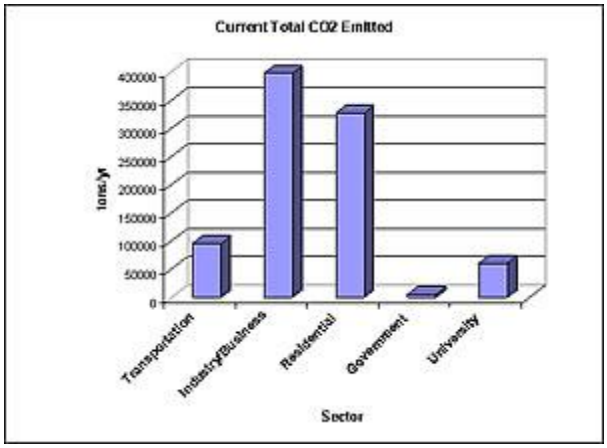
Sustainability in Cambridge: Building a Carbon Dioxide Emissions Inventory for Cambridge



A report to the Cambridge City Council
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Summer Program in International Environmental Assessment and Energy Policy,
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1. Preface

The Carbon Reduction Project in Cambridge has the goal of bringing about a 60% reduction in carbon dioxide emissions from the City of Cambridge. The project is being conducted by students and faculty from the Carolina Environmental Program of the University of North Carolina-Chapel Hill in the United States in collaboration with the Cambridge City Council and the Community Carbon Reduction (CRed) programme at the University of East Anglia.

In this second year of the project, the students worked with the city council to help them reduce their own carbon dioxide emissions by 60% by 2025, and to set examples for similar changes in the rest of the City. This year (2005), the students met with representatives from City Council, from the University of Cambridge, and from the industrial sector, as well as collected information on energy consumption in the residential and transportation sectors. In addition, they conducted surveys to determine the energy needs of Cambridge citizens, calculate how much carbon dioxide they currently emit, and assess the social acceptability of specific policies discussed elsewhere on this site.

The results of this suite of projects are presented here. The format of the material is to make it suitable for use in developing a web site for Cambridge. Bear this in mind while reading the material, as the language differs at times from normal prose for a report.

2. Why reduce carbon dioxide emissions in Cambridge?

Perhaps the most pressing reason to reduce carbon dioxide emissions in Cambridge is to help curb global climate change. We are all responsible for the 500 million tonnes of carbon dioxide the U.K. puts into the atmosphere every year. The potentially dramatic effects of climate change include rising sea levels accompanied by flooding, extremes of temperature, shifts in the growing belts of crops, and the emergence and/or spread of vector-born diseases. Though scientists around the globe disagree somewhat on whether humans have induced the recent increases in global temperature, there is broad scientific agreement that current trends in carbon dioxide emissions eventually will have significant effects on the climate. It is the opinion of the UNC students (and of the Intergovernmental Panel on Climate Change) that enough is known about the risks of global warming and the cost savings of reducing carbon dioxide to make implementing carbon-reducing policies worthwhile.

Potential health effects associated with carbon dioxide also provide reasons to reduce carbon dioxide. Though carbon dioxide in itself does not produce adverse health effects at the levels we are considering here (aside from those produced indirectly by climate change), the pollutants and particulate matter produced simultaneously when fossil fuels are burned certainly do. If carbon dioxide emissions were reduced, therefore, this would also decrease the subsequent emissions of other harmful pollutants.

The 60% challenge was introduced by the UK government in 2003, after a consultation on Great Britain's energy policy by a performance and innovation unit. Based on the PIU's recommendations, a White Paper was issued, outlining the government's approach to future energy policy. The 60% goal, if met in all the developed nations, would limit climate change to levels judged acceptable by the scientific community. Even before this goal was introduced, however, the world's political leaders got together in 1990 to discuss the threat of climate change caused by human activity. The outcome of this was the Kyoto Protocol, which commits its signatories to reductions in greenhouse gases. The UK has been at the forefront of this process.

The surveys conducted by this project suggest that Cambridge citizens are very interested in decreasing carbon dioxide emissions. The City Council has shown interest for quite some time as well. Cambridge is poised to lead Great Britain with regards to reducing carbon dioxide emissions, and City Council is poised to lead the City.

3. Effects of Carbon Dioxide Reduction on Human Health

Reducing atmospheric carbon dioxide has two primary effects on health: direct and indirect. Direct effects include those associated with climate change: deaths due to extremes of temperature; the spread of microbial and other vector-borne diseases; injuries due to extreme weather events such as hurricanes and flooding; etc. The potential for such effects has been well described in the scientific literature and in a recent publication by the Department of Health.

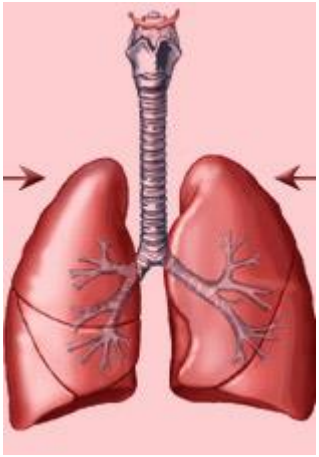
That latter study concludes that effects could include:

- *An increase of 2,800 heat-related summer deaths per year.*
- *An increase of 10,000 cases of food poisoning per year.*
- *An increase in vector-borne and water-borne diseases locally*
  (but the study concludes the overall health impact will be small).
- *A significant increase in major disasters caused by strong winter gales and coastal flooding*
  (the impact on health has not been assessed to date).
- *Several thousand extra ozone-related hospital admissions per year.*
- *An increase of 5,000 cases of skin cancer per year.*
- *An increase of 2,000 cases of cataracts per year.*
- *A decrease (a desired effect) of up to 20,000 deaths due to cold per year.*

For more information on these direct effects, we refer you to the web site maintained by the Intergovernmental Panel on Climate Change.

The present report directs attention to the indirect effects of reducing carbon dioxide. We also refer to these as "follow on" effects, as they follow from strategies that reduce carbon dioxide. Activities that cause emissions of Greenhouse Gases (GHGs) also emit other pollutants such as Particulate Matter, or small particles that can be inhaled. These particles can exacerbate and even cause diseases such as asthma, pneumonia, congestive heart failure and bronchitis.

Strategies that reduce emissions of carbon dioxide, therefore, often reduce these "follow on" health effects from particulates. As a result, the policies of carbon dioxide emission reduction proposed on this site may be justified in two ways: as contributing to the goal of Cambridge to reduce carbon dioxide emissions, and as reducing the burden of diseases associated with the "follow on" effects of particulate emissions. This page of the web site is dedicated to understanding the potential reduction in respiratory disease in Cambridge as particulate emissions are reduced following policies aimed initially at reducing carbon dioxide emissions. We are particularly interested here in policies aimed at reducing emissions associated with transportation.



Transportation reductions that lower the amount of gasoline and diesel burned can simultaneously lower the emissions of particulates and, hence, the incidence of diseases associated with particulates. This also reduces the health care costs resulting from treatment, and the lost productivity of workers affected by the diseases. As a result, policies that reduce particulate emissions, as a "follow on" effect of reducing carbon dioxide emissions, can be justified in part by the economic savings.

We have assessed the reduction in health effects resulting from the reduction in particulate emissions that follow from policies that reduce transportation in Cambridge. To assist in this assessment, we produced an EXCEL spreadsheet that allows simulation of the reduction in number of health effects and their costs.
The calculations of reduction in number of health effects, and total cost savings, that follow from reductions in particulate emissions by transportation in Cambridge were performed as follows:

1. The DMRB (Design Manual for Roads and Bridges: Screening Method, from the UK Highways Agency) computer code was obtained from Jo Dicks of the Cambridge City Council. This code allows the user to calculate the total concentration of particles (PM-10) in the air at different distances from a road, given information on number of vehicles per day, average speed, mix of vehicles (heavy and light) and background concentration.

2. The data needed by the DMRB code were obtained from a 2003 report on vehicle travel in Cambridge, which focuses on the 10 most traveled roads: Huntington,

Milton, Trumpington, Newmarket, Elizabeth, Parker, Silver, Gonville, Regent and Victoria.

3. For each of these roads, the data were entered into DMRB and the current annual average total PM-10 concentration calculated at a representative distance of 10 metres from the center of the road. This should be representative of exposures to people walking along, or living near, these roads under current (or baseline) conditions. In the Health Effects Spreadsheet, these values appear in Column 2 of Table 1.

4. A series of transportation policies then were simulated, corresponding to reductions in transportation (vehicle-miles traveled) of 10%, 20%, etc up to 100% on all roads simultaneously. The new PM-10 concentrations under these policies then were calculated. Results are shown in Column 3 of Table 1 of the spreadsheet (9 sets of predictions, one for each reduction). All results are in units of micrograms per cubic meter.

5. The difference in PM-10 concentration with and without the policy then was calculated by subtracting the latter from the former. These differences are shown in Column 4 of Table 1 of the spreadsheet (again, 9 sets of predictions, one for each policy). The average of this difference across all 10 roads then was estimated, and is used here as the average reduction in exposure to PM-10 in the Cambridge population. This average is shown in Row 23 under each column. NOTE: This procedure will be replaced in the future by one that produces a better estimate of the average reduction in exposure, using 2 dimensional surfaces of exposure reduction rather than point estimates near the major roads.

6. The report by the U.S. Environmental Protection Agency (BenMap; the Environmental Benefits Mapping and Analysis Program) was used to determine the reduction in health risk for each considered adverse effect resulting from the reduction in average PM-10 concentration. These effects included All Respiratory; Asthma; Chronic Lung Disease; Pneumonia; All Cardiac; and Dysrythmia. When multiple studies existed of the relationship between PM-10 concentration and probability of effect, the study results were averaged to obtain a single risk coefficient.

7. To calculate the reduction in number of health effects associated with a given policy, the log-linear model for exposure-response was used. When the difference in probability of effect is much less than 1 (as is the case here), this model reduces to: Change in Probability of Effect = B x (exp(beta x Change in PM-10) – 1) where B is the Background Probability of Effect in the Cambridge population; beta is the risk coefficient taken from the EPA report (fractional change per unit air concentration); and Change in PM-10 is the average difference in PM-10 concentration with and without the policy (from Step 5). Again, all concentrations are in units of micrograms per cubic meter. Results of the calculation of exp(beta x Change in PM-10) are shown in Table 2 of the spreadsheet. Where the background rates were available for the U.K., they were used. Otherwise, averages for the U.S. were used. Results of the calculation of Change in Probability of Effect are shown in Table 3 of the spreadsheet.

8. The cost per effect (GBP/effect) was obtained from a search of U.S. and U.K data. Where the costs were available from U.K. data, these were used. Where they were available only in the U.S., these were used with the current exchange rate to convert from USD to GDP.

9. The Change in Probability of Effect was multiplied by the Cost per Effect to obtain the cost savings for each effect per resident of Cambridge per year under each candidate transportation policy. The results are shown in Table 4 of the spreadsheet. Costs then were summed over all effects to obtain total cost savings per resident of Cambridge under each candidate policy. NOTE: This summation did not include the category All Respiratory Effects, as these are included under the separate effects.

10. The total cost savings throughout the City of Cambridge was calculated by multiplying the cost savings per resident per year times the number of residents in Cambridge (assumed here to be 120,000). As an example, the calculations predict that a 10% reduction in vehicle traffic will result in a health care savings of approximately 39,400 GBP in Cambridge each year; a 30% reduction in vehicle traffic will result in a health care savings of approximately 122,000 GBP in Cambridge each year; and a 60% reduction in vehicle traffic will result in a health care savings of approximately 298,000 GBP in Cambridge each year.

4. Carbon Reduction Strategies for the City of Cambridge

Carbon dioxide emissions in the City of Cambridge are divided here into five primary sectors: Residential, Commercial/Industrial, Transportation, University and City Council. There are approximately 1.13 million tonnes of carbon dioxide released per year from these five sectors combined. Assuming a population of approximately 120,000 people, this represents 9.4 tonnes per person per year. Residential energy use accounts for 29% of this total; Commercial/Industrial for 35%; Transportation for 30%; University for 5%; and City Council for the remainder (slightly less than 1%).

To assist in any analyses you might want to perform (e.g. to identify the most effective strategies of reduction), the students created an EXCEL spreadsheet that calculates energy use and carbon dioxide emissions from these five sectors. With it, you can simulate the effect of alternative control strategies on overall carbon dioxide emissions, locating strategies that bring about the greatest reductions. The EXCEL model is entitled City of Cambridge Energy and Carbon Model and can be obtained by contacting Dr. Douglas Crawford-Brown at dcrafor@email.unc.edu.

System Boundaries

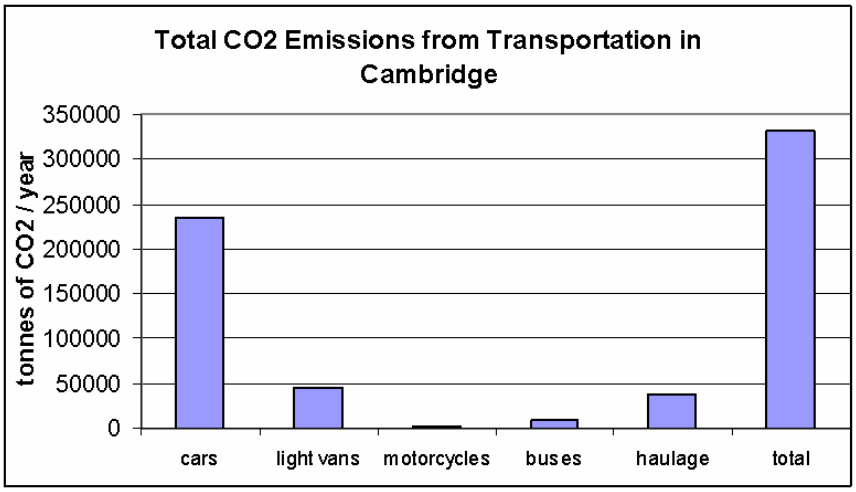
In conducting assessments of carbon dioxide emissions from an individual, organization or geographic area, it is essential to understand what is and is not included in the assessments- to define the system boundaries. A significant issue that arose in the assessment for Cambridge is how to allocate carbon dioxide emissions from the manufacturing of goods (tables, cars, etc) consumed in Cambridge but manufactured elsewhere. We have chosen to allocate those emissions back in the geographic area in which they were produced, rather than in Cambridge where they are consumed. This avoids "double counting" of the emissions for the world, since the

energy consumed in producing those goods is part of the total energy consumption at the point of manufacture. In addition, the geographic area producing the goods receives the economic benefit of that production, and so it seems more fair to allocate the carbon dioxide emissions to that area. We do, however, allocate to Cambridge all of the carbon dioxide produced during the USE of those goods in Cambridge.

4A. Transportation

The City of Cambridge emits about 337,000 tonnes of carbon dioxide per year from transportation. With a population of approximately 120,000 people, this indicates an emissions rate of approximately 2.8 tonnes of CO2 per person per year due to transportation alone. This represents approximately 30% of the total carbon dioxide emissions from the city. We consider here changes that could be introduced in transportation throughout Cambridge to reduce carbon dioxide emissions by 60% in this sector (i.e. from 337,000 tonnes per year to 134,800 tonnes per year).

Figure 1 show the breakdown of carbon dioxide emissions for different types of vehicles based on our assessment.



The data used to generate the carbon dioxide emissions from transportation in Figure 1 are based on the vehicle miles travelled per person in the Cambridgeshire region, obtained from the Department for Transport's National Road Traffic Survey. The current assessment assumes that the vehicle miles per person travelled in Cambridgeshire are representative of Cambridge. This assumption will not be exactly true, so further studies should be done to determine the vehicle miles travelled in the City of Cambridge. Also, the assessment is based on the assumption that the percent of road traffic by vehicle type in the UK, also from the National Road Traffic Survey, is representative of that in Cambridge.

Carbon Dioxide Emission Reduction Proposals

The following proposals are made for reducing carbon dioxide emissions from all transportation activities in the City of Cambridge (including contributions from transportation associated with industrial, business, government, university and citizen

sectors). Future studies will explore the issue of transportation reduction in more detail.

Short term strategies:

- *Increase the number of vehicles using alternative, clean fuels*
- *Continue maintenance on city cycle paths to encourage bike use*
- *Create new cycle paths as developments outside of Cambridge grow*
- *Provide partial funding or incentives for businesses encouraging employees to bike, walk, and car share*

Medium and long term strategies:

- *Create low emission zones*
- *Provide local housing for employees*
- *Create a car club*
- *Increase use of public transportation (with Cambridgeshire County Council) providing low cost or free bus services*

Follow-on effects

Reducing transportation emissions in Cambridge through reduction of gasoline and diesel burning has the "follow-on" effect of reducing other pollutants such as particulates and nitrogen oxides. These reductions, in turn, reduce the burden of health effects and their associated costs in the city. For details on these "follow-on" effects, see the Health and Carbon Dioxide Reduction section.

4B. Business and Industry

Climate change is no longer uncertain; there is increasing scientific consensus that it is real and that it is being fuelled partly by human activity. To reduce the risk of climate change, it is necessary for business and industry to implement sustainable management practices. "Business will play a pivotal role in meeting the sustainability challenges of the 21st century." (The Tellus Institute). In Cambridge, business and industry account for approximately 398,000 tonnes per year, or 35% of the carbon dioxide emissions from the the city, and so are significant contributors to the carbon reduction strategies needed by the city.

We invite business and industry to take part in carbon reduction by setting your own framework for policy and change implementation and to develop technologies for the new market in carbon-reducing means of satisfying the future needs of citizens. You have the opportunity to begin adopting these measures to drive the marketplace, and to work with the government to establish the national agenda in a way that recognizes the increasingly global nature of business. Since we believe strongly in having business and industry join as partners in the Carbon Reduction project, and since we believe that many of the most creative solutions to climate change are being produced in business and industry collaborations, we have taken an approach to this sector of carbon dioxide emissions that differs from the other sectors. Rather than describing specific carbon reduction strategies and targets to be met by the business and industry

sector, we have elected to create a report that will spur business and industry to develop their own measures. *Such collaborations between business leaders and communities will be essential as society balances the need for economic development and for reduction of carbon dioxide emissions. Our initial thoughts are provided below.*

Why should business and industry be interested in implementing sustainable management practices?

Sustainable Management Practices are the inclusion of the ideas of sustainability in the process of decision-making. They are a systematic approach for planning, controlling, measuring and improving an organisation's environmental effort, placing that effort within the framework of the three legs of sustainability: *environmental quality, social justice and economic vitality*. We believe there are several viable reasons for introducing sustainable management practices, associated with both economic benefits and the concept of corporate citizenship:

- *It lowers energy costs*
- *It is a potentially lucrative business where you have the opportunity to create new markets*
- *It represents Corporate Social Responsibility*
- *It is the company's obligation to be accountable to its investors and employees in all its operations, with the aim of achieving sustainable development*
- *It lifts employee morale*
- *It increases public confidence in your business*
- *Public concern about climate change could influence their preferences when deciding where to shop*
- *It enhances investor confidence (since you are driving the agenda rather than waiting for government intervention)*

What are some examples of energy saving measures that represent sustainable management practices?

In the area of lighting:

- *Use Day lighting*
- *Have lighting controls- timers and sensors that turn lights off when not needed*
- *Change to Compact Fluorescent Lights*
- In the area of waste:
- *Try to avoid creating waste in processes*
- *Recycle all materials possible*
- *Reuse everything that is possible*
- *Reduce packaging to avoid producing more waste*

In the area of air conditioning:

- *Control operating hours of air conditioning*

- *Use draught arresters and weather stripping around doors and windows and seal up cracks and gaps*
- *Make sure thermostat settings are not set too high or too low*
- *Locate air conditioners away from direct sunlight*

In the area of office equipment:

- *Make sure photocopiers, computers and printers are turned off at night and on weekends*
- *Switch off computer monitors when not using it*
- *When buying equipment make sure they have a high efficiency rating*

In the area of cooking:

- *Use microwaves as much as possible, especially when reheating.*
- *For commercial kitchens, restaurants and takeaways, try limiting times at which cooking equipment is operating at full power- when possible switch it off or turn it to a low setting when not needed.*
- *Use gas rather than electric fryers, hotplates and bain-maries*
- *Turn down the temperature of hot plates and fryers to low*

In the area of water heating:

- *Use kettles and instant water boilers rather than large urns*

In the area of electric motors:

- *Make sure motors are correctly sized and will not be running lightly loaded for long periods of time*
- *Where motors are running near full load for long periods of time, consider buying high efficiency ones*
- *Consider using electronic speed controllers on motors driving variable speed conveyor lines or pumps with a variable pumping rate*

In the area of compressed air:

- *Turn compressors off after hours when you do not need compressed air*
- *Have compressed air systems checked regularly for leaks and repaired if necessary*
- *Auditcompressed air needs to identify other opportunity savings*

In the area of building or renovation:

- *Incorporate energy efficient design principles*
- *Insulate ceilings and external walls to keep heat in during the winter and help keep it out during the summer*

- *Make sure that East, West and North facing windows are well shaded in summer. If you can not use external awning, blinds or louvers use tinted or reflective windows.*

All of the above energy saving management practices were taken from: www.sustainable.energy.sa.gov.au/pdfserve/advisory/small_business/management/pdf/energymgmt.pdf

Which businesses and industries here in Cambridge have begun adopting sustainable management practices?

Already numerous businesses and industries are accepting the need for reducing their carbon dioxide emissions and are leading local, regional, national and even global efforts on this front. Here are some businesses in Cambridge with a few practices they have implemented:

HSBC: Will cut its CO2 emissions by an average of five per cent, water and energy use by seven per cent and landfill waste by eight per cent, across 90 per cent of its operations by the end of 2007.

Sainsbury: Promotes the use of reusable bags and minimizes packaging in products

Marks and Spencer: Reducing waste from packaging, uses sustainable raw materials and is developing reusable bags.

BP: Has reduced their GHG emissions by 10% and promotes renewable energy resources.

Boots: Is minimizing their wastes and are working towards ISO 14001certification

WH Smith: 3% of their electricity comes from small-scale hydroelectric schemes and have reduced waste going to landfill by around 5%.

Gap: Uses low toxic materials and is incorporating ecological construction into their buildings.

French Connection: Reuses shipping cartons for in-country distributions

Next: Has developed a staff bus scheme to reduce employee transportation emissions.

Starbucks: Has a wide selection coffee and incorporates eco-friendly elements and materials.

Caffe Nero: Has a wide selection of Fair Trade Coffee

Costa Coffee: Has a wide selection of Fair Trade Coffee and Tee

Are there organisations that can help me begin with sustainable management practices?

Absolutely. Not only can they help with such practices, they can put in touch with, and help you to join, some of the more innovative and energetic business and industry consortia that are taking the lead in developing strategies to reduce climate change. These consortia are essential in helping spread the word that environmental policies can often make good business sense if approached wisely.

Cambridge Programme for Industry: This programme offers executive learning programmes and services. It is a non-profit organization within the University of Cambridge dedicated to help business leaders identify strategic opportunities and identify what it means to run a sustainable enterprise in practice. Businesses and industries that have had a particularly strong presence in the CPI activities that are relevant to climate change and carbon reduction include HSBC, the Confederation of British Industry, Tesco, Barclays, BBC Cisco Systems and Boots.

BSD Global: Business and Sustainable Development Global is a website where you can find strategies and tools, training opportunities and numerous case studies on what other businesses have done and how the actions they have taken have reduced their costs.

WBCSD: The World Business Council for Sustainable Development is a coalition of 175 international companies. The organization was formed with the goal to bring business leaders together to work on practical implementation of sustainability and eco-efficiency measures.

A case study: HSBC

HSBC is one of the largest banks in the world. It has offices in 77 countries and territories in Europe, the Asia-Pacific region, the Americas, the Middle East and Africa. Its central offices are located in London. HSBC has realized the need to move forward implementing Sustainable Management Practices. It considers that its greatest corporate responsibility is to be a successful company, and a fundamental part of being successful is that it is achieved in a sustainable manner meeting the needs of investors and NGO's. They began last year by committing themselves to go carbon neutral by reducing energy use, buying green electricity and offsetting the remaining CO2 emissions by investing in carbon credit or allowance. By the end of 2007 HSBC will cut its CO2 emissions by an average of 5%, water and energy by 7% and landfill waste by 8%, across 90% of its operations. Most of the savings will be achieved over the next three years by the introduction of new, efficient technologies during upgrades to the bank's 10,700-strong property portfolio, and improvements to individual regions' environmental maintenance and management programs. HSBC is not only reducing their emissions but is also championing the use of Sustainable Management Practices to its customers.

We applaud HSBC for these efforts, and consider them a case study of how carbon reduction strategies and sound business practices can be integrated. It is a perfect example of how business and industry can not only produce changes needed in Cambridge, but lead the effort to introduce them in every sector.

4C. University

The University of Cambridge is one of the oldest universities in the world. It has a world-wide reputation for outstanding academic achievement and a high quality of research undertaken in a wide range of science and art subjects. The University's achievements in the sciences can be measured by the more than sixty Nobel Prizes awarded to its members over the years. The University has also emerged as a leader in the reduction of carbon dioxide emissions. Two years ago, it switched to electricity powered by a renewable source (a Scottish hydroelectric provider). This action enabled the University to cut their carbon dioxide emissions by more than 60%, all from a single decision!

The University of Cambridge plays an important role within the City of Cambridge. While it is responsible for somewhat less than 5% (61,300 tonnes per year) of the overall carbon dioxide emissions in the city, its prestige and central role in the life of the city makes it an ideal leader (along with City Council) of efforts in all sectors of the city. Serving not only as a leader of the academic world, but also as a leader within the city, the University of Cambridge could take steps that influence carbon dioxide emissions in the City of Cambridge, the region and the nation. Perhaps the University of Cambridge can lead a movement of universities, as well as other sectors in the City of Cambridge, by making their own CRed pledge to reduce carbon dioxide emissions by 60%. While they have made important strides with the purchase of renewable energy, those advances are in danger of being lost as energy costs are reconsidered in light of fluctuating prices (see www.tec.bham.ac.uk).

We believe the University should make their recent switch of energy sources part of a CRed pledge that will remain a permanent feature of energy use on the campus.

Regardless of whether the University continues with the renewable source, they can take important steps to reduce energy consumption. This will reduce not only carbon dioxide emissions from the University Estate, but from the entire City of Cambridge in which the Estate sits. Since the University accounts for approximately 5% of the carbon dioxide emissions in cambridge, a 60% reduction in only the University emissions would produce a 5% x 60% = 3% reduction in overall emissions from the city.

Carbon Dioxide-Reducing Policies for The University of Cambridge

At present, the University consumes approximately 92,000,000 kWh of electricity per year and 80,000,000 kWh in gas. Heating accounts for 66% of this total (essentially entirely from gas); cooling and refrigeration for 2.3% (electricity); lighting for 15.6% (electricity); pumps and fans for 2% (electricity); and other (including IT) accounts for 14.1% (primarily electricity)

<u>Short-term strategies</u>

Heating: Insulate all water heaters and turn down the thermostats. This would result in a decrease in energy use of approximately 10% of that used to heat water. Since

heating of water represents approximately 14% of the overall energy use, this measure would result in a 1.4 % (10% x 14%) decrease in carbon dioxide emissions.

Lighting: Replace fluourescent lightbulbs with CFLs or T8s. If performed throughout the university, this would result in a 66% decrease in energy use for lighting. Since lighting accounts for 15.6% of overall energy use, this would produce a 66% x 15.6% = 10% decrease in energy use. *If the university were using the standard national mixture of electricity sources, the result would be a similar (10%) decrease in carbon dioxide emissions. However, with the university using a carbon-neutral supplier, there would be no reduction in carbon dioxide emissions under this strategy (since there are no emissions from the supplier).*

Lighting: Install light sensors in high-traffic areas. If performed throughout the university, this would result in a 30% decrease in energy use for lighting. Since lighting accounts for 15.6% of overall energy use, this would produce a 30% x 15.6% = 5% decrease in energy use. *If the university were using the standard national mixture of electricity sources, the result would be a similar (5%) decrease in carbon dioxide emissions. However, with the university using a carbon-neutral supplier, there would be no reduction in carbon dioxide emissions under this strategy (since there are no emissions from the supplier).*

Other (IT): Purchase energy efficient models of IT equipment, and software that programs computers for sleep mode. This could result in up to an 80% energy savings from IT equipment. If it is assumed that IT equipment represents 70% of the "other" category of energy use, since this category contributes 14.1% of overall energy use, this measure would produce a 70% x 80% x 14.1% = 8% decrease in energy use. If the university were using the standard national mixture of electricity sources, the result would be a similar (8%) decrease in carbon dioxide missions. However, with the university using a carbon-neutral supplier, there would be no reduction in carbon dioxide emissions under this strategy (since there are no emissions from the supplier).

Medium/long-term strategies

Heating: Install heat exchangers. These can reduce heating energy use by 12%. Since heating represents approximately 66% of the overall energy use, this measure would result in a 8% (12% x 66%) decrease in use of heating energy and carbon dioxide emissions.

Heating: Install solar water heaters. Up to 50% of energy for heating of water could be provided in this way. Since heating of water represents approximately 14% of the overall energy use, this measure would result in a 7% (50% x 14%) decrease in carbon dioxide emissions.

Cooling: Install high efficiency, high capacity cooling and refrigerant systems. These could reduce energy use for cooling by up to 40%. Since cooling and refrigeration represents approximately 2.3% of the overall energy use, this measure would result in a 1% (40% x 2.3%) decrease in use of heating energy and carbon dioxide emissions.

4D. Personal carbon emissions

There are a variety of measures individuals can take to reduce their own emissions of carbon dioxide, or your "carbon footprint". We list of few of the simpler ones here.

Easy, low cost solutions:

- *Bike or walk to work*
- *Reduce food miles - buy local products*
- *Use public transportation*
- *Reduce, reuse, recycle*
- *Reduce your consumption of energy and water*
- *Use reusable shopping bags*
- *Use energy efficient light bulbs*
- *Turn off and unplug stand-by appliances when not in use*
- *Turn off lights when you leave the room*
- *Change your electricity to a green energy tariff*
- *Buy products that use less packaging*
- *Vote for politicians that support carbon reduction policies*

Slightly more difficult, costly solutions:

- *Install insulation in your home and office*
- *Buy cars that get better gas mileage, or hybrid cars*
- *Install photovoltaic cells*
- *Install solar hot water panels*
- *Double glaze all windows*

The CRed programme has produced an internet-accessible software package (the Carbon Indicator) allowing you to determine the carbon dioxide emissions in your life, and to simulate the effect of changes you might make. This is useful in locating strategies that hold the greatest promise in reducing emissions. To see it, visit www.cred-uk.org:

4E. City Council

In order for the City Council to encourage policies in the rest of Cambridge, they must first serve as an example, reducing their own carbon emissions. This part of the report provides recommendations for instituting these reductions. Throughout, we have considered three reasons for introducing the changes: (1) some changes produce an immediate cost savings through modification of behaviour, with no initial cost; (2) some changes have an initial cost but produce savings in the long term, with a reasonable payback period (assumed here to be 3 years or less); and (3) some changes will increase overall costs, but are justified by the goal of City Council to take a leadership role. The following recommendations are in three parts: (A) potential changes in Council offices; (B) potential changes in Council housing stock; and (C) potential changes in Council transportation.

At present, the Council Estate (including offices, transportation and Council housing) is responsible for the emission of approximately 89,000 tonnes of carbon dioxide per year, which is 8% of the total for the City of Cambridge. This is divided between transportation associated with the Council fleet (1.2%); Guildhall (0.4%); other offices and structures (6%); and Council housing (92.4%). If Council housing is removed from these totals (based on the argument that these emissions should be counted within the Residential sector of the total city, rather than Council), the total emissions of carbon dioxide associated with the Council are 6588 tonnes per year (0.6% of the total from the City of Cambridge), divided between transportation associated with the Council fleet (15%); Guildhall (5%); and other offices and structures (85%). The total emissions rate per year from Guildhall and other offces and structures is approximately 5,600 tonnes per year, which is 0.5% of the total for the City of Cambridge.

Recommendations for Council Offices

The total energy consumption for Cambridge City Council structures, minus the Council Housing Stock, is ~18,248,635 kWh per year, costing a total of £576,083 (data taken from Carbon Trust Energy Management and Opportunities Assessment). The following policies are designed for the offices within City Council's control. In addition to reducing energy consumption (and, hence, reducing energy costs), the policies will reduce the amount of carbon dioxide released into the atmosphere. The policies are subdivided by energy use: heating, cooling, other (including IT equipment), lighting, and pumps & fans. In addition, we have subdivided the recommendations between Guildhall and all other Offices and Structures, based on the idea that Guildhall might become an example site for the proposed measures to reduce carbon dioxide emissions.

The recommendations are designed for the reader to pick and choose any combination of short term and medium/long term policies that best fit your needs. The carbon dioxide reductions from the medium/long-term measures are cumulative, including the reductions from the short-term measures.

One of the categories of energy use is catering. The percentage of energy allocated to catering, however, is very small. Because the suggested policies are focused on improving the areas of greatest energy consumption, no policies have been suggested for catering.

If all of the short term measures were implemented, this would yield a 30% reduction in Council office energy consumption and CO2 emissions. Since City Council offices represent approximately 80% of total emissions associated with City Council operations (having removed Council housing contributions), these policies would reduce overall carbon dioxide emissions associated with all aspects of City Council operations by 24% (80% x 30% = 24%).

<u>Office Portfolio A consists of:</u>

There are a number of low-cost, easy-to-implement methods that can be applied to Council offices in order to increase the energy efficiency and reduce carbon dioxide

emissions of each individual building. It is recommended here that these be applied to Guildhall first as demonstration projects, although the reductions below refer to bringing about these changes in the stock of office space.

1. Heating: This use accounts for approximately 66% of energy used in the Council offices, but due to the significantly lower carbon dioxide emissions per kWh from gas (0.00018 tonnes per kWh) versus electricity (0.00051 tonnes per kWh), heating accounts for 40% of Council carbon dioxide emissions.

- *Install an automated thermostat to regulate temperatures in the offices. Most offices currently have thermostats that must be manually changed. During off peak hours, or non working hours, the thermostat can be lowered, during winter, or raised, during summer, to account for the lack of people in the office. An automated thermostat will automatically raise/lower the thermostat to times set by an administrator. This is an energy efficient way to reduce the energy consumption because the thermostat is not constantly being changed during the office hours. This can reduce heating energy use by up to 10%, and so reduce overall carbon dioxide emissions by up to 4% (10% x 40% = 4%).*

- *Seal all gaps between window frames and walls. 10% to 30% of air leaks occur on the walls and windows. This is especially true of buildings such as Guildhall. This can reduce heating energy use by up to 5%, and so reduce overall carbon dioxide emissions by up to 2% (55% x 40% = 2%).*

- *Lower the thermostat on water heaters. For each 5.6 degrees C reduction in water temperature, water-heating energy consumption can be reduced 3% to 5%. Most manufacturers automatically set water heaters to 60 degrees Celsius. But if most of the hot water use is mixed with cold water, then 48.9 degrees C is satisfactory for most office needs. This can reduce heating energy use by up to 5%, and so reduce overall carbon dioxide emissions by up to 2% (5% x 40% = 2%).*

2. Cooling: This use accounts for approximately 2.3% of energy used in the Council offices, and for 4% of carbon dioxide emissions from Council offices.

- *Seal all gaps between window frames and walls. This is an easy and inexpensive way to insulate the office. In the summer, it reduces the amount of hot air entering the building, which reduces the amount of cooling needed. This can reduce cooling energy use by up to 15%, and so reduce overall carbon dioxide emissions by up to 0.6% (15% x 4% = 0.6%).*

3. Lighting: This use accounts for approximately 16% of energy used in the Council offices, and for 27% of carbon dioxide emissions from Council offices.

- *Replace lightbulbs with CFL's or T8s. CFL's or Compact Fluorescent Lighting consume 75-80% less electricity than regular light bulbs, and are replaced much less frequently- lasting up to 10 times as long than regular light bulbs. This can reduce lighting energy use by up to 60%, and so reduce overall carbon dioxide emissions by up to 16% (60% x 27% = 16%).*

4. Pumps and fans: This use accounts for approximately 2% of energy used in the Council offices, and for 3.4% of carbon dioxide emissions from Council offices.

- *Install Variable Speed controllers. Recent advances in microelectronics and control technology have resulted in the ability to use variable shaft speed controls on pumps and fans to manage the speed and flow throttling of the fluid load. Variable speed control technology can conserve energy by adjusting the velocity of flow, which minimizes the static pressure of the flow over the fluid loop. Thus, variable speed controllers typically reduce the compressor electrical use by 20% to 50%. This can reduce pump and fanenergy use by up to 50%, and so reduce overall carbon dioxide emissions by up to 1.7% (50% x 3.4% = 1.7%).*

5. Other (including IT): This use accounts for approximately 14% of energy used in the Council offices, and for 25% of carbon dioxide emissions from Council offices.

- *Turn off equipment during non-work hours rather than leaving it on or in standby. This can result in up to a 50% reduction in energy use, and hence carbon dioxide emissions, from this component if it applies to all equipment energy uses. It is more reasonable to assume that perhaps half of all such equipment already is being turned off in offices at night, and so this measure might produce a reduction in energy use by up to 25%, and so reduce overall carbon dioxide emissions by up to 6% (25% x 25% = 6%).*

- *Allocating specific responsibility for energy use (e.g. turning off lights, avoiding overheating/excessive cooling etc.) to designated individuals and offices. This achieved by training maintenance staff, having regular inspections of equipment, and educating all staff on energy-saving measures. Such a management scheme can reduce energy use overall by up to 5%.*

- *Sign up for and pay a renewable energy tariff. Using renewable energy is another way that carbon dioxide emissions can be cut. Renewable energy is generated by methods that do not release carbon dioxide (such as wind energy orhydroelectricity), or that re-absorb any carbon dioxide that is released (such as biomass). The energy provided by this tariff can contain varying percentages of renewable energy above that conventionally generated through the burning of fossil fuels. This percentage ranges from 10% to 100% (so check the details carefully when you consider a plan). There are also tariffs that put money towards a renewables or eco funds in addition to paying for the provided renewable energy. Further information on renewable providers available in Cambridge and the options they provide can be found at www.uswitch.com. By such a measure, the University of Cambridge reduced their carbon dioxide emissions by 60%, and was able to negotiate a deal with the provider to gain this energy at no cost above the national rate. City Council should explore such a deal with providers. Initially, it is recommended that City Council adopt a 10% renewables plan with the distributor. With a 10% renewables mixture, carbon dioxide emissions would be reduced in the offices by 33% (the percentage of energy from electricity) x 10% (the reduction in emissions per kWh, for an overall reduction of 3.3%.*

If all of the medium/long term measures were implemented, this would yield an additional 20% reduction in Council offices energy consumption and CO2 emissions, for a total (short plus medium/long-term) of 50%. Since City Council offices represent approximately 80% of total emissions associated with City Council operations (having removed Council housing contributions), these policies would reduce overall carbon dioxide emissions associated with all aspects of City Council operations by 40% (80% x 50% = 40%).

Office Portfolio B consists of:

There are a number of methods that involve greater expense than the short-term methods of Office Portfolio A, and hence require a longer implementation period matched to the cycle of larger capital investments and the Repair and Replacement budget process.

1. Heating: This use accounts for approximately 66% of energy used in the Council offices, but due to the significantly lower carbon dioxide emissions per kWh from gas (0.00018 tonnes per kWh) versus electricity (0.00051 tonnes per kWh), heating accounts for 40% of Council carbon dioxide emissions.

- *Replace old boilers with modern, efficient, ones. This is particularly the case in Guildhall, where the boiler efficiency could be improved by up to 25%. This can reduce heating energy use by up to 20%, and so reduce overall carbon dioxide emissions by up to 8% (20% x 40% = 8%).*

2. Cooling: This use accounts for approximately 2.3% of energy used in the Council offices, and for 4% of carbon dioxide emissions from Council offices.

- *Replace existing air conditioning systems (in those offices that are air conditioned- primarily Mandela House and some Community Centre space) with modern, efficient, ones. This can improve efficiency by up to 15%, reducing cooling energy use by up to 15% (again, in those offices that are air conditioned), and so reduce overall carbon dioxide emissions by up to 0.6% (15% x 4% = 0.6%) for such spaces.*

3. Other (including IT): This use accounts for approximately 14% of energy used in the Council offices, and for 25% of carbon dioxide emissions from Council offices.

- *Replace all IT equipment, copiers and printers with newer, more energy efficient models, using the Repair and Replacement cycle. The efficiency of the newest models, particularly computers with flat screens, can be 25% higher than older models. This can reduce overall carbon dioxide emissions by up to 6% (25% x 25% = 6%).*

- *Install an automated energy monitoring system in all buildings so as to better pinpoint areas of improvement. This might be accompanied by a budgeting change in which specific offices of the Council were responsible for the energy use in those offices. Such systems can reduce overall energy use in offices by up to 5%, and so reduce overall carbon dioxide emissions by up to 5%.*

Recommendations for Council Housing Stock

Most of the carbon dioxide emissions from the UK are produced as a by-product of energy production. Therefore, the easiest way to decrease carbon dioxide emissions is to increase energy efficiency and to change energy production from fossil fuels and other carbon releasing fuels to renewables or non-carbon releasing sources.

Dwellings currently consume about 30 percent of the total energy used in the U.K. Of the energy that the average home consumes each year, more than 60% is used for space heating and another 23% is used for waterheating and water consumption (see Figure 1). These, then, are the areas of domestic energy consumption that must be targeted to reduce overall energy use per dwelling.

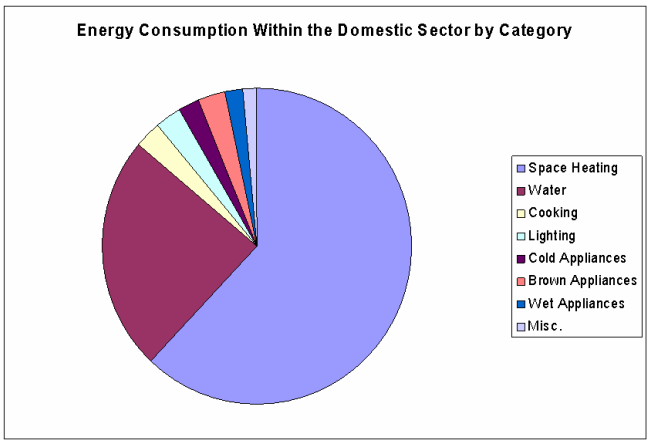


Figure 1: Energy Consumption within the Domestic Sector by Use

The housing stock owned by the City Council currently uses about 23611 kWh/yr per dwelling. The dwellings in Cambridge as a whole currently use 25332 kWh/yr per dwelling. Therefore, City Council housing currently meets or exceeds the standard set by the rest of the residences in Cambridge. We can also compare the energy consumption for Council housing and Cambridge City housing to the national average for energy consumption in a dwelling, which is about 33724 kWh/yr per dwelling. It is clear from these figures and the graphic below (see Figure 2) that the City Council housing stock releases less CO2 per annum per household than the average home in the UK.

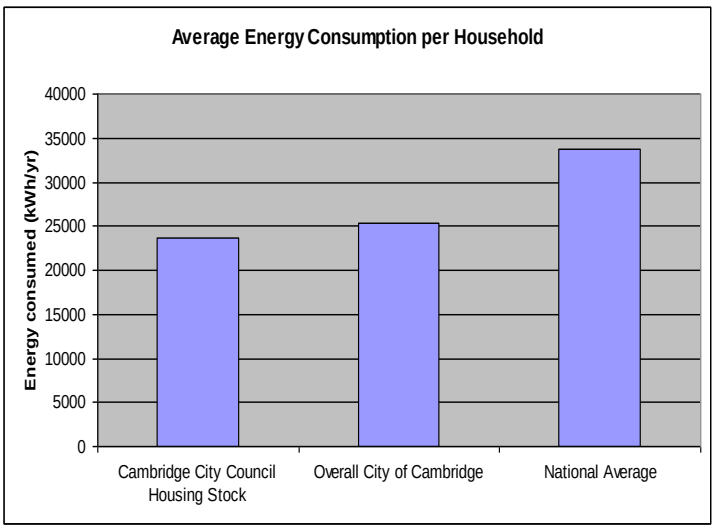


Figure 2: Energy Consumption per Council Stock Household

There are, however, measures that can be implemented that will further increase the energy efficiency of the housing stock. The changes that could be implemented are divided below into two main categories: short term goals (Portfolio A), and medium or longer term goals (Portfolio B). If all of the short term measures were implemented, this would yield a 10% reduction in Council housing stock energy consumption and CO2 emissions.

Housing Portfolio A consists of:

1. Improving efficiency. There are a number of low-cost, easy-to-implement methods that can be applied to Council housing stock in order to increase the energy efficiency and reduce carbon dioxide emissions of each individual dwelling.

- Develop up-to-data data on energy use in homes, and associated software. Currently, one of City Council's most pressing needs for its housing stock is up-to-date information on the current state of the dwellings. The data concerning which houses contain efficiency-increasing measures, such as loft or cavity insulation, needs to be updated. Further, the software that then converts this information to a SAP (Standard Assessment Procedure) and subsequently to carbon dioxide emissions is out-of-date. Better information will help the council to know where within their stock to make changes and which changes would be most effective in reducing carbon dioxide emissions. This strategy does not directly reduce carbon dioxide emissions, but will help the Council target opportunities for emissions reductions.

- Add loft and cavity wall insulation to those homes that do not currently have them. Just making these changes will save 6% of energy consumed by the housing stock, with a similar decrease in carbon dioxide emissions.

- Ensure that 20% of windows in all homes are double-glazed. Rooms that use the most energy for heating should be selected, as these are the rooms that lose the most heat. This change alone can decrease total energy consumption of the housing stock by 5%, assuming heating accounts for approximately 60% of the energy use, 20% of the windows are replaced, and total replacement results in a 15% decrease in energy use (so 60% x 20% x 15% = 2%). Note that this reduction would be 10% if ALL windows were replaced in the housing stock.

- Insulate hot water tanks and pipes. This can reduce the energy used for water heating within a home by 16%. If implemented in full, this measure would reduce the energy consumption of the housing stock by 2.4%, assuming water heating

accounts for approximately 23% of total home energy use and total insulation results in a 16% decrease in energy use for this activity (so 23% x 16% = 4.2%).

- Install 2 more energy efficient light bulbs in each home. This measure seems a small and insignificant one, as it can only reduce the energy consumption of the housing stock by 0.1%. However, it can help to make energy conservation a part of residents' thoughts. It is symbolic in this respect.

All of these changes implemented together will decrease the total energy consumption, and carbon dioxide emissions, of the housing stock by 10 to 12%.

2. Steps Beyond Energy Efficiency

It is clear that a 60% reduction in carbon dioxide emissions cannot be achieved through short-term energy efficiency methods alone. Energy must also be conserved during everyday consumption. Simple strategies for reducing your energy demand are:

- Turn off lights when leaving the room
- Turn appliances to "off" rather than standby
- Turn off the water faucet for activities such as brushing the teeth
- Wash full loads of laundry
- Put on a jumper rather than turning the heat on or up when possible

Council can help the residents of its housing stock to implement some of these personal practices by encouraging residents to make a personal CRed pledge and by continuing to distribute information from its Environmental Centre. Council could further publicize by perhaps holding events for its residents that would include education on personal energy consumption. It might also be possible to offer an award for the house within the housing stock having the lowest carbon dioxide emissions.

It is also council's responsibility to advertise its successes to the community, and to encourage the rest of Cambridge's residential community to implement carbon-reducing methods of their own.

Using renewable energy is another way that carbon dioxide emissions can be cut. Any large-scale implementation of such technologies would certainly be a long-term goal. The council can, however, begin creating a few high-profile pilot projects that would showcase carbon-saving technologies, such as solar water heaters, etc.

If all of the medium/long term measures were implemented, this would yield a 40% to 80% reduction in Council housing stock energy consumption and CO2 emissions.

Housing Portfolio B consists of:

1. Existing housing: The goals and methods included here are ones that are higher-cost and so present a challenge to implementation. Money saved from the energy-saving methods mentioned in Portfolio A could be added to the existing Repair and Replacement Fund or some new Low Carbon Technologies Fund and allowed to

accrue and eventually pay for some of these longer term measures. This would make these medium/long-term strategies more feasible for the council. It is essential that money saved through energy-saving measures be cycled back into paying for new energy-saving measures.

Some of the long-term, higher cost measures might include:

- *Provide external insulation to homes with solid walls rather than cavity walls, which number about 1500 of the council's 7758 units. These homes still lose heat through their walls, and insulation would reduce that loss. The insulation, however, requires a significant alteration in the dwellings' current facades and therefore a greater cost. This change can decrease total energy consumption of the housing stock by 9%, assuming heating accounts for approximately 60% of the energy use and total insulation results in a 15% decrease in energy use for heating (so 60% x 15% = 9%).*

- *Replace old boilers with new, more energy efficient ones at the end of the boilers' lifetime. This can increase heating efficiency by more than 20% per home. This change can decrease total energy consumption of the housing stock by 12%, assuming heating accounts for approximately 60% of the energy use and total replacement results in a 20% decrease in energy use for heating(so 60% x 20% = 12%).*

- *Replace other appliances with more efficient ones at the end of their lifetimes. These appliances include refrigerators, fridge-freezers, freezers and washing machines. For example, a new refrigerator (2005) can be up to 20% more efficient than an old one (1990), and a new fridge-freezer (2005) can be up to 35% more efficient than an old one (1990). This change alone can decrease total energy consumption of the housing stock by 3%, assuming appliances account for approximately 15% of the total energy use in a home and total replacementresults in a 20% decrease in energy use by appliances (so 15% x 20% = 3%).*

- *Replace all light bulbs with energy efficient ones. Assuming that 20% of light bulbs were energy efficient (from the short term goals), the energy savings would be 1.6% of total housing stock energy consumption.*

- *Implement or require a renewable energy tariff. The renewable energy provided can come from a number of different sources with varying percentages of renewable energy. There are also tariffs that put money towards a renewables fund in addition to paying for renewable energy. The percentage of electricity coming from renewables in "Green Energy" options ranges from 10% to 100%; it is probably not feasible to have all homes buy 100% renewable (there is insufficient supply in England to allow this), but a long-term goal of 30% is achievable. This would reduce carbon dioxide emissions by approximately 6%, assuming approximately 20% of energy use in the home is from electricity and 30% of this electricity were supplied by carbon-neutral sources (20% x 30% = 6%).*

- *Purchase microgenerators. These are devices attached to dwellings that generate energy for that dwelling alone. Further information on grants available from the government for small-scale renewable energy generation can be found at www.clear-skies.org. Microgenerators include: (i) Photovoltaic (PV) panels, which can provide anywhere from 5% to 50% of a home's total energy. This percentage depends, of course, on the number of panels included, their individual efficiency, and the solar insolation available to them. 50% is a best estimate for the upper range of possible energy provided in the UK. Government grant information can be found at www.est.co.uk/solar. (ii) Microturbines, which can be attached to the top of a single dwelling and generate up to 100% of a home's total energy. This once again depends upon the efficiency of the turbine and the wind energy available to it. Turbines often are subject to oppostion as being unaesthetic, so their social acceptability must be taken into account. Perhaps it would be possible to partner up with a design team that is a group of students or residents to help design aesthetically pleasing turbines. (iii) Solar Water heaters, which can generate up to 50% of a home's hot water.*

In publicizing the implementation of measures that increase heating efficiency, it is essential that the council continue to provide information on grant programs such as the Warm Front and the Heating Project.

If all of the measures described above were introduced to each dwelling in the Council housing stock, including the short-term measures in Portfolio A, there would be a subsequent 42% (with no microgenerators) to at least 80% (with microgenerators for heating-related energy uses) reduction in carbon dioxide emissions from that sector.

2. New housing: In addition to making long-term goals for existing dwellings, Cambridge also has the challenge of planning for nearly 16000 new dwellings. Some of these houses will become part of the Council Estate, and so must be considered in the directly implemented plans by the City Council. Even no-Council housing will be influenced both by permitting requirements, and by the examples set in Council housing. As a result, the City Council should consider how it will stimulate and encourage the use of carbon-reducing strategies in all new homes. In doing so, the city must work closely with developers to ensure that the new dwellings utilize the best available technologies and practices. BREEAM is an excellent resource in planning for low-carbon building; its website can be found at www.breeam.org. BREEAM includes building practices that are eco-friendly beyond just carbon reduction, though this is included.

Practices should include:

- *Including passive solar elements beginning in the design process. These elements are expensive to add to existing dwellings, but can be incorporated into new dwellings*
  relatively easily and inexpensively and save up to 20% of heating bills.

- *Using local building materials to reduce the carbon-dioxide releases associated with their transport.*

Recommendations for City Transportation

Current transportation-related carbon dioxide emissions attributed to the Cambridge City Council are from (i) employee commutes to work and (ii) emissions from the City Council fleet. Employee commuting to work contributes 291 tonnes of CO2 per year, and the city fleet contributes 729 tonnes of CO2 per year, for a total of 1020 tonnes per year. Two proposals are made here to reduce the amount of CO2 emitted by the City Council transportation sector. Within each proposal there are several plans that can contribute to the carbon dioxide reduction.

Portfolio A decreases the number of employees who drive to work alone through increasing the number of City Council commuters who cycle and car share to work. If introduced, these policies would reduce carbon dioxide emissions from the transportation associated with City Council employee commuting by 57%. Since City Council employee commuting represents approximately 30% of total transportation associated with City Council operations (the rest being from the Council fleet), these policies would reduce overall carbon dioxide emissions associated with all aspects of City Council transportation by 15% (30% x 57% = 17%). And since transportation represents 15% of overall City Council emissions (having removed Council housing contributions), these policies would reduce overall carbon dioxide emissions associated with all aspects of City Council operations by 2.6% (15% x 17% = 2.6%)

Transportation Portfolio A consists of:

1. Decrease number of council employees who drive to work alone. Currently a large proportion of employees working at city council drive to work alone, which is the commuting method that emits the most carbon dioxide per person. It is especially notable that 45% of employees drive alone and that only 17% of employees travel to work by bicycle. As a result, City Council employees emit more CO2 per person per year from commuting than is the case on average for the City of Cambridge. This clearly is an area in which City Council must improve to take a leadership role in the City.

Current Commuting Methods for City Council:

- 45% Drive alone
- 17% Cycle
- 11% Bus
- 9% Car share
- 9% Walk
- 5% Train
- 2.5% Motorcycle

The percentages of employees traveling to work by the above methods are taken from survey information received from Sally Pidgeon, the Environment Co-ordinator for the City of Cambridge. In order to estimate CO2 emissions, the average commuting distance for each person in the UK was used. The average worker in the UK travels 1268 miles while commuting to and from work per year (Department for Transport,

Transport Statistic Bulletin, National Travel Survey: 2003 Final Results). There were no data available about the average commuting distances of Cambridge citizens or City Council employees. Employees of Cambridge City Council may travel slightly more or less on average. The number of employees used in all calculations was 1200, which was taken from the Carbon Trust Energy Management Document.

2. Increase percentage of City Council employees who bike to work to 28%

Surveys done by the RAC Foundation have shown that 28% of citizens in Cambridge bike to work compared to only 4% of citizens in Great Britain. This indicates that a smaller percentage of employees at City Council bike to work (17%) when compared to the rest of the workforce in Cambridge (28%). In order to be a leader in the community, the City Council and its employees should match or exceed the measures that residents of Cambridge are taking to reduce carbon dioxide.

3. Increase percentage of City Council employees who bike to work to 43%

A survey provided by Martin Whiteland from the Cambridge University Environmental Office indicates that 43% of employees who work for Cambridge University cycle to work. Using the commuting habits of Cambridge University employees as a benchmark, a possible goal is to increase the percent of City Council employees who cycle to work from 17% to 43%. The following graph shows the current CO2 emissions from City Council employee commuting, and the predicted CO2 with an increase in cycling from 17% to 43%. This change would result in a decrease of 133.75 tonnes of CO2 per year.

4. Double the percentage of City Council employees who Car Share

It is understood that the employees of Cambridge City Council have needs that must be met and limitations in reducing their dependence on personal cars. The high costs of living in Cambridge make it appealing to live in nearby villages, which may make it difficult to walk or bike to work. Car sharing is an alternative to biking or walking that can reduce carbon dioxide emissions and save employees money as the cost of petrol continues to rise. An increase in car sharing from 9% to 18% of the total number of employees would result in a decrease of 23.15 tonnes of CO2 per year.

5. Total Reductions for Transportation Portfolio A

Each of the transportation plans can be implemented to create a change in the amount of CO2 released from employee commuting. The combined reduction of increasing the percent of employees biking from 17% to 43% and increasing the number who car share from 9% to 18% will decrease carbon dioxide emissions from employee commuting by 57 %, almost meeting the long term 60% reduction goal.

Portfolio B continues buying Liquefied Petroleum Gas (LPG) vehicles for the city fleet and contains a pilot biodiesel program for current diesel vehicles in the fleet. If introduced, these policies would reduce carbon dioxide emissions from the transportation associated with Council fleet by between 47% and 57%%. Since Council fleet represents approximately 70% of total transportation associated with

City Council operations (the rest being from the Council employees commuting), these policies would reduce overall carbon dioxide emissions associated with all aspects of City Council transportation by between 33% (70% x 47% = 33%) and 40% (70% x 57% = 40%). And since transportation represents 15% of overall City Council emissions (having removed Council housing contributions), these policies would reduce overall carbon dioxide emissions asociated with all aspects of City Council operations by between 5% (15% x 33% = 5%) and % (15% x 40% = 6%).

Transportation Portfolio B consists of:

1. Continue buying liquefied petroleum gas (LPG) vehicles and consider biodiesel for the city fleet. The Cambridge City Council's fleet manager, David Cox, supplied the data used for the calculations of carbon dioxide emissions from the city's fleet of 146 vehicles. This includes 72 LPG vehicles, 71 diesel vehicles, and 3 petrol vehicles.

2. Continue to find suppliers of Liquefied Petroleum Gas (LPG) vehicles. Mr. Cox expressed concerns that ordering LPG vehicles was less desirable than regular diesel vehicles due to the time required for delivery. In some cases, LPG vehicles take up to nine months to be delivered compared to a 6 week delivery time for regular diesel vehicles. *Therefore, effort must be directed towards finding additional suppliers of LPG vehicles to reduce the delivery time, or extending the planning horizon for purchases of new vehicles***.** The efforts of the Cambridge City Council to convert and buy LPG vehicles should be supported, since these vehicles currently reduce the city fleet's emissions of carbon dioxide by 351 tonnes of CO2 per year, out of a total of approximately 727 tonnes per year from City vehicles and 1022 tonnes per year from City vehiclesplus the vehicles City employees drive to and from work.

The following graph illustrates the current carbon dioxide savings of the City of Cambridge fleet in tonnes of CO2 per year due to the current number of LPG vehicles.

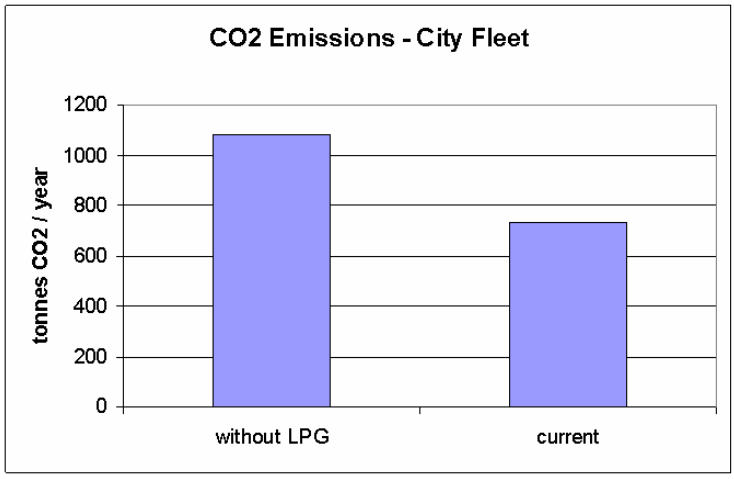


Figure 1. CO2 Emissions—City Fleet with and without LPG

Without the use of the city's LPG vehicles, those 351 tonnes of CO2 would significantly increase the current emissions of the city fleet. *Therefore, effort must be made to retain the LPG features of the current fleet, and to replace some of the rest of the fleet with LPG vehicles where feasible.* If all vehicles were moved to LGP, this would result in a 47% decrease in emissions associated with the Council fleet.

3. Implement a pilot biodiesel project

Biodiesel is fuel produced from the oil of crops including rapeseed, sunflower, and soybean oil or from waste cooking oils. These oils are processed and then reacted with methanol to produce methyl esters - rape methyl ester, or RME is most common in the UK (unprocessed oils can result in problems with engine performance, and so are not recommended). Biodiesel is typically sold as a blend of 5% biodiesel and 95% ultra low sulphur diesel that conforms to the current diesel specification, EN 590. This 5% blend is called B5. B20 is also a popular blend of biodiesel, with 20% biodiesel and 80% low sulphur diesel. When purchasing biodiesel one should check that the biodiesel purchased conforms to the recognised quality standard for diesel fuels.

B5 = a biodiesel mix containing 5% natural oil and 95% diesel fuel
B20 = a biodiesel mix containing 20% natural oil and 80% diesel fuel
B100 = a biodiesel fuel containing 100% natural oil

Biodiesel also contributes to an engine's lubrication, or its ease of movement, resulting in increased engine life. It is estimated that a biodiesel blend of just 1% could increase lubrication by as much as 65% (U.S. Dept. of Energy Office of Transportation Technology). There is no sulfur in pure biodiesel, thereby reducing sulfur dioxide air pollution. Studies also show that biodiesel reduces the fine particles emitted from diesel vehicles. A reduction in particle emissions can help to improve local air quality and reduce health impacts. Biodiesel is highly biodegradable and therefore does not accumulate in and pollute soil and waterways.

The rapeseed and other plants that are used to produce oils for biodiesel draw CO2 from the atmosphere in the process of building stems, leaves, seeds, and roots. Burning biodiesel in a vehicle returns the carbon from the fuel to the atmosphere as carbon dioxide. Vehicles using regular diesel and biodiesel both emit carbon dioxide. However, the carbon from CO2 released when burning biodiesel is recycled back into the growing plants (at least in part), preventing accumulation in the atmosphere. Approximately 78% of the carbon is re-cycled in this way, meaning that B100 reduces life-cycle carbon dioxide emissions by 78% compared to petroleum diesel. There is not a 100% reduction in CO2 emissions because it is necessary to take into account the carbon dioxide from petroleum fuels used for fertilizer, farm equipment, or transportation used in biodiesel production.

Levels of nitrogen oxide emissions may be higher using biodiesel than when using ultra low sulphur diesel. Cambridge is officially an Air Quality Management Area due to nitrogen dioxide levels exceeding, or anticipated to exceed, government limits at certain locations. Therefore, the switch to biodiesel would need to be assessed by the air office of the City Council.
Biodiesel also is less readily available than regular diesel. However, biodiesel with a 5% mix is currently available at petrol stations across the UK.Some older diesel vehicles (such as cars made before 1992) may experience clogging with higher concentrations of biodiesel, especially in cold months. Because of its ability to loosen deposits built up in the engine, use of biodiesel can cause the fuel filter to become jammed if the fuilter is not cleaned regularly

The EU Biofuels Directive was agreed in May 2003 and requires member states to take action to promote the use of biofuels and other renewable fuels in the transport sector. This Directive has set targets of 2 per cent of road fuels to be biofuel by 2005, and 5.75 per cent by 2010. The UK government has also introduced a 20 pence per litre duty reduction on biodiesel, which took effect in July 2002.

A pilot program could begin by using B5 in 10 diesel vehicles. Although this step would not make large changes in the amount of carbon dioxide released by the City fleet, this fuel is priced similarly to regular diesel fuel and is most readily available. This step could allow the fleet personnel to become familiar with the change, to assess vehicle performance, and to make plans for future, more significant, increases in use. These ten vehicles could then begin using a 20% mix of biodiesel and increase degree of CO2 reduction. However, more vehicles would have to begin using biodiesel in order to make a significant reduction in carbon dioxide. Also, a pilot program at Banham Poultry in partnership with CRed found that driver training (on driving habits that contribute to fuel efficiency) also had large influences on carbon dioxide reduction. This trial period could also be used to assess other carbon reducing methods.The trial period using only ten vehicles would not produce significant reductions in carbon dioxide (see Figure 2 below), resulting in only a 0.5% decrease in emissions.

However, an eventual switch to B20 in these 10 vehicles would produce a 1.5% decrease in CO2 emissions from the City fleet. Switching of the entire fleet of 71 diesel vehicles to B20 would result in a 14% decrease in CO2 emissions from the City fleet (NOTE: It is not possible to do both this AND switch these vehicles to LPG as in a proposal at the top of this page- one or the other can be done). Switching of the entire fleet of 71 diesel vehicles to B100 would result in a 57% decrease in CO2 emissions from the City fleet (NOTE: It is not possible to do both this AND switch these vehicles to LPG as in a proposal at the top of this page- one or the other can be done). Figure 3 shows the decrease in carbon dioxide emissions when using different blends of biodiesel in all 71 diesel vehicles in the fleet.

	CO2 Emissions (tonnes/yr)	**CO2 Savings (tonnes/yr)**
Current	729.27	
B5 (5% mix of biodiesel)	725.54	3.73
B20 (20% mix of biodiesel)	718.08	11.19

Figure 2. CO2 Emissions and Savings from 10 Biodiesel Vehicles

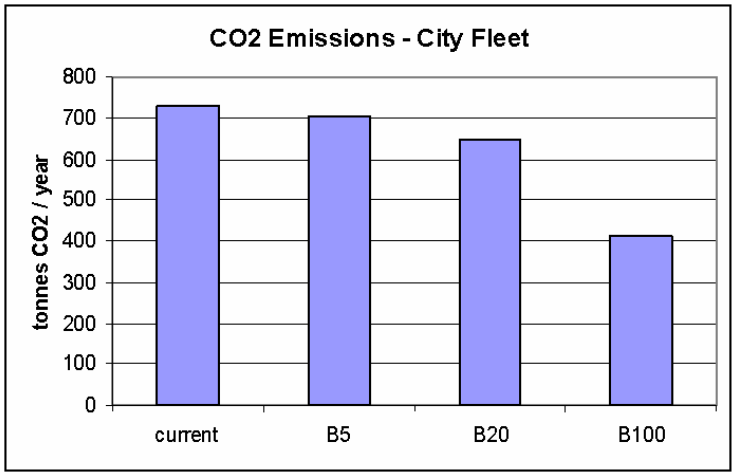


Figure 3. CO2 Emissions using Different Biodiesel Blends

4. Total Reduction from Transportation Portfolio B

The reduction of carbon dioxide emissions depends the mixture of proposals above adopted. Moving the entire fleet to LPG would produce a 47% reduction in the Council fleet emissions. Moving 10 diesel vehicles to B20 would produce a 1.5% decrease. Moving all diesel vehicles to B20 would produce a 14% decrease. Moving all vehicles to B100 would produce a 57% decrease.

5. A survey of citizen views in Cambridge

We conducted a survey on 27 July, 2005 around the market in Cambridge to determine how interested citizens are in carbon dioxide reduction and global climate change, how knowledgable they consider themselves on the subject, how willing they are to implement certain carbon-reducing measures in their lives, and how much they would be willing to pay for those measures to reduce carbon dioxide.

Some key findings are:

- *89% said they were moderately or extremely concerned about climate change*
- *87% said they were moderately or extremely convinced that reducing carbon dioxide emissions is essential in preventing climate change*
- *60% said that reductions must be driven by individuals, government and industry working together*
- *91% said they were moderately or extremely interested in reducing energy use and carbon dioxide emissions in their homes*
- *50% said they would need a reduction in Council Tax of 5% or more to stimulate their switching to energy efficient measures in the home*
- *23% said it would be difficult to reduce their use of the car*

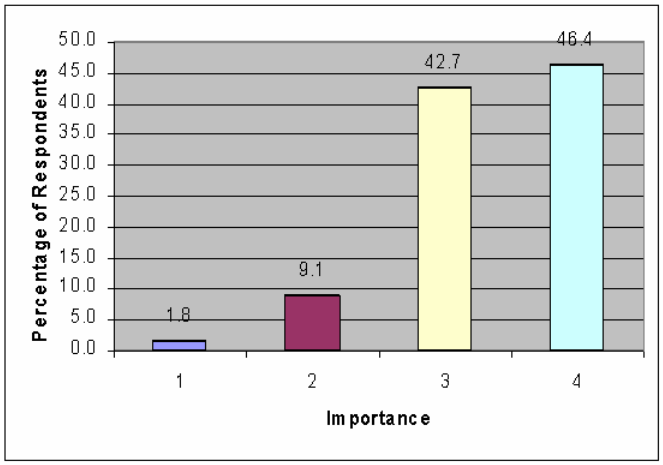
- *74% said that access to free information on carbon reducing measures would stimulate their use of such measures*
- *58% of people who do not use a bike as a primary means of getting to town said this was due to lack of appropriate paths*
- *37% of people said they would be willing to accept monthly energy bill increases of 10 pounds if the energy source were renewable*

Conclusions to be drawn are:

- Many people seem to have difficulty with existing bus routes
- About 1/3 would increase their electricity bill by 5 pounds if it was guaranteed that the money would go to renewable fuels
- Many people have already installed insulation, double glazing, and low energy light bulbs and wear a jumper and try to reduce heat in their homes, as well as ride a bike or walk primarily to get around
- Almost ½ of those surveyed would alter the exterior of their homes to reduce their carbon dioxide emissions
- Those who use their cars more than walking or biking seem to need to do so and aren't too willing to change
- Those who wouldn't decrease heating during the winter usually were elderly people or had very young children
- The majority of those surveyed (81.8%) would pay 500-2,000 pounds for a one-time cost of implementing carbon dioxide reducing technologies in their homes
- 60% said we are all equally responsible for cutting carbon emissions, but 25% (quite a large chunk) said it is only the government's responsibility
- Most people are very interested in decreasing carbon emissions on an individual and global level to help curb carbon dioxide emissions

Results for the individual questions are provided below:

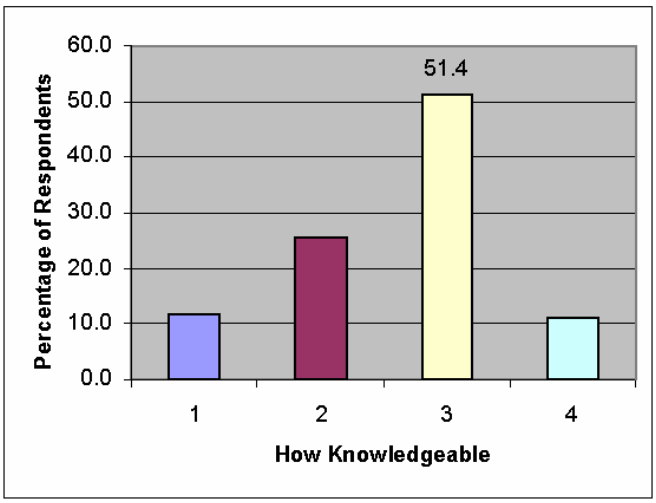
1. Considering everything you care about in life, how important to you is reducing carbon dioxide to help curb global climate change?



1. Not at all
2. Slightly
3. Moderately
4. Extremely

(Out of 110 respondents)

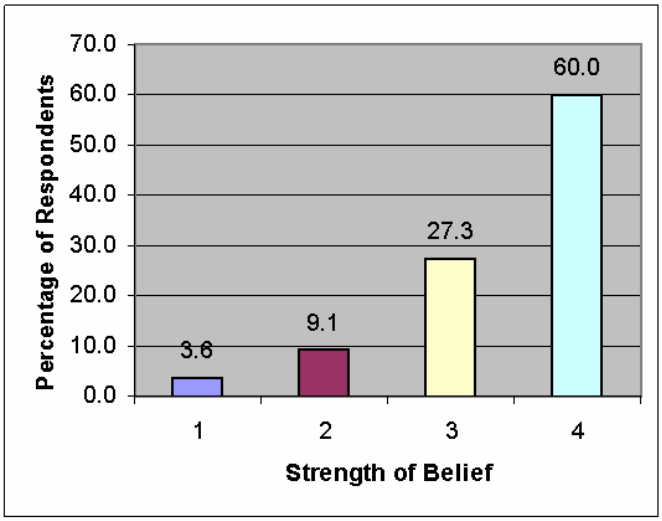
2. How knowledgeable do you consider yourself on the topic of carbon dioxide and global climate change?



1. Not at all
2. Slightly
3. Moderately
4. Extremely

(Out of 109 respondents)

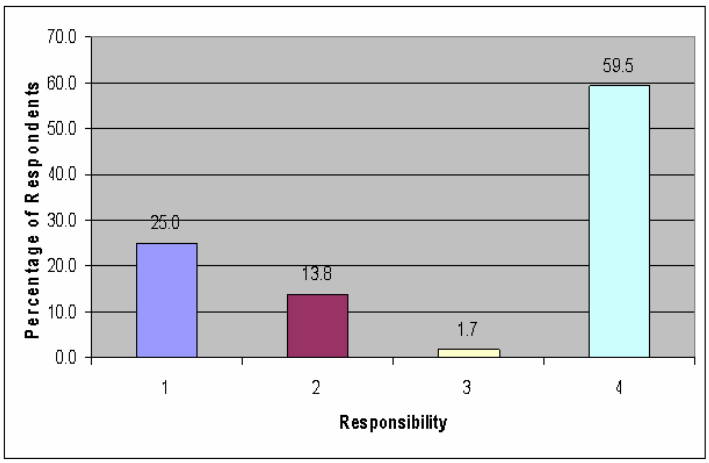
3. How strongly do you believe that reducing emissions of carbon dioxide from society is essential in preventing significant climate change?



1. Not at all
2. Slightly
3. Moderately
4. Extremely

(Out of 110 respondents)

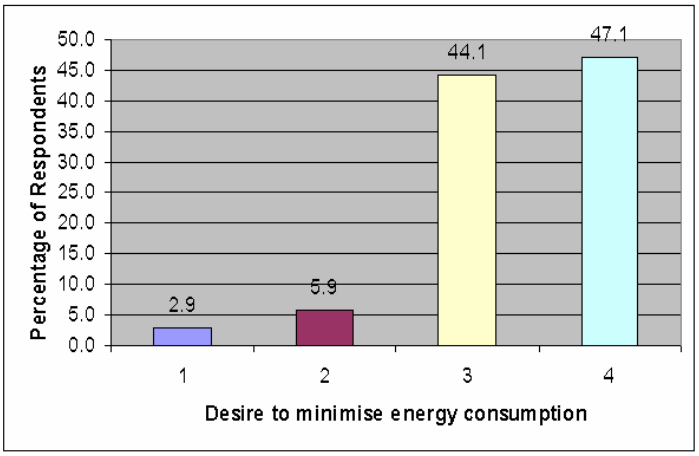
4. Who has primary responsibility for reducing emissions of carbon dioxide from society?



1. Government
2. Business/ Industry
3. Individuals
4. All of these equally

(Out of 116 respondents)

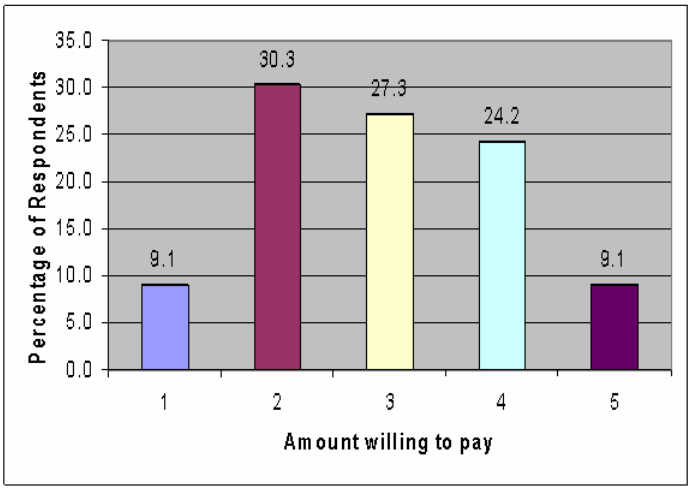
5. How interested are you in minimising energy consumption and carbon emissions in your own home?



1. Not at all
2. Slightly
3. Moderately
4. Extremely

(Out of 34 respondents)

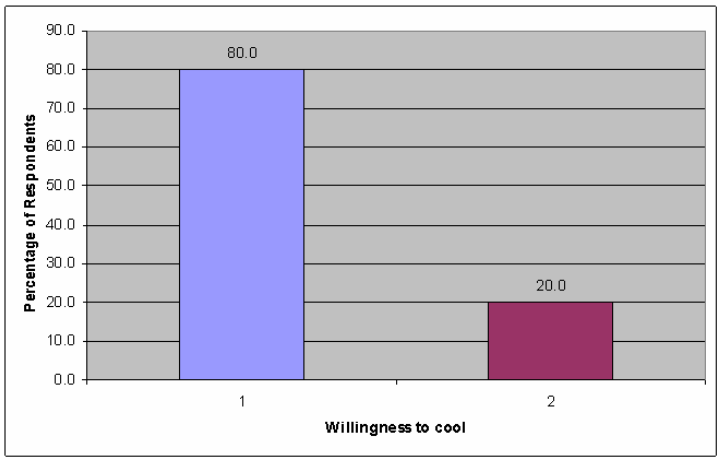
6. How much would you be willing to pay as a one-time cost to place energy-saving devices in your home?



1. Nothing
2. Up to 500 pounds
3. Up to 1,000 pounds
4. Up to 2,000 pounds
5. More than 2,000 pounds

(Out of 33 respondents)

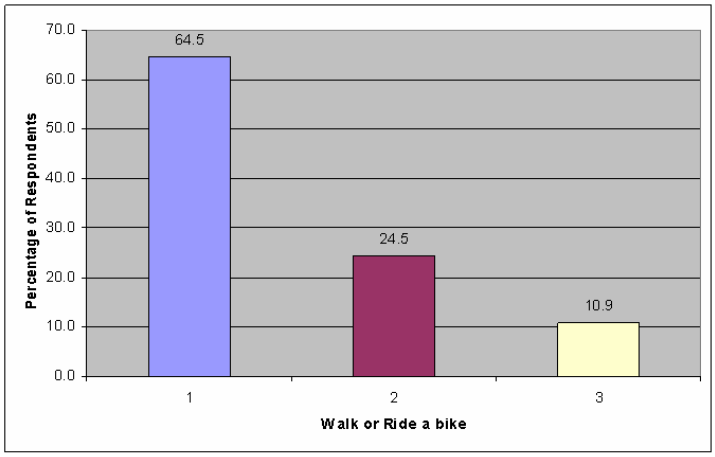
7. Would you be willing to let your home get cooler in the winter to cut energy costs and reduce carbon dioxide emissions (keep in mind you could put on more clothing)?



1. Yes
2. No

(Out of 35 respondents)

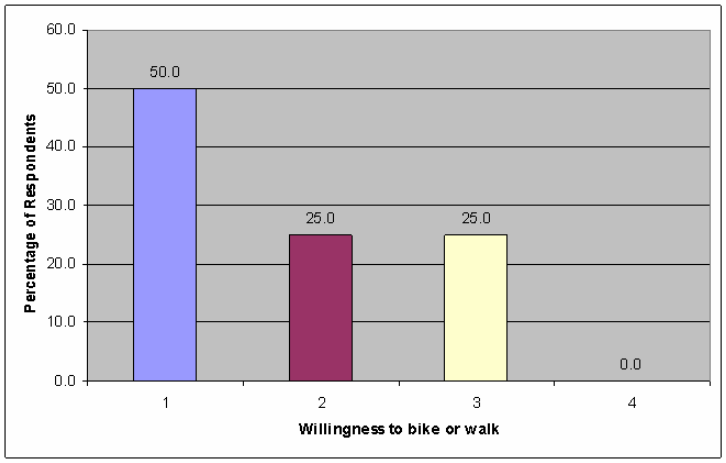
8. Do you currently walk or ride a bike as your primary way to get to work or to conduct chores?



1. Yes
2. No
3. Both

(Out of 110 respondents)

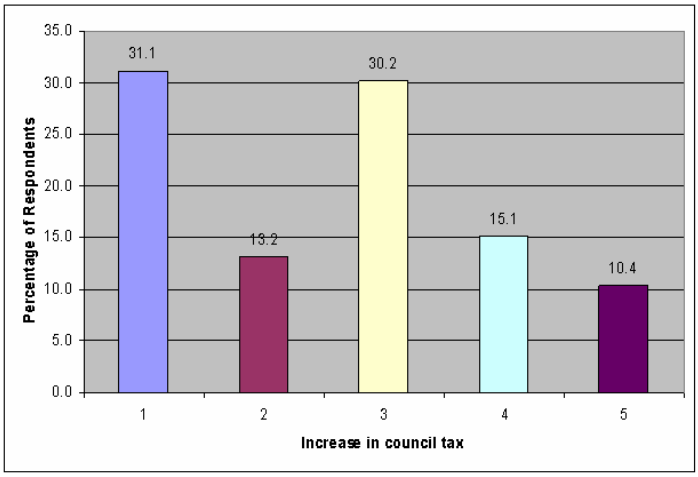
9. If you do not walk or ride a bike as your primary way to get to work or conduct chores, how willing would you be to start doing so in order to reduce carbon dioxide emissions?



1. Not at all
2. Slightly
3. Moderately
4. Extremely

(Out of 4 respondents)

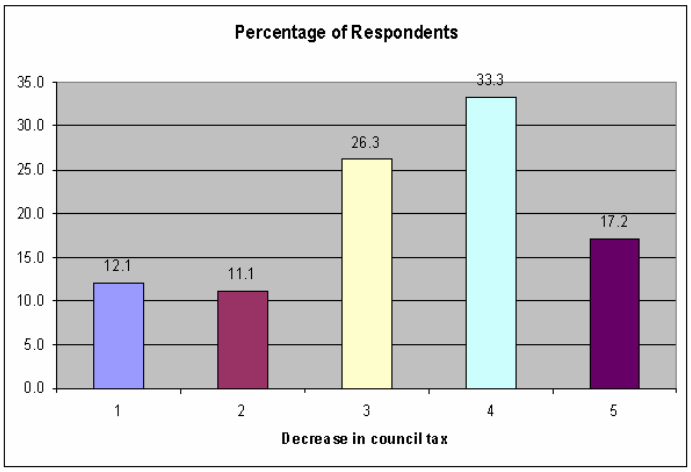
10. How much of an increase in council tax would you accept if it meant an improved ability of Council to implement policies that reduce carbon dioxide emissions in Cambridge?



1. Nothing
2. Up to 1%
3. Up to 5%
4. Up to 10%
5. More than 10%

(Out of 106 respondents)

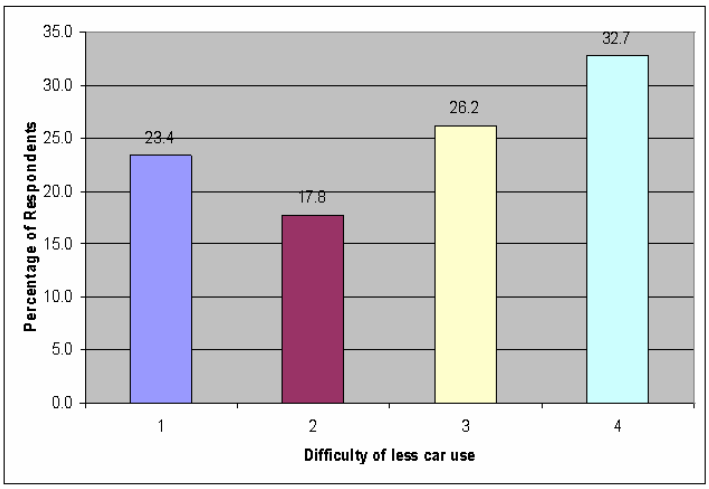
11. Rather than paying a higher council tax, suppose the Council would give you a reduction in tax to encourage you to adopt measures in your home or transport that reduce carbon dioxide emissions. By how much would they need to decrease your council tax to get you to make these changes?



1. Nothing
2. Up to 1%
3. Up to 5%
4. Up to 10%
5. More than 10%

(Out of 99 respondents)

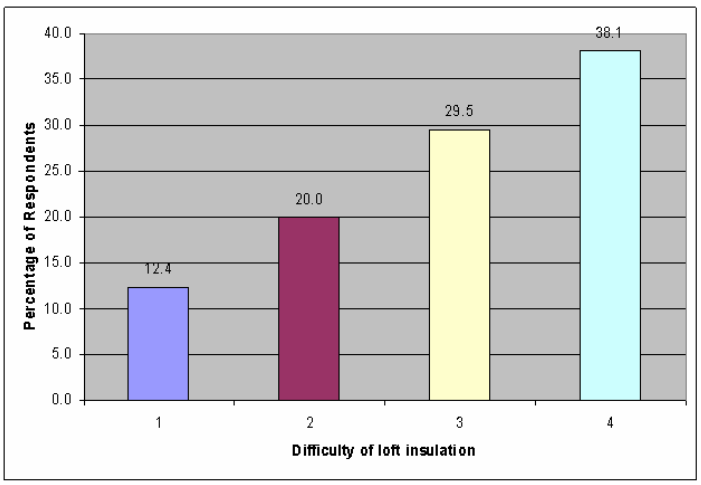
12a. How difficult would it be to use your car less?



1. Difficult
2. Neutral
3. Easy
4. Very easy

(Out of 107 respondents)

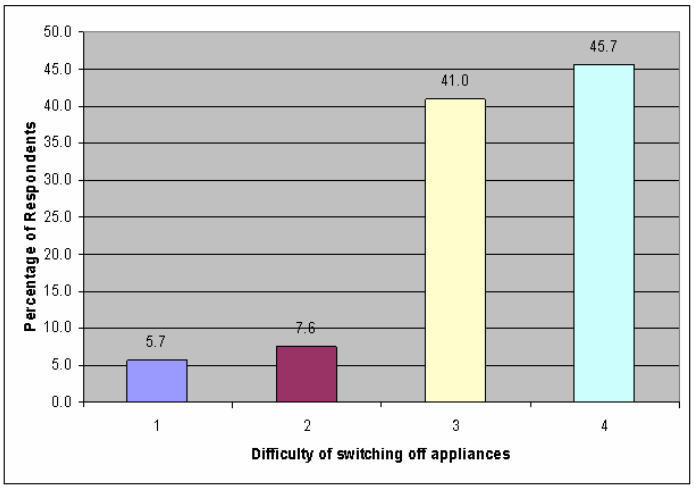
12b. How difficult would it be to install loft insulation?



1. Difficult
2. Neutral
3. Easy
4. Very Easy

(Out of 105 respondents)

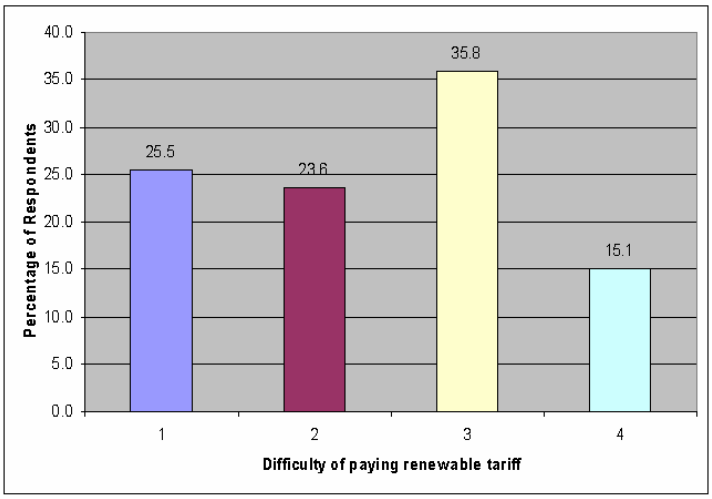
12c. How difficult would it be to switch off stand-by appliances?



1. Difficult
2. Neutral
3. Easy
4. Very easy

(Out of 105 respondents)

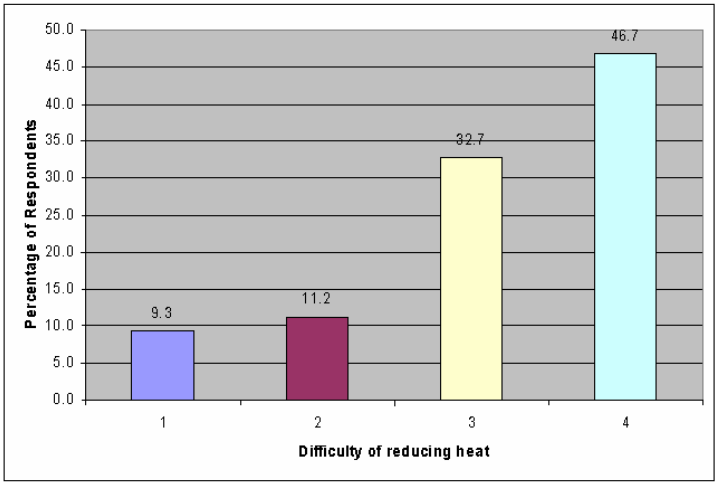
12d. How difficult would it be to pay a renewable energy tariff?



1. Difficult
2. Neutral
3. Easy
4. Very easy

(Out of 106 respondents)

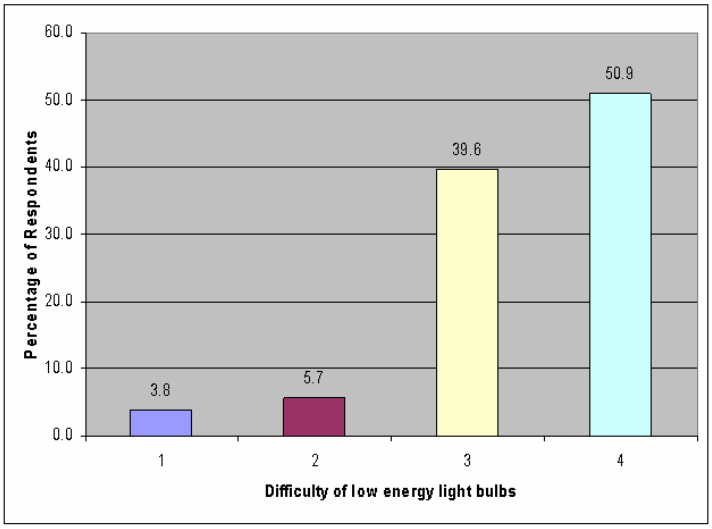
12e. How difficult would it be to put on a jumper in the home and reduce heating?



1. Difficult
2. Neutral
3. Easy
4. Very easy

(Out of 107 respondents)

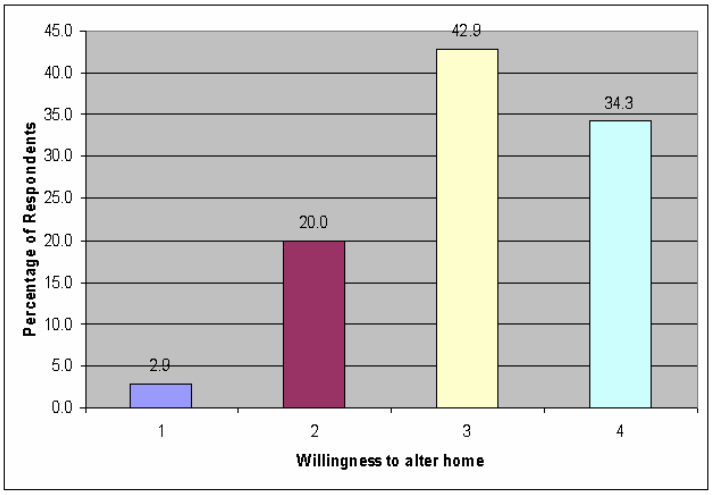
12f. How difficult would it be to fit low energy light bulbs throughout the house?



1. Difficult
2. Neutral
3. Easy
4. Very easy

(Out of 106 respondents)

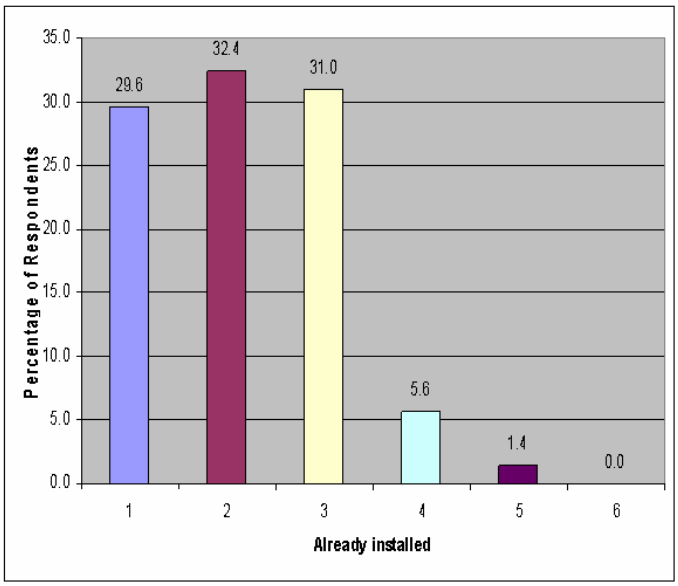
13. How willing would you be to alter the exterior of your home or add energy-saving structures to the outside of your house in order to reduce carbon emissions and decrease energy use?



1. Not at all
2. Slightly
3. Moderately
4. Extremely

(Out of 35 respondents)

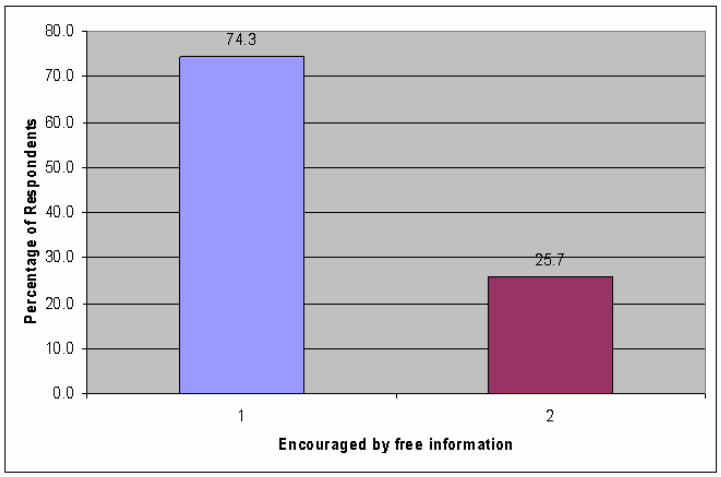
14. Which, if any, of the following green energy measures have you already installed in your home?



1. Insulation
2. Double glazing
3. Low energy light bulbs
4. Condensed boiler
5. Solar hot water panels
6. Photovoltaic cells

(Out of 71 respondents)

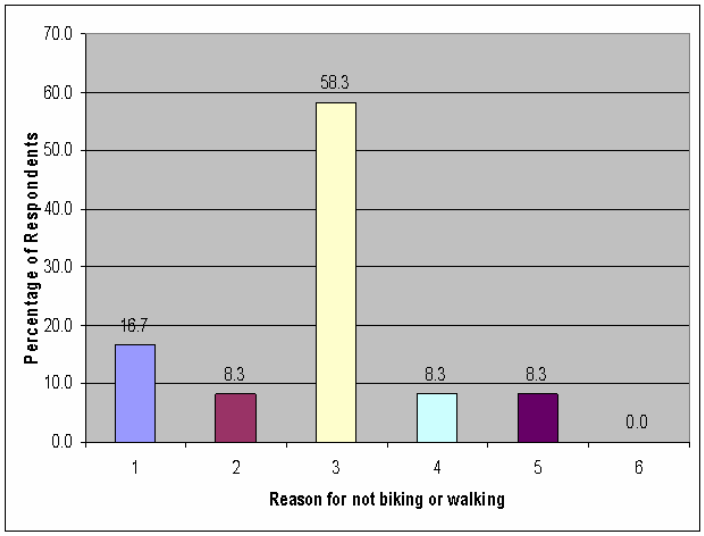
15. Would access to free information on technologies that reduce carbon dioxide emissions encourage you to invest more money and effort for domestic energy improvements?



1. Yes
2. No

(Out of 35 respondents)

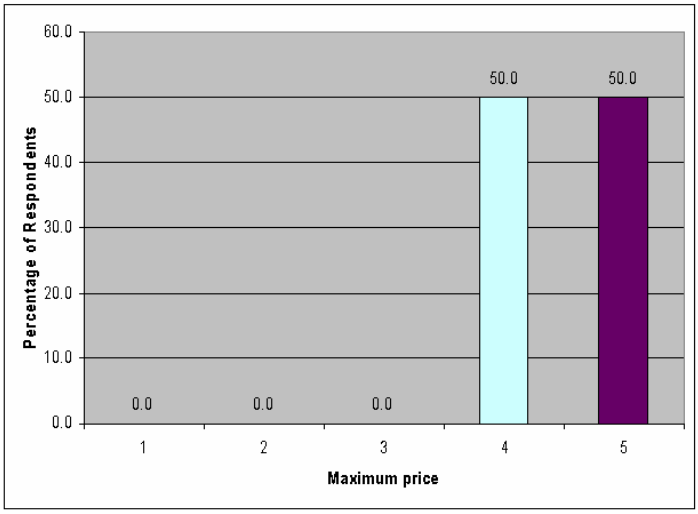
16. If you currently drive a car as your primary way to get to work or to conduct chores, which of the following explanations seem to explain your choice to not travel by bike or on foot?



1. Flexibility
2. Time required
3. Availability of suitable paths
4. Distance
5. Health limitations
6. Bike availability

(Out of 12 respondents)

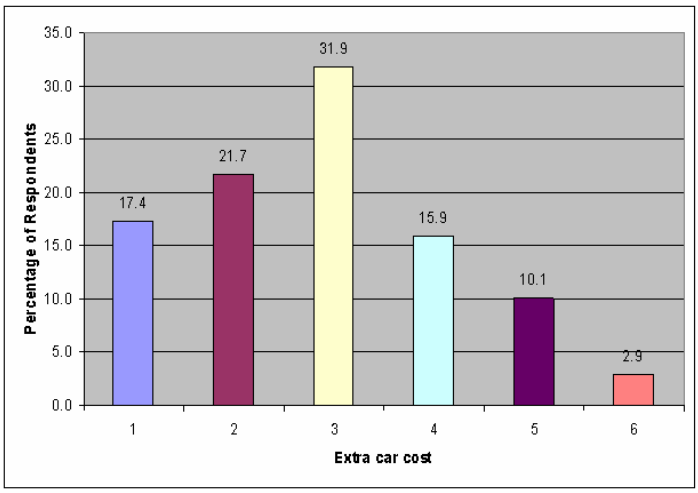
17. If you currently drive a car as your primary way to get to work or to conduct chores, what would need to be the maximum price of a bus to make it worth the effort to use a bus?



1. Nothing (free)
2. Up to 20p
3. Up to 50p
4. Up to 1 pound
5. More than 1 pound

(Out of 10 respondents)

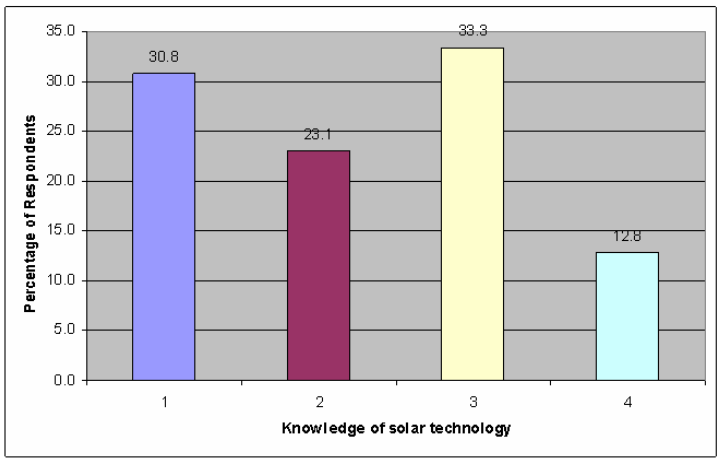
18. If you were to buy a new car, how much extra would you pay for it if it had a gas mileage double that of the car you were considering, but the cars were identical in all other respects?



1. Nothing
2. Up to 100 pounds
3. Up to 500 pounds
4. Up to 2,000 pounds
5. More than 2,000 pounds

(Out of 69 respondents)

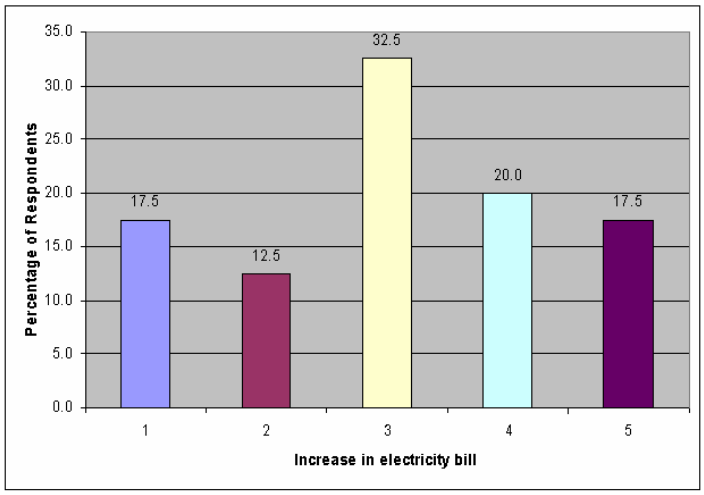
19. Do you feel you know enough about solar energy technology and products for the home to allow you to make decisions about whether to purchase them?



1. Not at all
2. Slightly
3. Moderately
4. Extremely

(Out of 39 respondents)

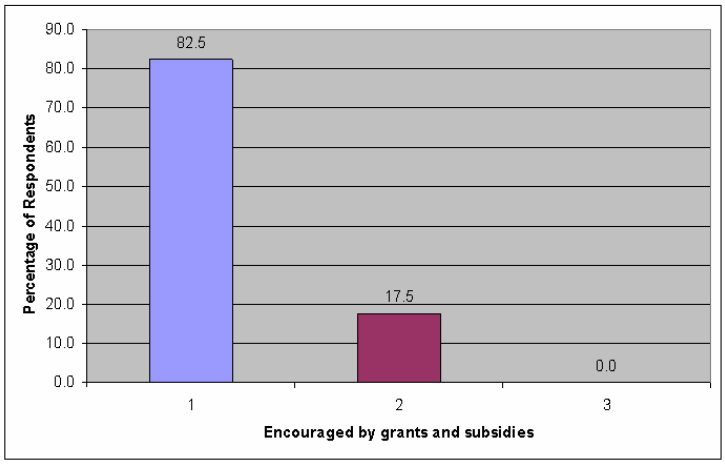
20. By how much would you be willing to increase your monthly home electricity bill if it could be guaranteed that the energy source reduced carbon dioxide emissions?



1. Nothing
2. Up to 1 pound
3. Up to 5 pounds
4. Up to 10 pounds
5. More than 10 pounds

(Out of 40 respondents)

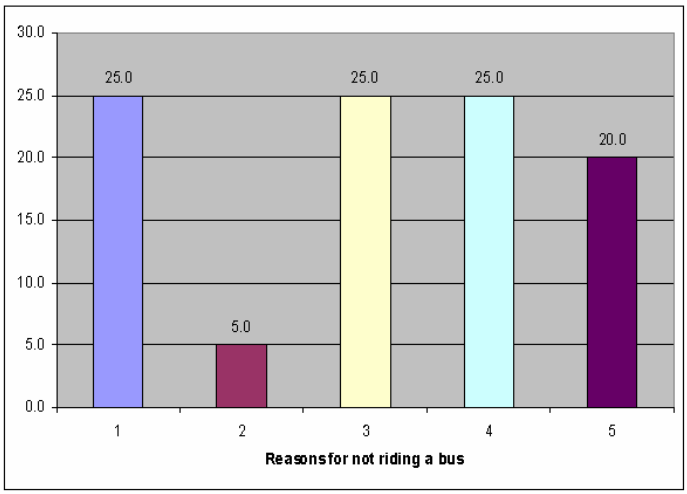
21. Would access to grants and subsidies available from the government and local authorities encourage you to invest more money and effort for domestic energy improvements?



1. Yes
2. No

(Out of 40 respondents)

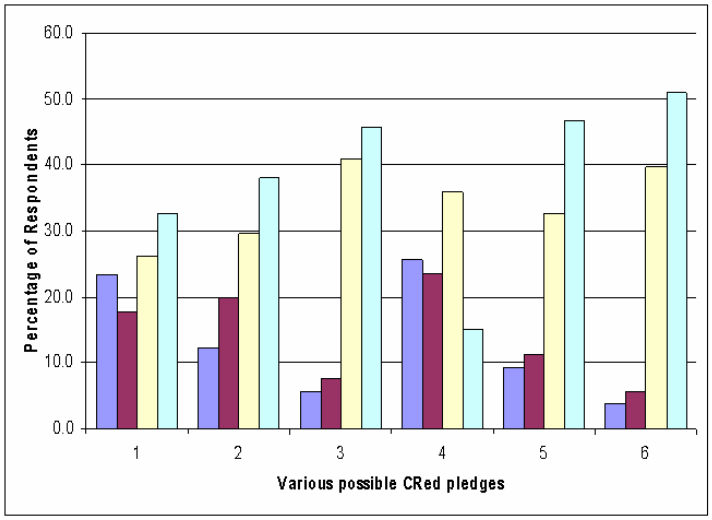
22. If you currently drive a car as your primary way to get to work or to conduct chores, which of the following explanations seem to explain your choice not to travel by bus?



1. Flexibility
2. Cost of buses
3. Availability of bus routes
4. Distance traveled
5. Time required to travel by bus

(Out of 20 respondents)

Comparison of the difficulty levels of the various cred pledges



1. Use the car less
2. Install loft insulation
3. Switch off stand-by appliances
4. Pay a renewable energy tariff
5. Put on a jumper and reduce heating in the home
6. Fit low energy light bulbs throughout the house

Green = Very Easy
Blue = Difficult