100mm (4 inches)
- 150mm (6 inches)
- 200mm (8 inches)
- Don't Know
- No loft

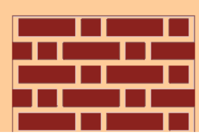
Does your loft have any flooring?:

- Yes
- No (or no loft)

What type of outside walls does your home have?

- Solid Brick Walls
- Cavity walls - no insulation
- Cavity walls - with insulation
- Modern Timber Frame
- Mixed cavity & solid
- Solid Stone Walls
- Solid Concrete Walls
- Other/Don't Know

It's often possible to tell the type of wall from the brick pattern. Left is a typical cavity wall, made up only from 'stretchers'. Right is a typical nine-inch solid wall brick pattern, where 'headers' (the short bricks) are laid crossways to tie the the wall.



What type of windows does your home have?

- All single glazed
- Some double or secondary glazed
- Most double or secondary glazed
- All double or secondary glazed

Is there any draught proofing on your windows and external doors?

(Assume sealed double glazed windows to be draughtproofed)

- None draught proofed
- Some draught proofed
- Most draught proofed
- All draught proofed

Your heating system:

What is the main system that you use for heating your home?

- Boiler & Radiators
- Warm Air System
- Room Heaters (eg gas fires)
- Electric Storage Heaters
- Other System

And what fuel does it use?

- Natural (mains) gas
- Electricity
- Oil
- Bottled Gas
- Solid Fuel (Coal, wood or peat)
- LPG (bulk)

Do you have a separate fire that you use regularly?

- Yes, electric
- Yes, solid fuel
- Yes, gas
- No

What type of heating controls do you have on your main heating system?

Please mark all that apply.

Room thermostat ○ Yes ◉ No

Timer/Programmer ○ Yes ◉ No

TRVs (Thermostatic radiator valve) ○ Yes ◉ No

Storage heater dials ○ Yes ◉ No

How old is this main heating system?

- Under 5 years old
- 5 to 10 years old
- 11 to 15 years old
- Over 15 years old

Do you have foil behind any of your radiators?

- None
- Yes, some
- Yes, all

Do you have a condensing boiler?

If you are not sure, please tick "No". Condensing Boilers are not the same as Combination Boilers (which don't have a hot water tank).

- No
- Yes

Your hot water system:

How is your hot water usually provided?

- From Central Heating system (with hot water tank)
- Instant Gas or Combi boiler
- Instant Electric
- Single Immersion (Economy 7/off-peak)
- Single Immersion (on-peak)
- Dual Immersion Heater (on & off peak)
- Gas, oil or solid fuel Range (eg AGA)
- Back boiler
- Don't Know or Other

How would you describe your hot water tank insulation?

- Not applicable (no tank)
- No insulation
- Solid foam insulation
- Jacket (no gaps around jacket)
- Jacket (with gaps around jacket)

If you have a hot water tank, is there insulation on the pipework between it and the boiler?

- Not applicable (no tank)
- Yes
- No
- Can't see pipes
- Don't know

What type of hot water controls do you have ?

Please mark all that apply

On/off switch ○ Yes ◉ No

Programmer / timer ○ Yes ◉ No

Hot water tank thermostat ○ Yes ◉ No

Lighting:

How many of your lights have low energy lightbulbs fitted?

- ○ None
- ○ One
- ○ Some
- ○ Most
- ○ All
- ◉ Don't know

Grants:

The following questions will be used to help us decide whether or not there may be a grant available to help you install any energy efficiency measures.

Is a member of your household

aged over 60?	○ Yes	○ No
in receipt of benefits?	○ Yes	○ No

How many people live in your home?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ More than 5

How many of the people in your home are aged under 16?

- ○ None
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ More than 5

Data Protection:

The Energy Saving Trust, the data controller, is collecting your data for the purpose of providing you with energy efficiency advice, taking the form of a personalised report and follow up consultations where appropriate, that will help you reduce your energy use. The Trust will retain your data for the purposes of carrying out research and statistical analysis into the energy efficiency of UK housing stock. Your local Energy Conservation Authority will also receive your data for the purposes of energy efficiency monitoring, targeting and reporting.
In future, the Trust may wish to send you further information including details of grants, special promotions and free offers which will help you save money on your energy bills. If you are happy to receive this please cross here ☐

Thank you for completing this questionnaire. Please make sure that your computer is connected to the internet (on line) and then click the 'Send survey' button.

If you you close this window without sending the survey none of the information you have entered will be saved.

We hope to be able to send you your energy efficiency advice through the normal letter post within a few days - so please make sure that you have included your full name and address!

[Send]

Appendix E: Street Light Electricity Usage in Focus Area

Street Name	Lamp columns	Illuminated Sign	Bollards	CIC	School Flasher	Total energy usage (watt/hr) Data minimum	Total energy usage (watt/hr) estimate
Acacia Road	24	5	2	2	0	1455	1455
Albert Road	7	0	0	0	0	490	490
Armfield Crescent	10	2	0	0	0	596	596
Baron Grove	5	0	0	0	0	175	175
Batsworth Road	6	0	0	0	0	365	365
Belgrave Road	6	0	0	0	0	420	420
Belgrave Walk	22	0	4	0	0	1843	1843
Bond Road	17	7	4	2	0	1123	1123
Bramcote Avenue	10	0	0	0	0	550	550
Chatsworth Place	4	0	0	0	0	280	280
Church Road*	20	5	12	0	0		4500
Church Walk	3	0	0	0	0	105	105
Commonside East*	20	14	12	0	0		5000
Commonside West*	20	7	8	2	0		4800
Cranmer Farm Close	4	0	0	0	0	140	140
Cranmer Road	15	2	0	0	2	4006	4006
Cricket Green	21	6	6	2	0	4068	4068
Croydon Road*	20	12	6	2			4500
Dearn Gardens	7	0	0	0	0	245	245
Denham Crescent	8	0	0	0	0	280	280
Eveline Road	10	6	0	0	0	702	702
Foxton Grove	0	0	0	0	0	0	0
Glebe Path	9	2	0	0	0	375	375
Haslemere Avenue	14	0	2	0	0	1914	1914
Kingsleigh Place	5	0	0	0	0	625	625
Laburnum Road	14	0	0	0	0	490	490
Langdale Avenue	12	0	0	0	0	840	840
Lock's Lane	9	3	2	0	0	954	954
London Road*	26	12	12	1	0		5500
Love Lane	26	1	0	0	0	995	995
Lower Green West	12	11	3	0	0	3354	3354
Lowry Crescent	23	0	0	0	0	1175	1175
Madeira Road	10	2	4	1	0	3909	3909
Merlin Close	0	0	0	0	0	0	0
Miles Road	13	0	0	0	0	595	
Mitcham Park	19	5	0	0	0	1153	1153
Mortimer Road	8	4	0	0	0	480	480
Mount Road	16	1	0	1	0	996	996

Street Name	Lamp columns	Illuminated Sign	Bollards	CIC	School Flasher	Total energy usage (watt/hr) Data minimum	Total energy usage (watt/hr) estimate
Pear Tree Close	4	0	0	0	0	140	
Potter Close	2	0	0	0	0	70	70
Queen Annes Gardens	2	0	0	0	0	70	70
Raleigh Gardens	17	10	4	0	0	2200	2200
Riverside Drive	10	0	0	0	0	370	370
Rock Close	0	0	0	0	0	0	0
Rowan Road	31	8	14	2	0	5178	5178
Sadler Close	0	0	0	0	0	0	0
St Mark's Road	17	17	8	0	0	1570	1570
Sunshine Way	6	2	0	0	0	270	270
Taffy's How	4	0	0	0	0	140	140
Taylor Road	5	2	0	0	0	235	235
The Close	4	0	0	0	0	140	140
Upper Green East	12	0	0	0	0	1400	1400
Walnut Tree Avenue	2	0	0	0	0	70	70
Western Road*	20	6	8	0	0		4800
Westfield Road	3	0	0	0	0	105	105
Whitford Gardens	7	0	0	0	0	490	490
						47146	76246
						47.146	76.246
					Summer time: power for 7 hrs	330.022	533.722 kW/day
					Winter time: power for 12 hrs	565.752	914.952 kW/day

(*) Road extended out of the Focus Area, estimated the number of lamp and other lighting devices.

Appendix F: Municipal Farming point in Mitcham

Building Type	Electricity	Gas	Person to Contact	Locations	Phone Number
Street Lighting electricity usage (inventory.doc on S:\Street Lighting Inventory\Unmetered_2003)	X		Dave Williams	13th Floor Civic centre	3209
Mitcham Libraries(Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Morden Libraries(Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Wimbledon Libraries(Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Colliers Wood Libraries(Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Pollards Hill Libraries(Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Raynes Park Libraries(Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
West Barnes Libraries(Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Donald Hope Library (Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Merton Heritage Centre (Energy bill from Invoices)	X	X	Anne Walshe	9th Floor Civic centre	3322
Canterbury Centre	X	X	Anne Walshe	9th Floor Civic centre	3322
Professional Development Centre	X	X	Anne Walshe	9th Floor Civic centre	3322
Merton Youth office	X	X	Anne Walshe	9th Floor Civic centre	3322
Schools - They handle their own bills by building (need to call them each separately)	X	X	N/A	N/A	N/A
Jan Mallinowski Centre	X	X	Kim Godbeer	N/A	020 86468300
26&33 Singleton Close		X	Laser	N/A	N/A
Abbey Orchard Estate		X	Laser	N/A	N/A
Abbey Orchards Estate		X	Laser	N/A	N/A
Abbotsbury Primary School		X	Laser	N/A	N/A
All Saints Redevelopment		X	Laser	N/A	N/A
Aragon Primary School		X	Laser	N/A	N/A
Benedict Primary School		X	Laser	N/A	N/A
Bond Primary School		X	Laser	N/A	N/A
Chapel Orchard		X	Laser	N/A	N/A

Building Type	Electricity	Gas	Person to Contact	Locations	Phone Number
Chaucer Building		X	Laser	N/A	N/A
Colliers Wood Library		X	Laser	N/A	N/A
Commons Extension		X	Laser	N/A	N/A
Cottenham Park		X	Laser	N/A	N/A
Cranmer Primary School		X	Laser	N/A	N/A
Cricket Green School		X	Laser	N/A	N/A
Dundonald Primary School		X	Laser	N/A	N/A
Dundonald Recreation Ground		X	Laser	N/A	N/A
Eastway Block A, Flats 10 - 46, Eastway, Surrey		X	Laser	N/A	N/A
Flat 1 & 3 Dunmore House		X	Laser	N/A	N/A
Garden Primary School		X	Laser	N/A	N/A
Garfield Primary School		X	Laser	N/A	N/A
Gifford House		X	Laser	N/A	N/A
Gladstone House, Flats 15/34, 49/65, 90, 119, 2 Sadler Close, Mitcham, Surrey		X	Laser	N/A	N/A
Gorringe Park Primary School		X	Laser	N/A	N/A
Harlands Estate		X	Laser	N/A	N/A
Hatfield Primary School		X	Laser	N/A	N/A
Haydons Road Youth Club		X	Laser	N/A	N/A
Housing & Social Services Department		X	Laser	N/A	N/A
Housing Division		X	Laser	N/A	N/A
John Innes Youth Centre		X	Laser	N/A	N/A
Joseph Hood First School		X	Laser	N/A	N/A
Joseph Hood Recreation Ground		X	Laser	N/A	N/A
King Georges Playing Fields		X	Laser	N/A	N/A
London Road Cemetery		X	Laser	N/A	N/A
Lonesome Primary School		X	Laser	N/A	N/A
Malmesbury Primary School		X	Laser	N/A	N/A
Melrose School		X	Laser	N/A	N/A
Merton & Sutton Cemetery		X	Laser	N/A	N/A
Merton Abbey Primary School		X	Laser	N/A	N/A
Merton Adult College		X	Laser	N/A	N/A
MERTON CIVIC CENTRE		X	Laser	N/A	N/A
Merton Civic Centre		X	Laser	N/A	N/A
Merton Hall		X	Laser	N/A	N/A
Merton Park Primary School		X	Laser	N/A	N/A
Merton Youth Office		X	Laser	N/A	N/A
Morden Primary School		X	Laser	N/A	N/A
Morden Recreation Centre		X	Laser	N/A	N/A
Northwest Quadrant		X	Laser	N/A	N/A
Oberon Sports Ground		X	Laser	N/A	N/A
Pelham Primary School		X	Laser	N/A	N/A
Pollards Hill Day Centre		X	Laser	N/A	N/A
Pollards Hill Youth Centre		X	Laser	N/A	N/A
Raynes Park Sports Ground		X	Laser	N/A	N/A

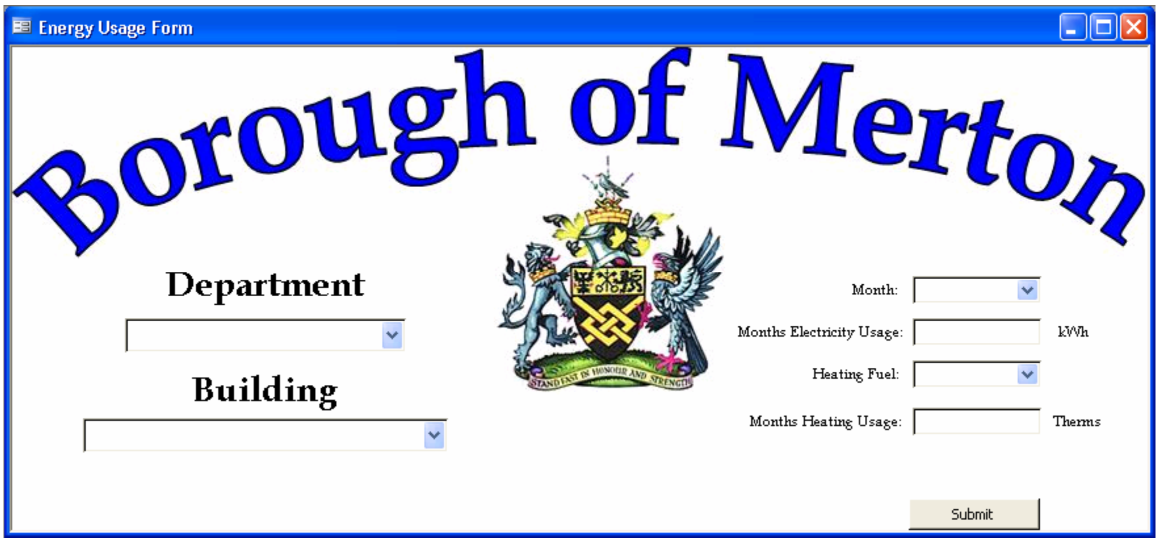
Building Type	Electricity	Gas	Person to Contact	Locations	Phone Number
Singlegate First School		X	Laser	N/A	N/A
Sacred Heart RC Primary School		X	Laser	N/A	N/A
Sir Joseph Hood Playing Fields		X	Laser	N/A	N/A
St Annes School		X	Laser	N/A	N/A
St Georges Street Car Park, St Georges Road, Wimbledon, London		X	Laser	N/A	N/A
St Matthews Primary School		X	Laser	N/A	N/A
St Peter & St Paul RC Primary Sch		X	Laser	N/A	N/A
St Thomas of Canterbury Primary School		X	Laser	N/A	N/A
Taylor Road Day Centre		X	Laser	N/A	N/A
The Priory C of E Primary School		X	Laser	N/A	N/A
The Sherwood Primary School		X	Laser	N/A	N/A
URSULINE CONVENT SCHOOL		X	Laser	N/A	N/A
Ursuline Convent School (Girls)		X	Laser	N/A	N/A
Vestry Hall & Annexe		X	Laser	N/A	N/A
Weir Road Resource Unit		X	Laser	N/A	N/A
William Morris Primary School		X	Laser	N/A	N/A
Wimbledon Chase Primary School		X	Laser	N/A	N/A
Wimbledon Park		X	Laser	N/A	N/A
Wimbledon Park Hall		X	Laser	N/A	N/A
Wimbledon Park Primary School		X	Laser	N/A	N/A
Wimbledon Reference Library		X	Laser	N/A	N/A
Worsfold House		X	Laser	N/A	N/A
Wykeham House		X	Laser	N/A	N/A
Yenston Close		X	Laser	N/A	N/A
Mitcham Fire station	X	X	Ian		020 7587 4944
Mitcham Police Station	X	X	Geoff Garn	London Metro Police	020 7161 2058
Internal Audit	X	X	Tony Skilbeck	12th Floor Civic centre	4176
Floor plans			John Mosely	10th Floor Civic centre	3289

Appendix G - Prototype Guide

Merton Intranet web-page for Energy Data Submission

To open this prototype:

1) Open up the mitcham_building_energy_char.mdb
2) Close the initial window which pops up
3) On the menu at the top of the screen choose Window > Unhide
4) Click Ok
5) Then go to the Forms tab on the database window which appears, and open the form titled "Webpage"



After these steps, it should open the intranet Web-page prototype. There are 6 fields in the form; their name, functionality and current states are listed in the table below.

FIELD NAME	FUNCTIONALITY	CURRENT STATE
Department	Select the department which the building is associated with	Currently includes 7 departments. (Chief Executive, Education, Environmental Services, Finance, Leisure, Libraries, Social Services)
Building	Contents are based on the department field. Used to select the building which data is being entered for.	Currently includes only a few buildings in each departments jurisdiction
Month	Select the month which data is inputting from	January – December, No specific link for uploading the data has been created.
Monthly Electricity Usage	Input monthly electricity usage of that building	A field call “txtElecUsage”, No specific link for uploading the data has been created.
Heating Fuel	Select the type of heating fuel	The two fuel types are fuel oil and natural gas, No specific link for uploading the data has been created.
Monthly Heating Usage	Input monthly heating usage of that building	A field call “txtHeatUsage”, No specific link for uploading the data has been created.

Updating the prototype:

To update the fields in the building drop down boxes, which are based on the department drop down box, we recommend you have a familiarity with access and Visual Basic coding.

First, open the Form “webpage” in design view, and then open the properties window for the department drop down box.

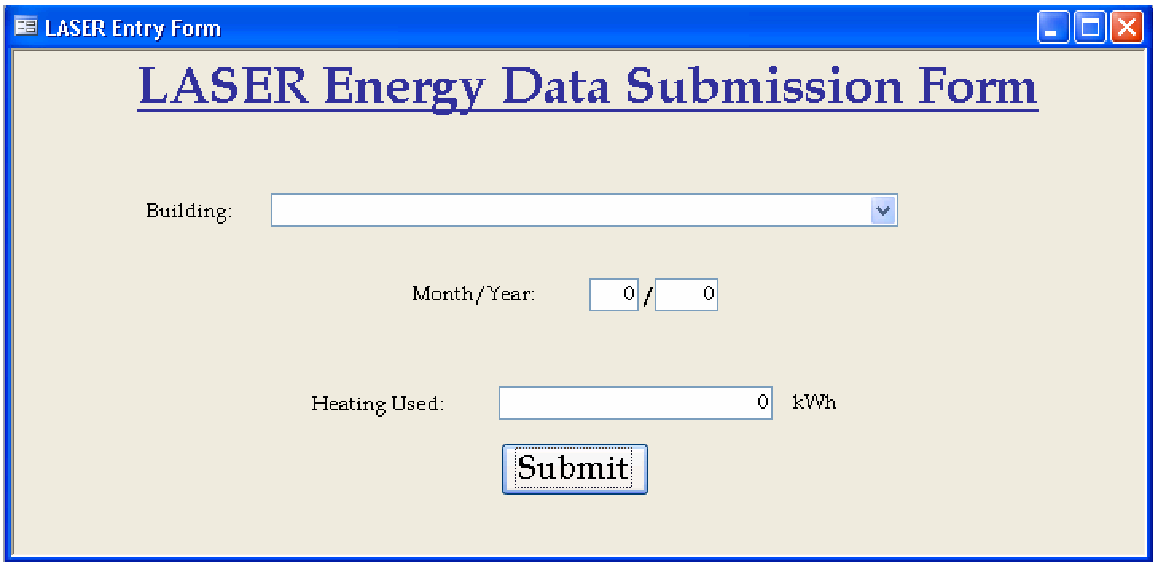
Next, navigate to the Events tab, and click the […] button next to the after update field (which says “Event Procedure” for its field value)

This will bring you to the VB code to update the Building drop down box. It should be fairly self explanatory, each block of code is separated in an ‘if’ statement, which checks what the department box has in it (if comboDept.Text = "Chief Executive", etc.). Within these block of code there is a line which starts with “ComboBuilding.RowSource =” this is the line which would be edited to change the contents of the building drop down menu. For example if it said “ComboBuilding.RowSource = "Vestry Hall;Mitcham Community Centre"” this means that the building drop down would display vestry hall and Mitcham community centre. If you wanted to add “police station” to the list, you would change it to “ComboBuilding.RowSource = "Vestry Hall;Mitcham Community Centre;police station"”

LASER Energy Data Submission Form

To open the prototype:

1) Open the file LaserData.mdb
2) Then navigate to the "forms" tab and open the form named "MonthlyDataEnter"



After these steps, it should open the Laser Energy Data Submission Form prototype. There are 6 fields in the form; their name, functionality and current states are listed in the table below.

FIELD NAME	FUNCTIONALITY	CURRENT STATES
Building	Allows the user to select a building which is managed by LASER, displays building name and address	Currently includes only a few buildings managed by LASER. However it is connected to the table Building_data, which links the address to a UPRN.
Month/Year	Date of the data to be entered	Input field specifying the month and year the data about to be entered is from. This data is added to the table MonthlyData when submit is clicked
Heating Used	Allows entry of the heating use of the building	Input field specifying heating use in kWh. This data is added to the table MonthlyData when submit is

		clicked.

To update the buildings in the drop down menu, merely add more buildings to the table Building_data

Appendix H – Possible Farming Points for Business Information

Businesses are ideal CHP and private wire candidates, since they are huge energy consumers, and are able to sign up to 15 year contacts. According to the previous WPI Energy Mapping team report, as well as information we collected over the course of our project, there are numerous farming points for different types of data about businesses within Merton. We recommend exploring the following farming points to see what data you can collect from them:

- Chamber of Commerce Business Directory
- Business Rate Directory
- Business License
- Experion Business Database
- Fire Inspections
- Health and Safety Inspection
- OSR1 Form (non-industrial)
- Physically visiting the site is also an option.

There are also other options that you could explore; Daniela Pavan has located the M3PP New/Amendments/ Additional Information Request form and the Office Shops and Railway premises Act 1963 form, in the M3PP form, there is a printed code (You can find the form scanned below, on that specific form the code is for food services) and sub-code (see table after scanned image for sub codes and their meanings).

These forms are from Karen Halls, an Administration Assistant from the Environmental and Health Regeneration (Planning and Public Protection) on the 14th floor of Civic Centre. From these forms you could possibly gather locations, business types and personal information about that specific business. Each new business has to fill out one of there forms and summit it to the council before opening. Therefore, locating these forms could prove quite useful. We, however, were unable to locate where these forms were stored due to a shortage of time.

Ideally – yearly change – of owners LP

← yearly? once-only?

?

HSE Health & Safety Executive

Office Shops and Railway Premises Act 1963

Notice in form prescribed by the Secretary of State for Employment, of employment of persons in office or shop premises.

Click here for guidance

If you intend to employ any person or persons to ~~work in shop or~~ office premises you are required by Section 49 of the Offices, Shops and Railway Premises Act 1963 and ~~the~~ Notification of Employment of Persons ~~Order 1964~~ to complete this form and send it to the appropriate authority. Please read the ~~explanatory notes~~ by clicking the 'Click here for guidance' link above before completing this form.

The appropriate authority will send a copy of the form to the fire authority for your area. (You may need a fire certificate -see note 9 in the guidance notes)

A separate form should be completed for each set of premises with a different postal address. Where several occupiers have premises at the same address, each occupier should complete a form in respect of his premises.

When completing this form please ensure you select the relevant checkbox for Part I or Part II, whichever is applicable.

Part I

☐ Notice is hereby given that on the *(insert date)* [ ], the employer specified in Part III of this notice, will begin to employ persons to work in the premises described therein.

Part II

☐ Notice is hereby given that the employer specified in part III of this notice is employing persons to work in the premises described therein.

Part III

1 (a) Name of employer [ ]

(b) Trading name, if any [ ]

2 (a) Postal address of the premises [ ]

(b) Telephone number [ ]

3 Nature of business [guided selection]

4 How many persons are or will be employed by the employer in office or shop premises at the above address in the following types of workplace? (see notes 3-7)

(a) Office [ ]

(b) Shop (retail) [ ]

(c) Wholesale department or warehouse [ ]

(d) Catering establishment open to the public [ ]

(e) Staff canteen [ ]

(f) Fuel storage depot [ ]

Total [0]

Of the **total** how many are females? [ ]

Add PTC, Main EH, SIC codes

To sell – 001 - / / / /

5 How many of the total are or will be employed on floors other than the ground floor? [ ]

6 Of the total stated in reply to question 4, are any (or will any be) housed in separate buildings? Yes ☐ No ☐

7 Is the employer the owner of the building(s) (or part of the building(s)) containing the premises? Yes ☐ No ☐

8 If not, state the name and address of the owner(s) or person(s) to whom rent is paid

[ ]

Signature of employer or person authorised to sign on his behalf [ ] Date [ ]

Continue

M3PP New/Amendments/Additional Information Request Form

New Business/change of use

M3PP New/Admendments/Additional Information Request Form.

Officer: ? Date:

Change: New Premises ☐ Not on LPG ☐ Premises Ceased Trading ☐

New Proprietor ☐ Change Trading Name ☐

Other ☐ Please state ______

PI Number: ______

Trading Name: ______

Premises Address: ______

______

Telephone Number: ______

Proprietor: ______

Date Started/Ceased Trading: ______

→ other

Premises Type Code: FR	
Main EH Trade Code:	Main TS Trade Code:
Additional Codes	Additional Codes

S/C NAICS ?

Old Dataflex No (if known): ______

Previous Trader Details (if known): ______

Any Other Information/Requests:

______

- **Note: Admin will NOT create a worksheet for a component unless requested to do so.** ?

Principal EHO	Principal TSO
Date	Date

H/\commercial\kh\m3\M3PP amendments request form.14-12-05

Sub Codes and Meanings

Food Registration

Premises Type

Code	**Description**
FPAC	Food Packers
FR01	Farm/smallholding
FR02	Manufacturer/processor
FR03	Slaughterer
FR04	Packer
FR05	Importer
FR06	Wholesale/Cash & Carry
FR07	Distribution/Warehouse
FR08	Retailer
FR09	Market
FR10	Restaurant/Café
FR11	Staff Canteen
FR12	Catering
FR13	Hospital/Residential Home/ Schl
FR14	Hotel/Pub/Guest house
FR15	Private HSE used Food Business
FR16	Premises used by no. Business
FR17	Mobile Premises
FR18	Other
GDNC	Garden Centre
HFLA	Occupied Flat
HOUS	Occupied House
HVAC	Vacant Residential Property
LICP	Licensed Premises
LNRH	Late Night Refreshment House
MST	Beauty Treatments Premises
NAIL	Nail Bar
OFF	Offices
OFFL	Off Licence
OSPC	Open Space
OTHE	Other
PETS	Pet Shop
PRK	Park
PTRL	Petrol Stations
PUB	Public House
REST	Restaurant
RET	Retail
SCH	School
SMKT	Supermarket
STBL	Stables
THR	Theatre
TKWY	Take-Away
WBAR	Wine Bar
WEIG	Weighbridges

Code	Description
WHOU	Warehouse
WSAL	Wholesaler
WSHP	Workshop

Appendix I – Day and Night time electricity usage in Merton

Estimate Merton electricity by time in MWh	Summer Minimum (04/08/2002)	Typical Summer (25/06/2002)	Typical Winter (03/12/2002)	Winter Maximum (10/12/2002)
0:00:00	53.277	59.579	71.480	78.981
0:30:00	50.791	55.899	72.000	78.710
1:00:00	49.305	53.977	72.715	79.209
1:30:00	48.496	53.916	73.041	79.368
2:00:00	47.446	54.019	71.880	78.472
2:30:00	46.419	53.452	70.736	78.039
3:00:00	45.456	52.801	70.804	78.986
3:30:00	44.647	52.020	69.079	77.536
4:00:00	44.451	51.970	66.936	75.938
4:30:00	43.904	51.467	65.600	74.578
5:00:00	43.664	50.654	64.995	74.082
5:30:00	43.204	50.960	65.552	74.298
6:00:00	42.439	52.261	67.293	75.730
6:30:00	43.183	57.209	72.820	81.146
7:00:00	44.459	62.603	79.305	87.537
7:30:00	46.250	70.419	88.578	95.773
8:00:00	48.546	75.562	93.023	100.960
8:30:00	51.474	78.946	94.405	103.124
9:00:00	54.183	80.182	93.775	102.860
9:30:00	56.896	81.780	94.580	104.395
10:00:00	59.325	82.314	94.776	104.957
10:30:00	61.929	82.653	94.505	105.018
11:00:00	63.646	82.948	94.623	105.212
11:30:00	64.822	83.177	94.702	105.346
12:00:00	65.686	83.794	94.698	105.770
12:30:00	66.217	84.078	94.794	106.233
13:00:00	65.904	83.077	94.066	105.232
13:30:00	64.533	82.559	93.814	105.311
14:00:00	63.049	82.102	94.405	105.825
14:30:00	62.419	81.699	94.779	106.443
15:00:00	61.597	81.404	94.556	106.411
15:30:00	60.989	80.569	95.163	107.158
16:00:00	60.829	81.457	98.581	110.915
16:30:00	61.385	82.663	104.438	115.274
17:00:00	62.017	82.906	108.534	117.894
17:30:00	62.371	82.272	109.598	119.009
18:00:00	62.351	80.481	109.028	117.448
18:30:00	61.997	77.827	106.476	115.342
19:00:00	61.437	76.093	104.731	112.996
19:30:00	61.267	74.243	102.442	110.967
20:00:00	60.565	72.632	99.053	107.932
20:30:00	61.321	70.865	96.641	104.985

Estimate Merton electricity by time in MWh	Summer Minimum (04/08/2002)	Typical Summer (25/06/2002)	Typical Winter (03/12/2002)	Winter Maximum (10/12/2002)
21:00:00	62.509	70.266	93.010	102.328
21:30:00	65.069	69.980	90.662	99.401
22:00:00	64.800	70.922	86.230	94.964
22:30:00	63.440	71.701	82.451	90.972
23:00:00	60.547	68.856	78.813	86.595
23:30:00	56.778	64.208	74.049	81.798
Total electricity in MWh in half hr per day	2697.290	3387.420	4198.216	4637.460
Total electricity in MW consume per day	1348.645	1693.710	2099.108	2318.730
Maximum	66.217	84.078	109.598	119.009
Minimum	42.439	50.654	64.995	74.082
Different between Max and Min	23.778	33.424	44.604	44.927