Encouraging sustainable lifestyles: local government, citizens and the impact of pro-environmental behaviour change programmes

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I, Kristy Lauren Corradi Revell confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

In recent years, it has become apparent that in order to achieve many policy objectives, it is often necessary to stimulate behaviour change on the part of the population. Concurrently, the role of local authorities in tackling unsustainability and reducing carbon emissions has become more prominent. This thesis describes research undertaken in London, UK, to understand how local authorities have worked to tackle unsustainability and encourage pro-environmental behaviour change through sustainability programmes, and what the environmental impact of such programmes is. Overall, this thesis provides a clear picture of how local environmental programmes which require individual behaviour change, can be monitored and evaluated.

To commence, a series of interviews with local authority sustainability officers found that the extent of their sustainability work was broad but there was a lack of robust monitoring and evaluation. To understand the potential contribution that sustainability programmes could make towards reducing carbon emissions, two programmes were monitored and evaluated.

The first programme evaluated was a home energy visit programme, known as RE:NEW, which intended to encourage reductions in household carbon emissions. The second programme evaluated was a Camden Green Zone, which provided secure and accessible cycle parking to residents to encourage cycling rates.

The environmental impact of both programmes was estimated in terms of carbon emissions abated. Evaluation found that for RE:NEW, the impact of the visits on the installation of significant energy efficiency measures and behaviour change was negligible.

For Green Zones, the intervention had no significant impact on the frequency or distance with which the sample group cycled, nor did it cause a significant modal shift in transport use.

Given this significant finding, that the interventions did not result in detectable behaviour change, a number of recommendations to increase the efficacy of such programmes are provided, as are recommendations for undertaking effective evaluation.

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Publications related to this thesis

Revell K., and Allen S., on behalf of the Parliamentary Office of Science and Technology (2012) Energy Use Behaviour Change. POSTnote Aug. (417). Available: http://www.parliament.uk/business/publications/research/briefing-papers/POST-PN-417

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Abbreviations

AGW	Anthropogenic Global Warming
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CCC	Committee on Climate Change
CERT	Carbon Emissions Reduction Target
CFL	Compact Fluorescent Lamp
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DFT	Department for Transport
EA	Environment Agency
EST	Energy Saving Trust
EU	European Union
GB	Great Britain
GHG	Greenhouse Gas
GLA	Greater London Authority
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
LGTA	Lissenden Gardens Tenants Association
$MtCO_2$	Mega-Tonnes Carbon Dioxide
$MtCO_2e$	Mega-Tonnes Carbon Dioxide Equivalent
NI	National Indicators
OFGEM	Office of Gas and Electricity Markets
PC	Personal Computer

RCT	Randomised Control Trial
RSL	Registered Social Landlord
TA	Tenants Association
TV	Television
UK	United Kingdom
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCED	World Commission on Environment and Development

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Chapter 1 Introduction

There is a consensus amongst climate change scientists that atmospheric concentrations of key greenhouse gases, have increased since 1750 due to human activities (IPCC, 2007, 2014b, Solomon et al., 2009). As a result, to prevent dangerous climate change, greenhouse gas concentrations in the atmosphere will need to be stabilised to ‘a level that would prevent dangerous anthropogenic interference with the climate system’ (UNFCCC, 1992: 4). The need to reduce the impact of human activities on the climate and contribute towards the prevention of dangerous climate change is one of the motivations of this thesis. One of the issues in the generation of the greenhouse gases that amplify this trend is the over-use of finite resources, particularly those which lead to increased carbon emissions. Therefore this thesis is also driven by a desire to make a small contribution towards addressing and reducing unsustainable consumption, waste and misuse of the world’s finite resources and this is relevant to those that may dispute the scientific evidence of climate change, yet support the notion that development must be more environmentally sustainable.

At the most fundamental level, this thesis is motivated by a concern for the environment and a desire to better understand how local authorities could support the population to reduce their impact on the environment. By focusing on inner London and a sample of local authorities, this thesis intends to explore how local authorities are currently working to reduce the environmental impact of their residents and encourage pro-environmental behaviour change. It also intends to understand what the environmental impact of this work is.

The increasing focus on local level action on unsustainability has directed this research, with local authorities, specifically, seeming a natural choice for this research, given that they are the level of government closest to the people (UNCED, 1992).

In addition, when undertaking the literature review, it became clear that detailed research on the specific types of sustainability work being delivered by local authorities on the ground was limited. Analyses of national and city-wide policies are frequently discussed in the literature, but the work of local authorities is rarely mentioned. Given this research was embarked upon to develop the evidence base on local authority sustainability programmes, with a focus on local authorities within London, the capital of the United Kingdom (UK).

1.1 Research Question and Strategy

The underlying research question of this thesis is: how do local authorities encourage pro-environmental behaviour through local authority sustainability interventions, and what is the environmental impact of such interventions? To be more specific this research question has been broken down into two more detailed questions which are answered within this thesis in relation to the capital city of the United Kingdom, London.

1. How are local authorities currently working to encourage pro-environmental behaviour amongst their residents and assist residents in a transition to a more sustainable lifestyle through local authority sustainability interventions?
2. What is the environmental impact of local authority sustainability interventions and any associated pro-environmental behavioural changes?

These two research questions are examined through three phases of research. The first question examines the wider context of this research and ascertains the nature and extent of sustainability work being undertaken by local authorities. The second research question examines the outcomes of two local authority sustainability programmes and quantifies their environmental impact. These research questions and how they are approached in this thesis are presented diagrammatically in Table 1.1.

1. Through local authority sustainability interventions, how are local authorities currently working to encourage pro-environmental behaviour amongst their residents and assist residents in a transition to a more sustainable lifestyle?	
↓ Phase 1: Interviews with inner London local authority sustainability officers (Chapter 4 and Chapter 7) ↓	
2. What is the impact of local authority sustainability programmes and any associated pro-environmental behavioural changes	
↓ Phase 2: Panel survey with residents from the RE:NEW home energy visit programme (Chapter 5 and Chapter 8)	↓ Phase 3: Monitoring of a 'Green Zone' that aimed to encourage cycling, as part of the wider 'Green Zones' programme (Chapter 6 and Chapter 8)

Table 1.1 Phases of research

1.2 Definition of Terms

Some of the key terms discussed in this thesis merit some further elaboration prior to in-depth discussion. Therefore these are discussed here.

1.2.1 Local Authorities and Borough Councils

Within this thesis there is much reference to 'local authorities'. A local authority, often referred to as a 'council', is a unit in the structure of local government in England. In many areas, there are two tiers of local government, for example, the upper tier is the county council and the lower tier is the district or borough council (HM Government, 2014b, HM Revenue and Customs, 2014). In England, the upper tiers of local government will be responsible for education, transport, planning, public safety, health and social care, leisure services such as libraries and sports centres and waste management. The lower tiers will be responsible for waste collection and recycling, housing, local planning and council tax collections.

This thesis focuses specifically on local authorities in London, the capital of the UK, and in London, there is just one (unitary) tier of local government. Therefore the borough councils are generally responsible for all of these functions mentioned above (HM Government, 2014b). The remit of the local authority is therefore very broad and there is opportunity to influence many key emitting sectors, including buildings, energy supply, transport, planning and waste. More information on the Greater London Authority (GLA) and its remit is discussed in section 3.1.

1.2.2 Sustainability Programmes

Throughout this thesis there will be reference made to 'sustainability programmes' or 'sustainability projects', or 'projects' or 'programmes'. These terms will be used interchangeably and refer to work being undertaken by local authorities to reduce the environmental impact of the borough, where the reduction in environmental impact could be achieved by encouraging pro-environmental behaviour change, or through another means such as tree planting, which does not necessarily relate to behaviour, but has other environmental benefits.

Reference will also be made to ‘sustainability interventions’ or ‘interventions’, where ‘intervention’ is used in this thesis to describe any regulation, policy, program, measure, activity, or event that aims to influence behaviour (Wilson and Dowlatabadi, 2007). Therefore interventions are ‘sustainability programmes’ or ‘sustainability projects’, but they have a specific focus on behaviour. Therefore any intervention is a sustainability project or programme but not all sustainability projects or programmes are interventions.

1.2.3 Carbon Dioxide

Carbon dioxide (CO_2) is ‘the principal anthropogenic greenhouse gas that affects the Earth’s radiative balance’ (IPCC, 2013). Throughout this thesis much reference is made to carbon and ‘carbon dioxide emissions’, ‘carbon reduction’, ‘carbon impact’ etc. Please note that where ‘carbon’ is referred to in this thesis, this is actually a reference to carbon dioxide equivalent (CO_2e), which is a standard unit used in carbon accounting to allow comparison of emissions of different greenhouse gases based on their Global Warming Potential (GWP). Where ‘carbon impact’ is referred to, this is actually a reference to carbon abatement potential.

GWP is a conversion factor which converts non-CO_2 emissions into the universal unit of CO_2e. More specifically, GWP is 'an index based on the radiative properties of greenhouse gases', with the GWP representing 'the combined effect of the differing times these gases remain in the atmosphere and their relative effectiveness in causing radiative forcing' (IPCC, 2013). 'The equivalent carbon dioxide emission is obtained by multiplying the emission of a greenhouse gas by its GWP for the given time horizon' (IPCC, 2013).

CO_2 is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1 (IPCC, 2013).

1.3 Thesis Structure

This thesis consists of ten chapters including this introduction. The next chapter starts by providing an overview of the literature that pertains to both sustainable development (section 2.1.1) and climate change (section 2.1.2), focusing on the role that cities and lower levels of government may play in addressing climate change and sustainable development (section 2.1.3 and 2.1.4). The chapter also provides an overview of pro-environmental behaviour and its many definitions (section 2.2) and Stern's (2000) work on environmentally significant behaviours is also deliberated. The chapter then moves on to look more closely at behaviour change theories and their use in government before moving on to discuss the role of behavioural change in decarbonising the UK (section 2.3.3).

Chapter 3 introduces the research strategy and the geographical location of the research, which is London, the capital city of the United Kingdom. A brief introduction into the mixed-methods approach used is given. The literature that is relevant to the evaluation of these two specific local authority sustainability programmes evaluated is also reviewed. These programmes sought to encourage behaviour change in the fields of household energy consumption and cycling.

Chapter 4 outlines the specific data collection and analysis methods used to gather evidence on local authority sustainability programmes and Chapter 5 and Chapter 6 outlines the specific data collection and analysis methods use to evaluate two specific local authority sustainability programmes.

The results of this evaluation are outlined in Chapter 7 and Chapter 8. Specifically, Chapter 7 examines and responds to the first research question by providing structured evidence about the nature and extent of sustainability work being undertaken by local authorities in London. Chapter 8 examines and responds to the second research question by providing results of the monitoring of two local authority sustainability programmes. In this chapter, the RE:NEW home energy visit programme is evaluated and the carbon impact of the programme is quantified for a sample of households, across three inner London boroughs. Detailed analysis estimates the carbon impact of a visit for each participant household. In addition, this chapter also evaluates whether an intervention to provide accessible and secure cycle parking, through a programme called Green Zones, causes participants to cycle more frequently and further. Detailed analysis estimates the carbon impact of observed changes in travel habits, as a result of the intervention.

Chapter 9 brings the results from Chapter 7and Chapter 8 together. Here all of the results are discussed and key recommendations as how to improve both programmes are presented. The contributions to knowledge from each analytical chapter are also identified.

Chapter 2 Introducing Pro-Environmental Behaviour Change

> 'To solve climate change in the long run, the day-to-day activities of individuals, families, firms, communities, and governments at multiple levels must change substantially' (Ostrom, 2010)

This chapter will provide an introduction to the inter-disciplinary literature that has informed this research. It draws together the literature from a number of disciplines and discourses, including psychology, economics, sociology, sustainable development, climate change science, environmental science and policy, amongst others.

The inter-disciplinary nature of this thesis is largely as a result of the focus on 'pro-environmental behaviour' (DEFRA, 2008, Kollmuss and Agyeman, 2002, Steg and Vlek, 2009). Pro-environmental behaviour is a conscious behaviour that intends to minimise the negative impact of human activity on the environment. This thesis is based on the premise that climate change is a symptom of unsustainable consumption patterns (Cohen et al., 1998). Specifically, it focuses on the potential impact that pro-environmental behavioural changes could have on reducing the impact of humans on the environment, and combatting dangerous climate change through the reduction of consumption associated carbon emissions.

This chapter intends to situate the research question within the wider literature that is of relevance to this thesis. This is done in three parts. To commence, section 2.1 introduces the literature pertaining to sustainable development and climate change, drawing out the distinctly different discourses of each discipline and discussing the particular British policy focus on climate change and carbon reduction. The review then focuses its attention on the role of cities as sites of both consumption and political power, which are integral to effectively tackling climate change and unsustainable development. The section draws to a close with a discussion on the pivotal role of local authorities in tackling climate change and their increasing work in tackling climate change and unsustainable consumption.

Section 2.2 introduces and defines pro-environmental behaviour, its relationship with sustainable development and climate change and how this behaviour is modelled and theorised in psychology, sociology and behavioural economics. The concept of environmentally-significant behaviours is also deliberated.

Section 2.3 brings attention on behaviour change in policy. Firstly discussing its rise in prominence within British policy and secondly, how behaviour change can be encouraged through the use of policy levers and interventions. This section is followed by a review of applications of behaviour change theory to a number of pro-environmental behaviours. Finally, this section moves on to describe the role of behaviour change in climate change policies, notably the work by the Committee on Climate Change, and a review of the methods utilised in the evaluation of pro-environmental behaviour change interventions. This section concludes that there is a lack of monitoring and evaluation of behaviour change interventions which acts as a barrier to the formulation of evidence-based policy.

The chapter concludes with section 2.4 which proposes that by monitoring and evaluating the impact of existing local authority sustainability behaviour change programmes, the evidence base on pro-environmental behaviour change interventions could be developed.

2.1 Sustainable Development and Climate Change

This section will reflect on the differences between two of the main research themes in this thesis: climate change and sustainable development. At first sight, it would seem that these research themes should be heavily interwoven, on the basis that climate change is a symptom of unsustainable consumption patterns (Cohen et al., 1998). However, the discourses around these two research themes generally ‘represent different cultures’ (Michaelis, 2003). Cohen et al. (1998) propose that this distinction has arisen because of ‘the very different approaches to science, politics and practice associated with the separate discourses and research cultures’ of these disciplines.

It is also worth mentioning at this point, that although policy makers and the media do ‘frequently assert that climate science is highly uncertain’, (Oreskes, 2004). In Oreskes’ (2004) review of 928 abstracts that mentioned ‘climate change’, published in refereed scientific journals between 1993 and 2003, it was found that no paper disagreed with the consensus position of the IPCC that the Earth's climate is being affected by human activities. This finding was also supported in a recent study by Cook et al. (2013) that found their results were consistent with Oreskes’ result and that overall ‘the number of papers rejecting Anthropogenic Global Warming (AGW) is a miniscule proportion of the published research’ (Cook et al., 2013). This thesis is written from a position that is in agreement with the consensus.

2.1.1 Sustainable Development

The Brundtland Commission's report originally defined sustainable development as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (WCED, 1987).

Historically, sustainable development, the parent of sustainable consumption, has been dominated by those from the social sciences who tend to define such problems in terms of human behaviour (Cohen et al., 1998, Swart et al., 2003). As a result, sustainable development has focused on the broader principles of sustainability, seeking to address tensions and build agreement among the three major thrusts of the sustainable development discourse: economic, environmental and social sustainability (Cohen et al., 1998, Michaelis, 2003, Swart et al., 2003).

Sustainable development first entered into policy debates in 1972 with the publication of the Club of Rome's Limits to Growth report (Meadows et al., 1972). The field gained additional momentum with the publication of the Brundtland Report in 1987 (WCED, 1987). Later the agenda shifted onto sustainable consumption, with this concept first entering the international policy arena at the 1992 Rio Earth Summit with the publication of Agenda 21 (UNCED, 1992). This report was essentially an action plan for sustainable development that was voluntarily adopted by 178 nations at the 1992 Rio Earth Summit (DEFRA, 2011c, Seyfang, 2005, UNCED, 1992).

Although Agenda 21 provided no explicit definition of 'sustainable consumption', it did identify that 'changing consumption patterns will require a multipronged strategy focusing on demand, meeting the basic needs of the poor, and reducing wastage and the use of finite resources in the production process' (UNCED, 1992: Section 4.5). Since the 1992 Rio Earth Summit, a precise definition of the term sustainable consumption has so far proved impossible to agree upon (Jackson and Michaelis, 2003, Seyfang, 2005). However, there is agreement within the international environmental policy debates that 'people's choices, behaviours and lifestyles will play a vital role in achieving sustainable development' (Jackson, 2005: 4), and given that climate change is one of the most important symptoms of unsustainability, it will also play a vital role in tackling climate change (Cohen et al., 1998). This behavioural change is discussed in more detail in section 2.2.

2.1.2 Climate Change

Running almost in parallel with the rise of sustainable development was the growth of the climate change discourse. In the late 1980's climate change was initially framed by natural scientists, who raised the prominence of the field with the development of the early Global Circulation Models (GCMs) (Swart et al., 2003). These natural scientists tended to investigate climate change using models based on physical flows of matter and energy. As a result, climate change science, analysis and policy have generally been dominated by science, economic thinking and the development of cost-effective responses to climate change (Cohen et al., 1998, Michaelis, 2003, Swart et al., 2003). However, this framing of climate change from a predominately natural science perspective caused the social context of climate change to be overlooked for a number of years, and for the social sustainability aspects of climate change to be largely sidelined (Cohen et al., 1998, Michaelis, 2003, Swart et al., 2003).

Climate change entered the policy arena in earnest with the creation of the Intergovernmental Panel on Climate Change (IPCC) in 1988. This intergovernmental body was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO), the programme was endorsed by the UN General Assembly later in 1988. Currently 195 countries are members of the IPCC (IPCC, c. 2013b).

The IPCC's first assessment report was published in 1990 and the climate change agenda gained additional momentum at the 1992 Rio Earth Summit with the creation of an international treaty: the United Nations Framework Convention on Climate Change (UNFCCC) (IPCC, c. 2013a, UNFCCC, 1992). This treaty was joined by countries in an effort 'to cooperatively consider what they could do to limit average global temperature increases and the resulting climate change', currently there are 195 Parties to the Convention. (UNFCCC, 2012)

In 1995, the IPCC's Second Assessment Report, followed by the agreement of the Kyoto Protocol in 1997, aimed to strengthen emission targets (IPCC, c. 2013a). The IPCC's Third, Fourth and Fifth Assessment Reports were published in 2001, 2007 and 2014, respectively (IPCC, 2014a). It is worth noting that it was not until the publication of the third assessment report, that a more inclusive analysis of the human dimensions of climate change was addressed by the IPCC (Swart et al., 2003).

2.1.2.1 The Climate Change Act 2008

In the UK, the challenge that climate change presents has been recognised and action has been taken to curb GHG emissions through the Climate Change Act 2008 (DECC, 2008). This act legally binds the UK to reducing territorial GHG emissions by 34% by 2020 and 80% by 2050, based on emission levels from 1990 (DECC, 2008). However these are challenging targets and to reach them will require a radical change in human behaviour and a shift towards lower carbon consumption patterns, particularly in relation to energy consumption (Lorenzoni et al., 2007).

To illustrate the influence of human behaviour on GHG emissions, in 2012, UK emissions were provisionally estimated to be 571.6 $MtCO_2e$. Of this 43.4% of these emissions were attributable to the consumption patterns of individuals, through residential energy consumption and individual travel (see Table 2.1) (DECC, 2013c).

Table 2.1 UK emissions estimates (DECC, 2013c)

Emission sector	**2011 emission estimates ($MtCO_2e$)**	**Emission estimates (per cent of total)**	**Information source**
Residential energy consumption by end-user	130.5	22.8%	DECC (2013c) Table 3: Residential combustion, by final user
Private vehicles	73.6	12.9%	DECC (2013c) Table 3: Passenger cars & motorcycles, by final user
Public transport	9.1	1.6%	DECC (2013c) Table 3: Buses and rail, by final user
Aviation	34.8	6.1%	DECC (2013c) Table 3: Domestic aviation, by final user (cruise, landing, take-off) and Table 8: CO_2e from UK international aviation bunkers
Total	248.0	43.4%	

In addition, this figure does not include the emissions that would have been embedded within goods and services (imported and domestic) that British individuals consumed. Therefore the contribution of individual consumption towards total emissions, is likely to be much larger than this figure indicates, as the work on consumption based emissions by (Broer, 2012), using emissions data from 2004, demonstrates. Given this contribution by individuals towards total carbon emissions, individual consumption is a central area of action that must be addressed if dangerous climate change is to be avoided.

However there is some criticism of the Climate Change Act 2008 and how it has caused British policy to become obsessed with carbon emissions, at the cost of wider sustainable development. It is proffered that a more holistic view on sustainability may create a better environmental result rather than this narrow focus on carbon (Restorick, 2011). Within the literature there are arguments that the British focus on climate change, which has been concentrated by the Climate Change Act 2008, 'risks excluding other urgent environmental and social justice issues' (Porritt, 2009: 17). This viewpoint is somewhat supported by the demise of the Sustainable Development Commission at the end of March, 2011 (Carrington, 2011, Sustainable Development Commission, 2011) and the marginalisation of wider sustainable development under the Coalition Government (Porritt, 2011).

Despite these criticisms, this research focuses on carbon reduction. The reason for this is not that this research does not acknowledge the importance of wider sustainability, but instead it appreciates that in general, climate change is a more 'manageable policy concept' than sustainable development (Porritt, 2009: 17), and according to politicians, is 'easier to understand and has more tangible outcomes' (Restorick, 2011). Therefore this research intends to be realistic by working with the current, more advanced, legislative framework that has been created as a result of the Climate Change Act 2008, and as a way of taking 'the first important steps away from unsustainable development' (Porritt, 2009: 17).

2.1.3 Focus on Cities

The publication of the Brundtland report in 1987 brought global attention on the issue of sustainable development and at the same time it recast the role of cities as central in addressing environmental issues and climate change (World Commission on Environment and Development, 1987). In recent years, this focus on cities has become more intensive (World Bank, 2010). This is partly as a result of increasing urbanisation and that urban areas are now the ‘dominant form of habitat for humankind’ (UN Habitat, 2013: v). It has also been partly as a result of the increasing national and international political focus on climate change, and the recognition that cities are dense areas of energy consumption and waste production, which also have the ability to govern and regulate many of their GHG emitting activities (Betsill and Bulkeley, 2007, Bulkeley and Betsill, 2005, Bulkeley and Betsill, 2013, Ostrom, 2010, Toly, 2008). Cities are therefore part of the problem, but also part of the solution, so have become central to the evolving landscape of climate change solutions and are an ‘essential part of the response’ (Betsill and Bulkeley, 2007, Bulkeley et al., 2012).

Considering this, cities have been exercising their power to address unsustainable development and climate change for over 30 years, through organisations such as ICLEI (formally known as the International Council for Local Environmental Initiatives), the Climate Alliance and the C40 Cities Climate Leadership Group. ICLEI, an early effort, was originally founded by a group of 200 local governments from 43 countries in 1990, at the first World Congress of Local Governments for a Sustainable Future, held at the United Nations in New York (ICLEI, 2012). ICLEI describes itself as ‘an association of cities and local governments dedicated to sustainable development’ (ICLEI, c. 2013). In 2003, ICLEI dropped their previous full name to become ‘ICLEI - Local Governments for Sustainability’, to reflect their aim to work on broader sustainability issues (ICLEI - Local Governments for Sustainability, c. 2013).

One of the most prominent ICLEI initiatives is Cities for Climate Protection, which was founded in 1993 with the intention of assisting cities in adopting and implementing policies to reduce local GHG emissions and enhance liveability and sustainability (ICLEI - Local Governments for Sustainability, 2008, Lindseth, 2004). Presently, more than 650 municipal governments from over 30 countries participate in the campaign (Toly, 2008)

Another prominent campaign is the C40 Cities Climate Leadership Group, which was created in 2005 by the former Mayor of London, Ken Livingstone, with the aim of reducing carbon emissions and increasing energy efficiency in large cities across the world (C40 Cities Climate Leadership Group, 2011). The following year in 2006, the C40 experienced further expansion, driven by the engagement of a number of Mayors from high profile cities and with support from the Clinton Climate Initiative (Bulkeley et al., 2012, C40 Cities Climate Leadership Group, 2011).

Additional prominent municipal-led organisations include the United States Conference of Mayors' (USCOM) Climate Protection Agreement, the European Covenant of Mayors, the Climate Alliance and Energy Cities (Bulkeley, 2010, Bulkeley et al., 2012, Climate Alliance, 2013, Energy Cities, c. 2013, The Covenant of Mayors, c. 2013, The United States Conference of Mayors, 2008, Toly, 2008). This abundance of organisations demonstrates the extent of the municipal response to climate change and that rather than being only a marginal concern in a few municipalities, climate change is now a strategic concern for many municipalities (Bulkeley et al., 2012).

2.1.4 Focus on Local Authorities

An extension of this action from cities and municipalities is the increasing role of local authorities in addressing unsustainable development and climate change (Gibbs and Jonas, 2000, Gibbs et al., 1996). There are good reasons for this. Firstly, local authorities, as local governing bodies, are well placed to influence carbon emission reductions through 'the services they deliver, their role as social landlords, trusted community leaders and major employers, and their regulatory and strategic functions' (CCC, 2012). In addition, as a key player in the governance framework, local authorities can influence many key emitting sectors, including buildings, energy supply, transport, planning and waste management. Together these sectors account for 40% of GHG emissions (Bulkeley and Betsill, 2005, CCC, 2012: 8).

Local authorities also have the power to establish local environmental policies and regulations. Finally, and possibly the most important point, is that local authorities are at a 'level of governance closest to the people' and therefore, 'they play a vital role in educating, mobilizing and responding to the public to promote sustainable development' (UNCED, 1992: Section 28.1). Therefore 'the nature of a local authority's relationship with the community is identified as particularly important in terms of the potential influence that it might be able to exert' (Peters et al., 2010). Consequently, 'local authorities and the urban areas which they govern are increasingly charged with delivering sustainable development' (Bulkeley and Betsill, 2005) and by extension, addressing climate change.

This importance of local authorities in addressing sustainable development was highlighted a number of years ago, at the 1992 Rio

Earth Summit, in Agenda 21. Agenda 21 asserted that 'so many of the problems and solutions being addressed by Agenda 21 have their roots in local activities, [that] the participation and cooperation of local authorities will be a determining factor in fulfilling its objectives' (UNCED, 1992: Section 28.1). This was supported by a call to action, which proposed that local authorities should produce 'a local Agenda 21' for their community (UNCED, 1992: Section 28.2). In the UK, central government explicitly supported the development of Local Agenda 21 (Bulkeley and Betsill, 2005).

In 2000, English local authorities were given impetus to focus their efforts once again, this time on climate change, with the Nottingham Declaration. The Nottingham Declaration was created to recognise 'the central role of local authorities in leading society's response to the challenge of climate change' (Energy Saving Trust, 2008). This declaration has been signed by 300 English local authorities, who in doing so, committed to 'tackling the causes and effects of a changing climate' (Nottingham City Council, 2000). In 2012, the Nottingham Declaration was succeeded by 'Climate Local' which is an initiative of the Local Government Association. Climate Local aims 'to drive, inspire and support council action on carbon reduction and climate resilience' (HM Government, 2012b, Local Government Association, c. 2013). As of July 2013, 73 councils had signed up to Climate Local (Breeze, 2013).

This importance of local authorities has also recently been acknowledged by the Department of Energy and Climate Change (DECC) in their memorandum of understanding with the Local Government Association (LGA), where they recognised the 'pivotal role councils have in tackling climate change' and 'that local action affects the ability of national government to meet its targets' (DECC and LGA, 2011: 3). This was echoed by the Committee on Climate Change (CCC) who have asserted that ‘there is a crucial role for local authorities in reducing emissions to meet national carbon budgets’ (CCC, 2012: 8) and that in fact ‘emissions reductions without local action will be insufficient’ (CCC, 2012: 4).

Additionally, this focus on local action has intensified recently because of a shift in British politics and the introduction of the ‘Big Society’ agenda and its legislative framework, the Localism Act, which was enshrined in law in 2011 (Department for Communities and Local Government, 2012). The ‘Big Society’ is intended to improve people’s lives by ‘putting more power in people's hands’ (The Conservative Party, c. 2013) through a ‘transfer of power from Whitehall to local communities’ and local government (The Conservative Party, c. 2013) This transfer of power is facilitated by the Localism Act. (Cabinet Office, 2010, John and Richardson, 2012, Lowndes and Pratchett, 2011).

The Localism Act is intended to ‘achieve a substantial and lasting shift in power away from central government and towards local people’ (Department for Communities and Local Government, 2011: 3). It also intends to pass ‘power to a local level, creating space for local authorities to lead and innovate’ (Department for Communities and Local Government, 2011: 19). Overall, the act has reduced the control on local government and given it more flexibility (John and Richardson, 2012). For sustainable development specifically, this has meant a move away from action by central government towards local level action and initatives.

The British Coalition Government (elected in May 2010) assert that the ‘Government can set a framework for SD [sustainable development] at a national level, but many changes need to happen through the Big Society at a local level, ensuring our communities work more closely together, using local insight, energy and knowledge to develop solutions tailored to local circumstances' (DEFRA, 2011b: 6). Therefore the 'Big Society' agenda does put the onus for action on sustainability and climate change onto individuals, local communities and local government, and away from central government (Seyfang et al., 2010).

However, despite this increasing and apparent focus on the local and local governments and the 'crucial role' that they will play in reducing emissions to meet national carbon budgets (CCC, 2012: 8), it is all too often the case that in practice 'climate change remains a marginal issue' within local government (Bulkeley, 2010) and that a 'stubborn gap between the rhetoric and reality of local climate policy' continues to exist (Betsill and Bulkeley, 2007).

Firstly, a lack of commitment from elected members within the local authority can lead to a lack of action, as can a lack of funding (Allman et al., 2004, Peters et al., 2012). Engaging citizens on climate change and sustainability issues is also often thwarted by challenges and there are a number of well documented barriers to engagement. Many local authorities find it difficult, not only to engage with residents, but also to encourage attitude and behavioural change because of citizen apathy towards the subject. They can also find it hard to penetrate certain target sectors of society as a result of residents' modern hectic lifestyles (Fudge and Peters, 2009, Peters et al., 2012). Other residents are difficult to engage because they lack trust in the local authority or confidence in their policies, and this acts as a barrier to the forging of meaningful relationships with residents and community groups and effective sustainability programmes (Fudge and Peters, 2009, Peters et al., 2013, Peters et al., 2012).

Another factor that may influence the extent of local authority action is the lack of statutory framework to incentivise local authorities in Britain to act on Climate Change. However, this has not always been the case. Between the years of 2008 and 2009 the Labour Government introduced 198 indicators on which local authorities had to report to central government. Of specific importance to climate change were National Indicators (NI) 185, 186 and 188 which focused on reporting CO_2 emission reductions from local authority operations, per capita CO_2 emissions in the local authority and adaption to Climate Change, respectively (HM Government, 2008).

Whilst these indicators were in place, two-thirds of local areas signed up to reduce emissions in their local areas by 2011 (CCC, 2012) and it was observed by the Audit Commission that although NI 186 'has weaknesses as a measure of performance, it has, in many areas, prompted concerted action for the first time' (The Audit Commission, 2009: 19). Suggesting that reporting on the indicator was having a positive impact on local authority action on climate change.

Yet these indicators were abolished in 2010 with the intention of freeing local authorities so that they may 'focus on protecting frontline services' (HM Government, 2010b). As a result, there is now no statutory framework in place for local carbon reduction and no requirement for local authorities to set targets to reduce emissions (CCC, 2012, Friends of the Earth, 2011). As a result, the Committee on Climate Change conclude 'that there is a significant risk that there will be limited activity' on climate change, 'given the removal of the national indicator framework and the highly constrained fiscal situation' (CCC, 2012).

2.2 Pro-Environmental Behaviour

This section will provide an introduction and overview to the literature on pro-environmental behaviour change, which is a specific type of behaviour change that spans a number of research themes including environmental science, economics and behavioural economics, sociology, anthropology, psychology and more specifically, environmental psychology (Jackson, 2005, Turaga et al., 2010, Young and Middlemiss, 2012). As a result this has led to differences in the discourses. Generally the main discourses are situated within psychology (and by extension environmental psychology), sociology and behavioural economics, the latter of which is quite popular within the policy context (Institute for Government and Cabinet Office, 2010, Thaler and Sunstein, 2009) and although a distinctly different discipline to psychology it does seek 'to use psychology to inform economics' (Camerer, 1999).

Consequently and given this cross-disciplinary nature of the topic, it should come as no surprise that no single definition of 'pro-environmental behaviour' has been agreed. Kollmuss and Agyeman (2002) define pro-environmental behaviour as 'behaviour that consciously seeks to minimize the negative impact of one's actions on the natural and built world'. Steg and Vlek (2009) define it as 'behaviour that harms the environment as little as possible, or even benefits the environment'. Whereas Bamberg and Möser (2007) view pro-environmental behaviour by its motivations and as 'a mixture of self-interest and of concern for other people, the next generation, other species, or whole eco-systems'.

This thesis views pro-environmental behaviour as a combination of these definitions and as behaviour that consciously seeks to minimise the negative impact and harm of one's actions on the environment, such behaviour can be motivated by a mixture of intrinsic and extrinsic values. Intrinsic values are those that place value on 'a sense of community, affiliation to friends and family and self-development' and extrinsic values are contingent on 'the perceptions of others – they relate to envy of 'higher' social strata, admiration of material wealth, or power' (Crompton, 2010).

The adoption of pro-environmental behaviours is a key part of addressing unsustainable development and consumption and by extension, climate change, for 'behaviour changes will be needed to deliver sustainable development' (HM Government, 2005). Examples of pro-environmental behaviours include recycling household waste, reducing water consumption by taking shorter showers or reducing energy consumption by turning down the thermostat and switching appliances off standby. Pro-environmental behaviours can also relate to travel, for example, choosing to walk or cycle short journeys rather than travelling by car, or taking fewer flights, and also to purchasing behaviours, for example choosing to eat less meat.

2.2.1.1 Impact of pro-environmental behaviour

Cleary these different pro-environmental behaviours are varied and the reduction in negative impact on the environment, as a result of the adoption of such behaviours, is not the same. For example, the carbon impact of choosing to recycle one's waste or using reusable shopping bags is likely to be lower than choosing not to fly overseas (Steg and Vlek, 2009).

Therefore, as this thesis focuses on the impact of changes in pro-environmental behaviours it is important to identify how this impact will be measured. As a result, this research makes use of Stern's (2000) concept of 'environmentally significant behaviour' where the environmental significance or the impact of the behaviour is defined as 'the extent to which it changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself' (Stern, 2000). Therefore an impact oriented focus on pro-environmental behaviours concentrates attention onto the actual environmental impact of the behaviour in question (Gatersleben et al., 2002).

This thesis will make use of Stern's (2000) advice to target pro-environmental behaviours based on their environmental impact and given the dominance of carbon emission reduction in Britain, as a result of the Climate Change Act (section 2.1.2.1), this thesis will restrict this definition of 'environmental impact' to focus specifically on the carbon impact or 'carbon-significance' of different pro-environmental behavioural changes.

This focus on carbon-significant behaviours is driven by acceptance that the Climate Change Act 2008 has given Britain a legislative framework that strongly supports carbon abatement. Therefore carbon is a currency that policy makers are familiar with and by using this measure the effects of behaviour change can be converted into units that are meaningful to both scientists and policy makers (Gatersleben et al., 2002). In addition, it also facilitates easy comparison of different sustainability interventions, to ascertain which are most effective at reducing carbon emissions.

2.2.2 Models of Pro-Environmental Behaviour

Over approximately the last forty years, a range of models, interpretations and frameworks of pro-environmental behaviour have been proffered in an attempt to describe the factors that influence this type of behaviour. Models have been developed within a number of disciplines and this has given way to multiple interpretations of pro-environmental behaviour change. It is worth noting at this point that this thesis concentrates on particular interventions that initiate behaviour change and the environmental impact of these interventions, rather than researching the existing domain of behaviour change theory.

As a result, this thesis does not attempt to contest the multiple interpretations of behaviours, which have arisen from the different disciplines (e.g. as manifestations of social practices in sociology or as a result of norms, intent or attitudes, in psychology). Therefore, although this section will describe the mainstream psychological, sociological and economic models and their explanations for behaviour change, for they are dominant in both policy and academic circles, it is beyond the scope of this thesis to critically review these fields. Instead these models will be used to identify the mechanisms that are being used by policy makers to change behaviour, in an effort to identify the mechanisms that are most effective.

2.2.2.1 Models of behaviour from psychology

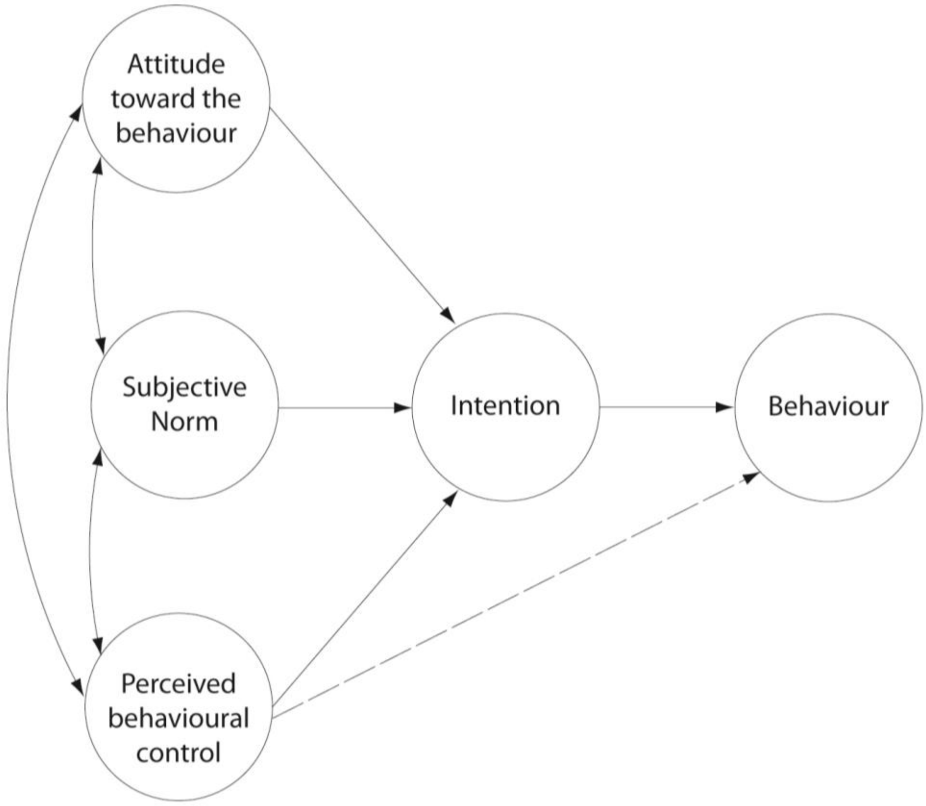
Over the last 40 years a number of models of pro-environmental behaviour have been developed within psychology to describe the determinants that influence behaviour. Initially these models of behavioural change were rational and they supported the notion the population merely needed more information, which would in turn lead to environmental concern and enactment of the pro-environmental behaviour (see Figure 2.1) (Kollmuss and Agyeman, 2002). Burgess et al. (1998) term this type of model the ‘knowledge deficit model’.

Reproduced from: Kollmuss and Agyeman (2002)

Figure 2.1 Early linear models of environmental behaviour change

However, many studies have since refuted the effectiveness of these information deficit models, with Burgess et al. (1998) observing that ‘delivering change in people's attitudes and values is highly contingent on many factors’, whilst other studies have shown that increases in knowledge and awareness and strongly held pro-environmental values, attitudes, and intentions do not necessarily lead to pro-environmental behaviour (Kollmuss and Agyeman, 2002, Peattie, 2010). Despite this, recent environmental programmes led by the British Government have continued to be centred on encouraging behaviour change through information and education, for example the ‘Act on CO_2’ campaign.

Since the rejection of the information deficit model a number of more complex models have been developed (Jackson, 2005). Generally, of these models there is no one dominant model or framework, though some are used more frequently than others (Peattie, 2010). One of the most dominant models is the ‘Theory of Planned Behaviour’ (TPB), developed by Ajzen (1991) and an extension to the ‘Theory of Reasoned Action’ (Ajzen, 1980, Fishbein and Ajzen, 1975).



Reproduced from: Ajzen (1991)

Figure 2.2 Ajzen's Theory of Planned Behaviour

The TPB model (see Figure 2.2) postulates that the intention to perform a particular behaviour is an outcome of three conceptually independent determinants which are attitudes towards that behaviour, subjective norms and one's perceived control over the behaviour in question (Ajzen, 1980, 1991, Ajzen and Madden, 1986). Where attitude towards the behaviour 'refers to the degree to which a person has a favourable or unfavourable evaluation of the behaviour in question' (Ajzen and Madden, 1986), subjective norm is a social factor and refers to 'the perceived social pressure to perform or not to perform the behaviour' (Ajzen and Madden, 1986) and finally perceived control refers to 'the person's belief as to how easy or difficult performance of the behaviour is likely to be', (Ajzen, 1991, Ajzen and Madden, 1986). Generally, the more favourable and stronger these determinants are, the greater the 'individual's intention to perform the behaviour' (Ajzen, 1991).

This TPB model has been adapted to explain pro-environmental behaviours in a number of studies. Knussen et al. (2004), Mannetti et al. (2004) and Terry et al. (1999) have all used it to explain recycling behaviours, whereas Bamberg et al. (2003), De Groot and Steg (2007) and Heath and Gifford (2002) have used it to explain transport mode use. The TPB model has also been used to examine the undertaking of environmentally relevant behaviours (Harland et al., 1999) and to understand and predict environmental activism intentions (Fielding et al., 2008).

2.2.2.2 Behavioural Economics

At this point, it is also worth discussing the field of behavioural economics and how it sits within the behaviour change literature, given its increased prominence in British policy. Originally economics was informed by psychology but as the two discourses developed over the years, the fields became separated and followed different paths of development. However in recent years there has been a 'reunification of psychology and economics' (Camerer, 1999), with psychological models increasingly being used to inform economics (Camerer, 1999, Camerer and Loewenstein, 2004, Rabin, 1998). This approach has been termed 'behavioural economics' and has proved quite popular within the policy context, particularly in Britain (Cabinet Office, 2013, Institute for Government and Cabinet Office, 2010, Thaler and Sunstein, 2009).

Behavioural economics aims to address the assumption within standard economic models that individuals can be modelled as ‘homo economicus’, or ‘economic man’, and that they think and choose unfailingly well, making decisions that maximise self-interest because they have unbounded rationality, unbounded willpower and complete self-control (Mullainathan and Thaler, 2000, Rabin, 2002, Thaler and Sunstein, 2009). Behavioural economics is based on the idea that these assumptions are not supported by the behavioural evidence, given that humans rely on a limited number of heuristic principles, and that these assumptions are therefore false.

Heuristics are strategies that ignore part of the decision information, with the goal of making decisions more quickly, frugally or accurately than more complex methods (Gigerenzer and Gaissmaier, 2011). Although in general these heuristics are quite useful they can sometimes lead to severe and systematic errors and can make individuals act against their own long-term interest (Pollitt and Shaorshadze, 2011, Tversky and Kahneman, 1974). To illustrate, one heuristic known as the ‘availability’ heuristic causes people to judge the likelihood of a risk by the readiness (the availability) with which examples come to mind.

To elaborate, if many examples of a risk in question are at the forefront of a person’s mind, for example as a result of media attention, then it is more likely that the person will be concerned about that risk (Thaler and Sunstein, 2009). To illustrate, people may be worried about road traffic accidents or being knocked down by a vehicle and killed because these events are frequently in the news. However, they may not consider the risks of air pollution caused by vehicular traffic, despite particulate air pollution in the UK being estimated to cause 29,000 deaths per year whereas road traffic accidents cause fewer than 2,000 a year (House of Commons

Environmental Audit Committee, 2011). This bias is also known as the media amplification bias.

Such heuristics and biases are caused by the interactions between two systems in the mind, which are associated with two modes of cognitive functioning. Kahneman (2011) in his book 'Thinking Fast and Slow' refers to these as System 1 and System 2. 'System 1 'operates automatically and quickly, with little or no effort and no sense of voluntary control' (Kahneman, 2011: 20) and System 2 'allocates attention to the effortful mental activities that demand it, including complete computations' (Kahneman, 2011: 21). These systems are essentially intuition vs. reasoning and it is the interactions between these two systems that cause heuristics and biases to emerge (Kahneman, 2002, Thaler and Sunstein, 2009).

Building on this work, Thaler and Sunstein (2009) in their popularised book 'nudge', advocate the use of a particular type of behaviour change intervention that is called 'nudging'. Thaler and Sunstein (2009: 6) define a nudge as 'any aspect of the choice architecture (the context in which people make decisions) that alters people's behaviour in a predictable way, without forbidding any options or significantly changing their economic incentives'. Nudges are non-regulatory and intend to ensure that an individual's freedoms are not restricted. Instead nudges just frame the decision differently.

Nudges make use of heuristics and the associated biases, by changing the choice architecture, to nudge people's behaviour in a predictable way with the intended result being that the individual will make a better decision. (Kahneman, 2011, Thaler and Sunstein, 2009). An example of a nudge would be making the stairs of a building more visible, prominent and attractive than the lift. This prominence can ‘nudge’ individuals to take the stairs rather than the lift, to the benefit of both their own health and the environment, by increasing their physical activity levels and reducing energy consumption.

Yet the nudge approach is not without its criticism and the effectiveness of nudges is widely questioned. Despite this, the fact that nudges seem straightforward and appear to offer ‘low cost solutions that do not require legislation and can be applied to a wide array of problems arising from our behaviour’ has certainly increased their popularity within British Government (House of Lords, 2011, Marteau et al., 2011, Michie and West, 2012).

Utilisation of behavioural science theory to support the encouragement of pro-environmental behaviour change is not as widespread as with psychological models such as the TPB model, yet there are still a number of applications. Behavioural economic theory has been used to explain how travel demand can be adapted using behaviour change techniques, to reduce energy consumption and carbon emissions (Avineri, 2012, Metcalfe and Dolan, 2012). Household energy consumption has also utilised behavioural economic theory to explain domestic energy consumption behaviours including habits, adoption of energy efficiency investments (such as wall or loft insulation), willingness to contribute to public goods (such as green energy) and the adoption of pro-environmental behaviour (Cabinet Office et al., 2011, Pollitt and Shaorshadze, 2011). Behavioural economics has also been utilised to understand how recycling behaviours can be changed (John et al., 2011) and how best to communicate climate change (Spence and Pidgeon, 2010)

2.2.2.3 Sociology and Practice Theory

It is also important to mention another relatively recent framing of behaviour change which has come from sociology. This framing is quite different from the psychological and economic framings and is called practice theory. Although there is no leading version of practice theory there are some influential interpretations, notably Giddens (1984) and Bourdieu (1990) and more recently and in relation to consumption, the work of Shove (2004) and Warde (2005) have been important.

Social practice theory is essentially based on the premise that human behaviour and consumption is a societal phenomenon rather than an outcome of individual decisions. Therefore social practice theory is in contrast with other dominant theories of behaviour from psychology and behavioural economics, which explain behaviour as a result of an individual's decisions and support the idea 'that social order is then a product of the combination of single interests' (Reckwitz, 2002). Instead social practice theory emphasises that the development of behaviour is a collective endeavour, as opposed to being an outcome of individual endeavour. In social practice theory, social order is therefore 'embedded in collective cognitive and symbolic structures, in a shared knowledge' (Reckwitz, 2002) and practices are defined as:

> 'a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge' (Reckwitz, 2002)

Practice theory, being situated within sociology has tended to investigate pro-environmental behaviour change through the lens of sustainable consumption. Although a relatively new field, social practice theory has been used within a number of studies to explain sustainable consumption. Shove (2004) has made extensive use of social practices to understand three ordinary practices: comfort, cleanliness and convenience, which she terms ‘environmental hotspots of consumption’ (Shove, 2004: 3). Southerton (2012) has also advocated a practice-based approach to reconceptualise human actions in an effort to encourage a change in practices towards a direction that fosters more sustainable forms of consumption.

Warde (2005) has theorised that it is practices, rather than individual desires that create wants, and therefore it is ‘engagement in the practice, rather than any personal decision about a course of conduct, that explains the nature and process of consumption’ (Warde, 2005). This theory therefore raises uncertainty as to an individual’s agency for change towards more sustainable consumption patterns. Individuals may in fact be, or feel that they are locked in to certain unsustainable behaviours by a need for more fundamental and structural change in society, or a shift in cultural expectations and practices. For example, the desire for detached suburban housing has created urban sprawl. Serving such sprawl by efficient public transport is difficult and this has encouraged private car use. As a result, residents in suburban areas may feel unable to use public transport, for example to travel to work, due to a lack of adequate service. They may be, or feel locked-in to private car use (Jackson, 2005, Maniates, 2001, Sanne, 2002, Seyfang, 2005, Shove, 2004, Shove, 2010a).

However, a social practices approach to understanding sustainable consumption is not mainstream within policy circles and as Shove (2010b) observes, ‘the gulf between the forms of psychology and economics on which the majority of UK policy-making depends, and the issues that attract attention in social theory, is really wide'. The influence of these three schools of thought, in relation to behaviour change, and their influence on policy is discussed in section 2.3.

2.3 Behaviour Change in Policy

For policy makers, the onus of tackling unsustainability and unsustainable consumption, and by extension climate change, has fallen increasingly on the individual as a consumer, a principal actor and a lever of change (Barr et al., 2011, Dobson, 2010, Maniates, 2001, Sanne, 2002, Seyfang, 2005). This is despite the arguments from social practice theory that assert uncertainty surrounding the level of agency that individuals have towards changing unsustainable consumption behaviours or adopting pro-environmental behaviours.

Regardless, in line with the individualist nature of many western societies, policy responses to unsustainable consumption and climate change continue to focus on the individual as agents for change by encouraging these 'sovereign consumers' to make more sustainable choices (Hargreaves, 2011, Jackson, 2005: 4). However, this focus on the individual and behaviour change is not limited to the realms of sustainable consumption and climate change (though it is used widely in this area). In fact, this focus on 'behaviour change' is part of a wider movement in policy and in the UK behaviour change ideas have been applied to a number of policy challenges, including those related to health, finance, crime and climate change. For example, healthy eating has been encouraged through the introduction of food traffic-light labelling (using red, amber and green colour-coding to signify how healthy a food choice is; with more green lights signifying healthier choices), and organ donation has been encouraged through the introduction of 'required choice' for driving vehicle licence applicants (Cabinet Office, 2011a, House of Lords, 2011, Thaler and Sunstein, 2009, Whitehead et al., 2011).

A number of reasons for this increasing focus on behaviour change could be proffered. This focus could be as a result of austerity, with behaviour change ideas being used to justify the cutting of state spending and the construction of a much smaller state (Marteau et al., 2011, Whitehead et al., 2011). Alternatively, it may be as a result of ideology, with the aim of maintaining individual freedoms and choice, whilst promoting personal responsibility. (Institute for Government and Cabinet Office, 2010, Thaler and Sunstein, 2009, Whitehead et al., 2011). This is one of the reasons implied by the Coalition Government (HM Government, 2010a).

The British Government have demonstrated a keen interest in both behaviour change ideas and nudges in particular and upon taking power in 2010 the Coalition Government pledged that they would change people's behaviour by 'finding intelligent ways to encourage, support and enable people to make better choices for themselves' (HM Government, 2010a: 7-8). These 'intelligent ways' were proposed in place of rules and regulation, which the Coalition saw as 'bureaucratic levers of the past' (HM Government, 2010a: 7). The Coalition pledged to reduce 'the burden of regulation' through the 'red tape challenge' (Cabinet Office, 2012, HM Government, 2010a). This increasing focus on behaviour change also led to an inquiry into behaviour change by the House of Lords Science and Technology Select Committee. The aim of this inquiry was to ascertain if the government's approach to behaviour change was effective, and whether it could be improved (House of Lords, 2011).

2.3.1 Enacting Behaviour Change with Policy Levers

The types of levers that could be used in an intervention to encourage behaviour change are varied. As a result, each policy lever should be targeted to the specific type of behaviour that is trying to be changed. The range of interventions available to policy makers can be ordered into a 'ladder of interventions', where the highest rung of the ladder includes interventions that are most restrictive and the lower rungs are home to those interventions that are least restrictive. This is illustrated in Table 2.2, which has been prepared based upon the work of the House of Lords (2011), the Nuffield Council on Bioethics (2007), at the Parliamentary Office of Science and Technology (2012), by the author of this thesis.

This variance in the restrictiveness of the different interventions is necessary because the more restrictive an intervention is, the more likely that it will only be publicly acceptable if the loss of liberty can be weighed favourably against the desired result. For example, the ban on smoking in public places has been deemed acceptable by the electorate and indeed this intervention experienced greater support after its implementation. However, in general, a mix of different types of interventions is advocated as being more effective at changing behaviour, and this mix should include both regulatory and non-regulatory measures (House of Lords, 2011).

Table 2.2 Ladder of interventions and examples from the UK

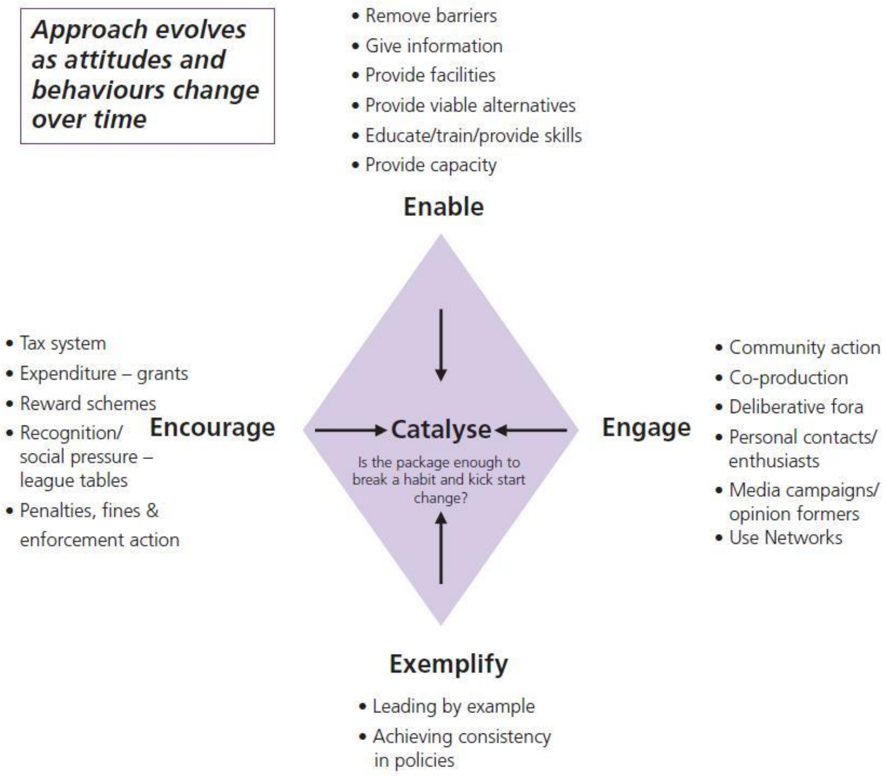
		Intervention type	Examples of policy interventions in the UK
Regulation of the individual		Eliminate choice by prohibiting goods or services	Phased ban on the manufacture and sale of incandescent bulbs, 2009
		Restrict choice and options available to individuals	Hosepipe ban in 2012; Banning the use of hose pipes yet gardens can still be watered by hand
Fiscal measures directed at individual		Guide choice through financial disincentives to make some behaviours more costly	Car use discouraged through the London Congestion Charge zone
		Guide choice through financial incentives to make some behaviours financially beneficial	The Green Deal and ECO encourages property insulation through loans and grants / The cycle to work tax break scheme encourages bicycle ownership and cycling
Non-regulatory and non-fiscal measures		Guide choice through non-fiscal incentives and disincentives which reward or penalise certain behaviours	Camden council’s ‘please cycle’ programme offers rewards and prizes to cyclists based on their cycle mileage
	‘Nudges’	Guide choices through changing the default policy or options	The UK government’s 10% carbon reduction target changed the default level and times for heating and cooling in government offices
		Enable choice by designing or controlling the physical or social environment	Country-wide local authority recycling programmes provide recycling infrastructure and door-step collection services
		Use social norms and salience to provide information about what others are doing	First Utility customers are provided with feedback on their household energy use and compared against other households, through household electricity reports.
		Provide information	Television advertising through the Act on CO_2 campaign to educate the public about climate change
		Do nothing and monitor the situation	DEFRA’s public attitudes survey to monitor attitudes towards the environment and climate change

Table developed by the author and based on similar tables from: House of Lords (2011), Nuffield Council on Bioethics (2007), Parliamentary Office of Science and Technology (2012)

2.3.2 Behaviour Change in Pro-Environmental Policy

In the UK, the use of behaviour change ideas, models and frameworks and the associated policy levers, have been used in policies that aim to encourage sustainable lifestyles. Over the past decade, this has been exemplified by the work of the Centre of Expertise on Influencing Behaviour at DEFRA, the Cabinet Office's Behavioural Insights Team, DECC's Customer Insight Team and the DfT (Cabinet Office et al., 2011, DEFRA, 2008, 2011a, DfT, 2010, 2011a, b).

One of the key behavioural models developed and used by the British Government is DEFRA's 4 E's policy framework (enable, encourage, engage and exemplify) which was first published in the 2005 report 'Securing the future' (HM Government, 2005) and developed later in 2008 as part of the framework for pro-environmental behaviour (DEFRA, 2008) and the sustainable lifestyles framework (DEFRA, 2011a). This 4 E's framework is a checklist of four elements that DEFRA assert should underpin behaviour change policies. These elements intend to ensure that a mix of interventions is employed to create the right conditions for behaviour change (DEFRA, 2011a). As can be seen in Figure 2.3, DEFRA's model is built on 'enabling', which makes it easier to act, 'engaging' which is about getting people involved, 'exemplifying' which about leading by example and demonstrating a shared responsibility and 'encouraging' which involves giving the right signals (HM Government, 2005).



Taken from: HM Government (2005)

Figure 2.3 DEFRA's 4 E's model

DEFRA’s 4 E’s model also informed the MINDSPACE model, which was developed by the Institute for Government and the Behavioural Insights Team at the Cabinet Office (2010). MINDSPACE is based on principles from behavioural economics and psychology and focuses strongly on individual decision-making. It advocates the use of ‘nudging’ or ‘non-coercive’ influences to change behaviour. MINDSPACE builds upon DEFRA’s 4 E’s to include ‘evaluate’ and ‘explore’. These 6 E’s work as an enhanced framework within which the MINDSPACE tools for changing behaviour can be applied (Institute for Government and Cabinet Office, 2010).

DECC also make use of behavioural theories to model energy efficiency and consumption behaviours with DECC’s Customer

Insight Team running training programmes for staff on the sociological, psychological and behavioural economics approach to behaviour change (Chatterton, 2011, Parliamentary Office of Science and Technology, 2012). In these programmes DECC makes use of both Triandis' (1977) 'Theory of Interpersonal Behaviour', which is a psychological model that focuses on individual decision making based on rational choice, the MINDSPACE model and also social practice theory (Chatterton, 2011, Parliamentary Office of Science and Technology, 2012). DECC has also worked in partnership with the Behavioural Insights Team at the Cabinet Office to utilise and test theories from behavioural economics, for example, they have researched how to encourage the uptake of energy efficiency products (using financial incentives) and how to encourage reductions in energy consumption (using feedback, labelling and information and social norms) (Cabinet Office et al., 2011, DECC, 2014a, 2014b).

The DFT also make use of behaviour change techniques to better understand how people could be influenced to achieve policy objectives, for example, to use lower carbon transport modes (Department for Transport, 2010, 2011a, b).

2.3.3 Behaviour Change and Decarbonisation

In addition to the political interest in behaviour change techniques and the prevelance of use of behavioural theories, models and frameworks within government departments, behaviour change is also an integral part of the UK's response to climate change and the decarbonisation targets legislated by the Climate Change Act 2008 (DECC, 2008).

In Britain, the route to decarbonisation is mapped out in carbon budgets that have been created by the Committee on Climate Change (CCC). The CCC is a statutory body of independent climate change advisors that was established under the Climate Change Act 2008. This body advises the UK Government on emission targets and as part of this role, the CCC create carbon budgets which are intended to support the UK in meeting the target to reduce GHG emissions by 80% by 2050. The CCC also monitors the progress that Britain makes in reducing GHG emissions (CCC, c. 2013, McGregor et al., 2012). The most recent of these Carbon Budgets is the Fourth Carbon Budget, which focuses on reducing emissions between 2023-27 (CCC, 2010). The three preceding budgets to this were published together in a single report and have covered the periods of 2008-12, 2013-17, and 2018-22 (CCC, 2008). The fifth carbon budget is due to be published in December 2015. All four budgets have been enshrined in law and aim to identify:

> ‘a range of options for reducing emissions across the key emitting sectors of the economy...which reflect a combination of improved energy efficiency and behaviour change to reduce demand for emitting activities and increasing use of low-carbon sources of energy supply in place of unabated fossil fuels’ (CCC, 2012)

This approach is very similar to other scenario exercises in that the CCC conclude that a combination of technological and lifestyle (behavioural) changes is required (HM Government, 2011, IPCC et al., 2000, Michaelis, 2003).

Thinking about this mix of behaviour change and technology specifically, the CCC assert that they ‘believe there is significant potential’ to make emissions savings from behaviour change. However, they also observe that behaviour change would not be sufficient as ‘an alternative to radical energy efficiency improvement and investment in low-carbon energy sources’ (CCC, 2008). One of the reasons for this is that the amount of emission reduction achievable in practice, as a result of behavioural change, is ambiguous. This is because it is dependent ‘on social attitudes and behaviour, and on the effectiveness of the policy levers used to encourage change’ (CCC, 2008).

Given this ambiguity, the budgets have pursued a number of abatement options that have tended to focus on technical fixes to give reductions in emissions, ‘simply because it is possible to design policy levers which will actually deliver’ (CCC, 2008). In addition, and as noticed by Michaelis (2003) another possible explanation for this focus on technological fixes may be because generally, in carbon modelling, although extensive quantitative work can be drawn upon to support estimations of technological potential, ‘assumptions about lifestyle changes are usually unsupported guesses’. This is simply because the empirical evidence to support these lifestyle changes is incredibly limited and this would act as a barrier to creating robust models.

However this focus on technological fixes does not offset the reality that ‘all deep decarbonisation scenarios require elements of change in supply and demand – i.e., technology and behaviour’ (Usher and Strachan, 2010). It also does not detract from the fact that technological fixes require public acceptance prior to adoption. As a result, the uptake and penetration of these technologies will be dependent on the decisions that consumers make. Generally, the carbon budgets do acknowledge that the requirement for behaviour change cannot be avoided and although technological fixes have hitherto been preferred, level of acceptance of new technologies is considered and behavioural changes do remain within the models that inform the budgets, in fact a number of behavioural changes are discussed (CCC, 2010, 2012).

For example, with respect to travel, behavioural changes included within the scenarios modelled include the adoption of ‘smart choices’. Smart choices are measures that intend to ‘influence people’s travel behaviour towards less carbon intensive alternatives’ and encourage people to switch from private cars to alternatives such as public transport, cycling and walking (CCC, 2010). In the models it is assumed that this behaviour change will reduce vehicle kilometres by 5% (CCC, 2010). It is also modelled that eco-driving techniques will be rolled-out and the extended ambition scenario assumes that by 2020, 10% of drivers will be trained in eco-driving (CCC, 2010).

With respect to residential buildings, the extended ambition scenario assumes that household energy use will be reduced as a result of behavioural change. Specifically, three behaviours are modelled and these are that households will reduce the temperature to which they heat their homes by 1 degree Celsius, that households will wash their clothes at a lower temperature in the washing machine and that householders will switch off unnecessary lights (CCC, 2010). For these three behaviours, it is assumed that 15 million, 15 million and 8 million households, respectively, will adopt these three behaviours by 2022 (CCC, 2010, Parliamentary Office of Science and Technology, 2012).

Further behaviour changes discussed within the budgets are that households will make more efficient use of heating controls and take shorter showers to use less hot water (CCC, 2010). Food consumption patterns are also modelled to change, with reduced consumption of carbon-intensive foods (meat) (CCC, 2010). Reductions in food waste are also considered (CCC, 2010). However, the CCC does not recommend which levers should be used to enact such consumer behaviours nor do they specify the mechanisms for encouraging the adoption of new technologies.

As a result, it is impossible to conclude whether or not these rates of adoption, by millions of households, and the modelled carbon savings, are reasonable. To elaborate, if it was known that the government intended to regulate these behaviours then it could be estimated with greater certainty that the rate of adoption would be relatively high. Conversely, if it was known that the government merely intended to deliver an information campaign to encourage these behaviours, then adoption levels could be reasonably assumed to be minimal. However, without knowing which levers and policies will be used to encourage the adoption of these behaviours, it is impossible to know if these models are reasonable.

Finally, acceptance of new technologies is considered within the carbon budgets. For when it comes to technological solutions such as the adoption of heat pumps or electric vehicles or the installation of residential building insulation, all of these options face some risks and barriers to their uptake. One such barrier to uptake observed in the budgets is consumer acceptability (CCC, 2012, 2010). Therefore, to model this, different deployment levels have been built into the budgets to ‘reflect risks that delivery may fall short of technical potential’ and this is because deployment is dependent upon the ‘successful implementation of policies to overcome barriers and drive uptake’ (CCC, 2012).

Although the budgets present different options to reduce GHG emissions through technological fixes to change behaviour and reduce demand, the ‘optimal mix of technologies and consumer behaviours’ is not specified and the reason given for this is that ‘it is not the role of the Committee to predict what precise mix of different technologies will be used to deliver future carbon budgets’, for that is ‘neither possible nor necessary’ (CCC, 2012, 2010). Reasons for this are that ‘future technological developments and costs are uncertain’ (CCC, 2010) and the aim of the carbon budgets is simply to demonstrate that ‘there are plausible scenarios for meeting the 2050 target, at reasonable cost’ (CCC, 2012). However, this lack of clarity does create a gap in understanding as to how, and to what extent, different technologies will penetrate society and the extent to which behaviour change will be adopted.

Indeed the responsibility for developing and delivering the policies that will overcome barriers and drive uptake to support the meeting of the legislated budgets sits firmly with the government (CCC, 2010). Therefore, by extension it could be reasonably assumed that the government will decide the precise mix of different technologies and behaviour change. However, there remains a lack of clarity around how these various behaviour changes will be enacted in practice for there is not a great deal of empirical evidence available on the efficacy of behaviour change programmes and this acts as a barrier to robust modelling of the behaviour change aspects of the budgets, and also understanding the potential adoption rates of new technologies.

However, this lack of clarity as to how behavioural changes can be effectively encouraged in the population using specific policy levers is not limited to the realms of climate change and sustainable development. In fact, a key finding of the House of Lords (2011) inquiry into behaviour change was that there is ‘a lack of applied research at a population level to support specific interventions to change the behaviour’ and that this is ‘a barrier to the formulation of evidence-based policies to change behaviour’ (House of Lords, 2011).

To address this problem, the House of Lords inquiry asserted that the government needs to evaluate their behaviour change interventions more rigorously ‘to establish whether policies are working’ but more importantly, to establish if ‘they contribute to the development of a much needed evidence-base for the effectiveness of interventions at a population level’ (House of Lords, 2011). The government’s response to this inquiry agreed that it is of critical importance that they ensure that behavioural interventions are properly evaluated and noted that they are increasingly focusing on this area (Cabinet Office, 2011b).

It is certainly true, that in relation to the behaviours proposed within the carbon budgets, there is a lack of applied research to support understanding of the efficacy of specific policy levers and interventions that intend to change behaviour. This has led to a focus on technical fixes in the budgets, rather than behaviour change. This is despite the CCC supporting the notion that there is significant potential to make emissions savings from behaviour change.

This lack of applied research also acts as a barrier to the formulation of evidence-based behaviour change policies, for it is not known which policy levers and intervention programmes will be most effective at actually delivering behaviour change and the uptake of new low-carbon technologies. This acts as a barrier to the formulation of realistic carbon budgets.

Evidence to support expected rates of uptake of new technologies is weak and this is partly because it relies on human behaviour. As a result, there is ambiguity as to the extent to which new technologies will be adopted. Therefore although values of carbon savings in the carbon budgets are attributed to a number of technological solutions, as well as behavioural changes, because of a lack of evidence the magnitude of GHG's that could be abated, in practice, is largely unknown.

2.3.4 Evaluating Behaviour Change

To establish this much-needed evidence base and to support the formulation of evidence-based policy, more extensive and robust evaluation of behaviour change interventions is necessary.

Specifically, in relation to the evaluation of pro-environmental behaviour change interventions, there is a need to focus not only on the effectiveness of specific policy levers and interventions and their effect on behaviour but also to focus on the environmental impact of the interventions, or as advocated in section 2.2.1.1, the carbon impact. For regrettably, the majority of evaluation of the effectiveness of policies to promote pro-environmental behaviour change of individuals, is measured in relation to the level of desired behavioural change rather than in terms of actual reductions in environmental or carbon impact, despite this being 'the ultimate goal of behavioural interventions in the environmental domain' (Csutora, 2012, Steg and Vlek, 2009).

In terms of evaluation of behaviour change interventions, a number of different methods are supported in the literature. For example Steg and Vlek (2009) advocate that interventions should be evaluated for their effectiveness using methods based on solid experimental research design. This is echoed in the British Academy report by John and Richardson (2012) who agree that there is a need for better evidence on effective methods and as a result, they advocate the use of more randomised controlled trials (RCTs) to test out behaviour change interventions. RCTs were also supported in the evidence at the House of Lords Inquiry (2011). However, this was in conflict with the views of other scholars who provided evidence, such as Pawson, who advocated the use of a more ‘comprehensive or a multi-method evaluation’ (House of Lords, 2011).

However, within the constraints of time, finance and capability, and given that little evaluation is being undertaken presently, it may be somewhat unrealistic to deliver randomised controlled trials on a widespread scale. Instead it may be more appropriate to evaluate existing behaviour change interventions using natural experiments. These experiments would therefore present an opportunity to monitor particular interventions that use specific policy levers to encourage particular behaviour change. Evaluation could then be undertaken to observe the penetration rate of the intervention (the number of people that have adopted the behaviour change), the longevity of the change and the impact of change, which is dependent upon the level of behaviour prior to the intervention and whether the behaviour was adopted partially, fully, or not at all.

2.4 Pro-Environmental Behaviour Change at the Local Level

In this chapter, the case has been made that there is an increasing focus on local authorities to take action on the environment and climate change (section 2.1.4) (CCC, 2012, DECC and LGA, 2011). There is also strong support from the British government for all levels of government to make use of behaviour change techniques and interventions, this includes local authorities (section 2.3) (House of Lords, 2011, John and Richardson, 2012). This was emphasised by the government in their evidence to the House of Lords (2011) inquiry where they demonstrated a preference for a greater role for local authorities in the development of policy that will impact upon the use of behaviour change interventions.

As a result, this chapter concludes that these circumstances may well offer an opportunity for researchers and policy makers to develop the evidence base on pro-environmental behaviour change interventions and their effectiveness, by monitoring and evaluating the impact of local authority sustainability behaviour change programmes (see section 2.2.1.1).

This opportunity is echoed in the House of Lords (2011) inquiry report where it was asserted that decentralising the responsibility for delivering behaviour change interventions to local authorities 'may provide a useful opportunity to tailor local behaviour change initiatives and to help build the evidence-base for applied behaviour change research at the population level'. In addition, action at a local level is supported specifically for the reason that 'different local areas have different local needs and so interventions should reflect these differences' (House of Lords 2011). This sentiment is shared by Lucas (2008), in relation to the encouragement of pro-environmental behaviour, who asserts 'that devolving power to ground-level agencies and organisations of individuals is the most effective way to encourage change'.

Many local authorities in Britain are indeed working to encourage pro-environmental behaviour change through sustainability programmes (John et al., 2011, John and Richardson, 2012, Lucas et al., 2008, Peters et al., 2010). However, while there are a number of examples of local authority sustainability programmes, the evidence of their impact on lifestyle change is very scarce (Peters et al., 2010). This is also observed by Bulkeley (2010) who notes that 'to date the literature has provided very little evidence of the extent to which the growing mass of urban policies and initiatives to address climate change are having an impact either in terms of reducing GHG emissions or through reducing vulnerability to climate risks'. Lucas et al. (2008) observes the same issue, noting that there is a lack of available data with which to ensure that the evaluation of the impact of policies on pro-environmental behaviours is possible.

Therefore, undertaking evaluation and assessment of the impact of policies and interventions that intend to encourage pro-environmental behaviour change, presents an opportunity to gather evidence and improve sustainability programmes within local government. At the same time, the evidence base pertaining to pro-environmental behaviour change could be developed to inform a research strategy that could support more robust behavioural modelling within the carbon budgets. However, it is important to consider that local authorities alone are unlikely to have the necessary skills, expertise and resources to evaluate programmes robustly and therefore require support in this endeavour (House of Lords, 2011).

2.5 Summary

This thesis has focused on understanding the potential contribution that pro-environmental behaviour changes could make towards reducing consumption related carbon emissions and specifically on the pro-environmental behaviour changes that are encouraged through local authority sustainability programmes. As a result, this research has drawn on both the sustainable development and climate change discourses. Attention has been placed on both the requirement for pro-environmental behaviour change, which has been largely demonstrated by the sustainable development literature (section 2.1.1), and the need for large-scale carbon abatement, which has been largely demonstrated by the climate change literature (section 2.1.2).

This chapter then moves onto cities and the lower levels of government, notably local authorities, and the roles that they may play in addressing climate change and sustainable development. This review identified them as both part of the problem but also a very important element of the solution (section 2.1.3 and 2.1.4). This review also demonstrated that within the context of Britain and as a result of a shift in politics towards ‘localism’, there has been an increasing focus on local authorities to respond and take action on climate change and sustainable development. It was observed that the British central government has acknowledged the ‘pivotal role’ that councils have to play in tackling climate change (DECC and LGA, 2011: 3).

Section 2.2 moved on to provide an overview of pro-environmental behaviour and its many definitions. Stern’s (2000) work on environmentally significant behaviours was deliberated and the use of his approach that places emphasis on ‘environmentally-significant behaviours’ will be used in the methodology of this thesis; whereby an ‘environmentally significant behaviour’ will be determined based on its ‘carbon impact’, ‘carbon-significance’, or ‘carbon abatement potential’. This is because of the intense political focus on carbon emission reduction in Britain, as a result of the Climate Change Act (section 2.1.2.1). This section of the thesis concluded with the presentation of the multiple interpretations, models and frameworks that have been developed within psychology, sociology and behavioural economics, to explain the factors that influence pro-environmental behaviour (section 2.2.2).

Finally, this chapter discussed the popularity of behaviour change theories, the use of behavioural insights and the associated policy levers that have been used by the British Government to enact behaviour change (section 2.3 and 2.3.1). Examples of the specific application of behaviour change ideas, models and frameworks and the associated policy levers, to pro-environmental behaviour, from both research and policy contexts, was also discussed (section 2.3.2). Finally, the role of behavioural change in decarbonising the UK, reducing GHG emissions, meeting the Climate Change Act's targets and preventing dangerous climate change was discussed (section 2.3.3).

2.6 Conclusion

This review concluded that due to a lack of evaluation of behaviour change programmes, there was a vast gap in understanding as to what influences people's behaviour and which interventions and policy levers are most effective at changing and encouraging pro-environmental behaviour within the constraints of the political realm (section 2.3.4). This chapter concluded that the evaluation of local authority sustainability programmes may provide an opportunity to develop the evidence base on pro-environmental behaviour change, which can support the formulation of stronger evidence-based policies and potentially even inform the development of more robust behavioural modelling within the carbon budgets (section 2.4).

This therefore highlighted some key issues that are to be resolved in this thesis. As presented in the introduction, the first research question intends to understand how local authorities are working to encourage pro-environmental behaviour. Therefore, to answer this question, initially it is necessary to provide more structured evidence about how local authorities are currently working to encourage pro-environmental behaviour in the population, through their sustainability programmes. This is to ascertain the extent of sustainability work being delivered by local authorities and to establish which behaviours are being encouraged by local authorities. There is also a need to undertake an assessment to ascertain whether local authorities are encouraging those behaviours mentioned within the CCC's carbon budgets. Then a review of the extent to which programmes are being evaluated will also need to be undertaken.

Once this is established, focus may then fall specifically on the evaluation of the impact of local authority sustainability programmes. This therefore relates to the second research question. It is proposed that the environmental impact of programmes be measured, quantified and evaluated in terms of the carbon abated (carbon-significant) behaviours. This is to ascertain the carbon impact of both the structural elements of the programme and any associated pro-environmental behaviour changes.

Chapter 3 Focus of Research

The central aim of this research is to understand better how local authorities are working to encourage pro-environmental behaviour, through their sustainability programmes, and the environmental impact of this work.

To do this, this thesis has made use of a number of methods to undertake three interwoven phases of research and answer the research questions (see Table 3.1). This chapter introduces an overview of this mixed-method design, which involves collecting and analysing both quantitative and qualitative data (Cresswell, 2003)..

Table 3.1 Phases of research and research questions

<table>
<tr><td>Research question 1: How are local authorities currently working to encourage pro-environmental behaviour amongst their residents and assist residents in a transition to a more sustainable lifestyle?</td><td colspan="2">Phase 1: Interviews with inner London local authority sustainability officers</td><td>Qualitative</td></tr>
<tr><td>Research question 2: What is the impact of local authority sustainability programmes and any associated pro-environmental behavioural changes?</td><td>Phase 2: Panel survey with residents from the RE:NEW home energy visit programme</td><td>Phase 3: Monitoring of a 'Green Zone' that aimed to encourage cycling, as part of the wider 'Green Zones' programme</td><td>Quantitative</td></tr>
</table>

This mixed method design, as shown in Table 3.1 is therefore a sequential exploratory design, that involves a qualitative stage of research that was elaborated on and developed in a quantitative stage (Cresswell, 2003, Tashakkori and Teddlie, 1998). As a result, the methods used to collect and analyse data were different for each phase of research, therefore the detailed methodologies for each of these three phases of research follow in the next three chapters (Chapter 4 to Chapter 6). Final interpretation of the entire analysis, for all phases of the research, is undertaken in two results chapter. Chapter 7 details the results from Phase 1 of the research. Chapter 8 details results from Phase 2 and Phase 3 of the research.

In light of the limited research done so far on this topic, and to limit the boundary of this research, this research has been undertaken with a specific focus on a limited number of local authorities in London. The first phase of research focuses on eight inner London local authorities. The final two phases ran in parallel and focused on two specific local authority sustainability programmes.

The first phase of this research, to answer the first research question, specifically aimed to broadly understand the nature of the sustainability work that was being undertaken by local authorities to encourage pro-environmental behaviour change and reduce the environmental impact of their boroughs. Therefore the initial phase developed the evidence base and provided more structured evidence about the different sustainability programmes being delivered within inner London.

To this end, a series of semi-structured, exploratory interviews were undertaken with eight inner London local authority council officers. These interviews intended to find out more about the different sustainability programmes that local authorities had in the past, and were currently delivering in their boroughs, generate discussion around these projects and elicit insights into the factors that influence their perceived effectiveness. A more detailed discussion of the questions asked in these interviews, and the methods used are detailed within Chapter 4. The results are detailed within Chapter 7.

A practical benefit of undertaking the initial interviews with council sustainability officers was that the interviews facilitated the fostering of a number of working relationships with three local authorities in inner London. These local authorities were worked with to undertake additional monitoring of their sustainability programmes and to estimate the environmental impact of the sustainability interventions.

Given this, between March 2012 and February 2014, access was negotiated with three inner London local authorities to allow monitoring of two different sustainability programmes that encouraged two different pro-environmental behaviours. This was to estimate their environmental impact in terms of carbon abated.

The first programme evaluated (Phase 2 of the research) focused on reducing energy consumption through a home energy visit programme called RE:NEW and this programme worked directly with local residents to change their energy (and water) consumption behaviours. RE:NEW was delivered simultaneously across all London Boroughs, however this research focused specifically on three inner London boroughs. To monitor the impact of the programme in these three boroughs, additional data collection, that was an extension to the existing local authority monitoring that was built into the programme, had to be undertaken. The RE:NEW programme and methods of monitoring and data collection are spoken about at length in Chapter 5. Chapter 8 details the results.

The second programme evaluate (Phase 3 of the research) aimed to encourage low-carbon transport by encouraging cycling through the provision of accessible and secure street-level cycle parking within a residential neighbourhood. This programme was delivered as part of a wider initiative by Camden Council, called ‘Green Zones’ and it worked directly with local residents to change their cycling habits. As a result, access to evaluate this project had to be negotiated with not only the local authority but also the local residents group.

To evaluate the local authority sustainability projects within this research, DEFRA’s 4 E’s (Figure 2.3) and the Ladder of Interventions (Table 2.2) will be utilised. These frameworks have been used because they interpret and identify nuances within projects and the specific levers of behaviour change they use. For example, DEFRA’s 4 E’s identifies whether a behaviour change lever is enabling change through the provision of training or engaging people by working with trusted messengers. Whereas the Ladder of Interventions categorises the lever of behaviour change based on how restrictive that lever is, for example the provision of infrastructure is identified as a non-regulatory and non-fiscal lever which will ‘nudge’ behaviour change. Both of these frameworks are therefore helpful in understanding and categorising how the project intends to change behaviour and through which levers.

These frameworks are therefore different to, for example, Ajzen’s Theory of Planned Behaviour (Ajzen, 1991) which instead focuses on which factors must be focused upon in order to change behaviour (attitude, perceived behavioural control and the subjective norm). It postulates that behaviour is an outcome of these three determinants. It is therefore less helpful than DEFRA’s 4 E’s and the Ladder of Interventions, which categorise the specific levers of behaviour change that a project utilises.

Table 3.2 Use of DEFRA's 4 E's in RE:NEW and Green Zones

		RE:NEW	Green Zones
Enable Systems and capacity: make it easier to act	Remove barriers, ensure ability to act	Yes, through provision of energy saving measures	Yes, by providing the cycle parking, this as a barrier itself is removed
	Give Information and build understanding	Yes, through behaviour change advice	No
	Provide facilities or viable alternatives	No	Yes, by providing the cycle parking
	Educate/train/provide skills	No, not to householders who are the target of the programme	No, not to participants who are the target of the programme
	Provide Capacity	No, not to householders who are the target of the programme	No, not to participants who are the target of the programme
Encourage Provide incentives and disincentives: give the right signals	Provide Incentives to encourage	Yes, through provision of energy saving measures	Yes, by providing the cycle parking
	Use Disincentives to discourage	No	No
	Provide feedback	No	No
Engage Get people involved	Work with trusted messengers	Yes, the local authority	Yes, the local authority and the tenants association
	Use networks	No	Yes, the tenants association
	Coproduce with the community	No	Yes, the tenants association
	Use insight to target segments of the borough population	Yes, by targeting specific wards	Yes, the Green Zones programme meant targets volunteered
Exemplify Demonstrate shared responsibility	Lead by example	Yes, by pro-actively delivering the programme	Yes, by pro-actively delivering the programme
	Consistency in policies	Yes, by pro-actively delivering the programme	Yes, by pro-actively delivering the programme
	Demonstrate others are acting	No	Yes, by working with the residents association who gave their time for free

Based on the descriptions of interventions, as described within the Ladder of Interventions (Table 2.2), The RE:NEW and the Green Zones programmes worked to encourage behaviour change through the use of non-regulatory, non-fiscal 'nudges', to guide choice through non-fiscal incentives or enable choice by changing the physical infrastructure. Both programmes utilised many of the tools identified in DEFRA's four E's (see Figure 2.3). Interactions with the E's and both programmes are detailed within Table 3.2.

Given this focus on two specific pro-environmental programmes and therefore two specific pro-environmental behaviours, as well as the focus on London Local Authorities, this chapter will introduce the context of this research and the capital city of London, in the United Kingdom, where this research has been undertaken. In addition, it will also provide a brief background to the literature that pertains to the specific behaviours encouraged by the RE:NEW and the Green Zones programmes which are focused upon later in this thesis. These programmes intend to change energy consumption and conservation behaviours and cycling behaviours

3.1 Focus on London Local Authorities

London is the capital city of Britain and one of the largest in Europe, having grown by 14% in the last decade (2001 to 2011) to reach 8.2 million by the 2011 census. It is projected that the population will reach 9.1 million by 2021 (GLA, 2013b).

However London has a number of environmental challenges. Firstly, London lags behind the national average in terms of recycling waste, this poor performance is often blamed on the housing typology of the city (GLA 2013a, GLA 2011a). London continues to have levels of PM_{10} and NO_2 that exceed national air quality standards, and the limits for NO_2 are not expected to reach EU compliance (under the EU air quality directive) before 2025 (GLA, 2010a, House of Commons Environmental Audit Committee, 2011).

Air quality is of course an issue that is linked to transport and this challenge could easily become worse, in light of growing population, if appropriate action is not taken. As a result, there is a need to shift Londoners onto more sustainable modes of transport like walking, cycling and public transport, to reduce the environmental impact of transport in London. In addition, in relation to private car use, the Mayor has advocated the adoption of electric vehicles. However, all of this will require a shift in attitudes and the provision of enabling infrastructure (GLA, 2010b, GLA, 2013d).

London is also at risk from energy insecurity, notably electricity. Presently, London uses 13% of the nation's electricity supply but only generates about 2% of the nation's capacity; this is clearly as a result of the high urban density of the capital. However, this does place attention on the need for London to increase its decentralised electricity production capacity. Especially in light of the capital's projected population increase, reducing demand would make this challenge more manageable (London Assembly Environment Committee, 2011).

London continues to be water stressed with current consumption at unsustainable rates. Londoners use 14% more water than the national average, something that is often blamed on small household sizes, which are less water efficient (GLA, 2011b). At the same time, London is at risk from surface water flooding, largely as a result of the vast impermeable surfaces in the city. Responses to mitigate this risk include greening the city to reduce the speed of run-off into drainage systems and supporting households to capture rainwater for non-potable uses. This has the additional benefit of reducing demand on mains water and reducing water stress in the city (GLA, 2013a, GLA, 2011b)

Within London, the Greater London Authority (GLA) controls city-wide administration and the Mayor of London with the GLA Assembly is responsible for many of London's environmental policies and strategies. Local administration is coordinated by London's 32 boroughs and each borough is managed by a local council, also known as a local authority. Each council is responsible for the administration of their borough and for delivering public services with the authority for services including highways, transport planning (but not passenger transport), housing, environmental health, waste collection and disposal and local and strategic planning, sitting with these local authorities (CCC, 2012: 14).

London boroughs are categorised into two types, with 12 boroughs categorised as inner boroughs and 20 as outer boroughs. This research will focus on inner London local authorities in particular. The City of London represents the 33rd borough of the capital but is operated differently, through the City Corporation, which has a wider remit than that of an ordinary local authority (City of London Corporation, 2013).

Given this large number of boroughs across London, this research will focus on inner London local authorities in particular. Inner London local authorities share a number of similarities and characteristics, all of which all impact upon residents ability to transition to a more sustainable and low carbon lifestyle. With respect to transport, inner London boroughs experience high levels of traffic congestion, poor air quality and low car ownership, currently average car ownership for inner London households is 0.6 cars per household whereas the English average is 1.2 (GLA 2010a, 2010b, 2012).

In relation to housing, inner London boroughs experience a very high density of population, with 99.5 people per hectare compared to an English average of 4 people per hectare, and many households live in flats (73.1% compared to an English average of 22.1%) (GLA 2012, Office for National Statistics, 2011a). Low numbers of residents live in owner occupied properties (33.5% compared to the English average of 63.4%) and high numbers of residents live within social housing (32.8% compared to the English average of 17.7%), and in privately rented accommodation (30.8% compared to the English average of 16.8%) (Office for National Statistics, 2011b). In addition, within inner London there is a general lack of private outdoor space and also public green space, with 21.7% of inner London being green space, compared to an English average of 87.5% (GLA 2012).

Clearly, London has not only a number of environmental challenges which it needs to respond to, but inner London and its specific context presents a particular challenge of its own.

3.2 Energy Consumption

This section introduces the literature that specifically pertains to the RE:NEW home energy visit project. The methods used to evaluate this programme are detailed within Chapter 5. Chapter 7 details the results. This project intended to reduce household energy consumption through a home energy visit programme. It worked directly with local residents to change their energy consumption behaviours. As a result, this section introduces the background literature on energy consumption behaviours.

In the UK in 2011, residential energy consumption was responsible for 23% of all carbon emissions (DECC 2013c). Given this figure, households constitute an important target group if Climate Change targets legislated under the Climate Change Act (DECC 2008) are to be met. Modelling by the CCC demonstrates that under the medium abatement scenario, between the years of 2010 and 2030 a total saving of 98 $MtCO_2$ will need to be achieved from the residential energy use sector. To put this figure into perspective, of the total reduction in GHG emissions required, this represents 34% of the total (CCC 2012).

Within the context of London there are additional targets to be met with respect to GHG emissions. In 2008, the Mayor of London committed the city to ambitious climate change targets, asserting that London will reduce its carbon emissions within the city by 60% by 2025, based on 1990 levels (GLA 2008). This represents a significant challenge in terms of reducing household energy consumption, especially given that figures from 2008 estimate that 36% (15.9 $MtCO_2$) of London's total emissions were as a result of residential energy consumption, meaning that the average London household emits approximately 4970 $kgCO_2$ per year (GLA 2011). In response to these targets, the Mayor of London has started to take action to reduce carbon emissions caused by household energy consumption. One example of this is the RE:NEW home energy retrofit programme.

3.2.1 Changing Energy Consumption Behaviours

Closer inspection of carbon emissions from residential energy consumption in the UK reveals that in 2012, space heating was the single largest contributor (52%). The next most significant area was lighting and appliances (30%) and finally cooking and water heating (18%) (CCC 2012). However, understanding how to change these behaviours is a very complex topic that has permeated the literature of a number of disciplines, in an effort to establish the behavioural determinants for household energy consumption (Abrahamse and Steg, 2009, Abrahamse et al., 2005, Lopes et al., 2012, Steg, 2008, Steg and Vlek, 2009).

As a result, there are a range of models that have been developed to describe the factors that influence energy consumption behaviours. Examples of these models include those used to explain pro-environmental behaviour change, for Ajzen's theory of planned behaviour (discussed in section 2.2.2). However, no one dominant model or framework is utilised to model and understand energy conservation behaviours. Therefore, different strategies are utilised to encourage energy conservation behaviours (Chatterton, 2011, Steg, 2008, Wilson and Dowlatabadi, 2007).

Household energy conservation behaviours can be divided into two categories: efficiency behaviours and curtailment behaviours (Abrahamse et al., 2005, Gardner and Stern, 1996). Curtailment behaviours are those that are habitual and repeated, for example, taking shorter showers to use less hot water, switching off unnecessary lights and turning down the thermostat (Barr et al., 2005, Gardner and Stern, 1996). Efficiency behaviours can be described as one-off or occasional behaviours and include the installation of energy saving measures such as wall or loft insulation, they also relate to purchasing, for example, the purchasing of an energy efficient appliance (Barr et al., 2005, Gardner and Stern, 1996).

Generally programmes to reduce energy consumption focus on encouraging both efficiency and curtailment behaviours. However, and as observed in section 2.3.3, efforts to reduce carbon emissions in Britain have tended to focus on encouraging the adoption of new technologies (efficiency behaviours). This is because the amount of emission reduction achievable from such changes can be more easily quantified than from curtailment behaviours. In addition, policies are generally more acceptable to the public when they target efficiency behaviours rather than curtailment behaviours, for this does not restrict individual freedoms and choice (Steg, 2008).

There are a number of barriers to changing energy use behaviours and these barriers are dependent on the specific type of behaviour in question. The distinction between efficiency and curtailment behaviours is not only related to the frequency with which these behaviours are practised, these two types of behaviour are in fact controlled by two different systems in the mind. This means that they respond in different ways to behaviour change levers (see section 2.2.2.2 for a review of the two systems and how they impact decision making).

To elaborate, curtailment behaviours, which are habitual, tend to be mediated by system 1, which operates automatically and with little conscious control (see section 2.2.2.2 for information on system 1 and system 2). Whereas, efficiency behaviours which are occasional, tend to be mediated by both systems in the mind, with higher order decision-making being modulated by system 2, which is thoughtful and allocates attention to decision making (Kahneman, 2011, Parliamentary Office of Science and Technology, 2012). As a result, these behaviours are performed with different amounts of deliberation, with habitual behaviours being undertaken less consciously and using automated cognitive processes, this makes habitual behaviours more difficult to change (Steg and Vlek, 2009). Therefore, encouraging energy use behaviour change requires different tools. The selection of these tools is dictated by the behaviour in question.

One tool that is often used to encourage curtailment behaviours is informational strategies, which can be used to overcome the barriers related to knowledge, attitudes, perceptions and motivations and encourage curtailment behaviours (Steg, 2008, Steg and Vlek, 2009). Information can be used to increase understanding, it can be tailored and delivered as feedback, it can be used to persuade and it can make use of social norms. It can also be delivered through generic information campaigns.

However, evidence demonstrates that information campaigns rarely result in any more than modest behavioural changes (Burgess et al., 1998, Kollmuss and Agyeman, 2002, Steg, 2008, Steg and Vlek, 2009). Despite this, information campaigns remain popular as a behaviour change tool because they do not contravene political intentions to maintain individual freedoms and choice, as society moves toward deregulation and privatisation (Whitehead et al., 2011, Vedung, 1995 as cited in Gyberg and Palm, 2009).

Efficiency behaviours tend to be delivered through structural strategies. Structural strategies change the decision making context by changing the availability, cost and benefit of the behaviour or its alternatives (Steg and Vlek, 2009). For example, in relation to the installation of new energy efficiency measures, typically the most important factors in the decision are the cost of installation and the payback period (Faiers et al., 2007). However, there are other barriers to the behaviour, for example, the hassle factor of installing such measures (Caird et al., 2008).

Structural measures can be used to lever change. For example, the provision of a loan can offset the upfront cost of installing the measure, thus financial incentives can also encourage uptake. For example, in the UK, the Green Deal programme offers grants and loans to householders to install energy efficiency measures and the feed-in-tariff and the Renewable Heat Incentive financially reward renewable energy generation and renewable heat generation, respectively (HM Government, 2013a, b, 2014a). In addition, services can also be offered to lever change. For example, loft clearance services could potentially ease the hassle factor of installing loft insulation (Cabinet Office et al., 2011), though results on such studies demonstrate that this may not be wholly effective (DECC, 2013b).

In general a combination of informational and structural strategies or a range of policy tools is most effective at levering change (House of Lords, 2011, Steg and Vlek, 2009). This approach is utilised in the 'home energy visit'. A home energy visit is a particular type of informational strategy, described by Abrahamse et al. (2005) as a 'visit by an auditor who gives households a range of energy-saving options (efficiency and curtailment behaviours) based on their current situation'. The visit therefore revolves around the provision of specific, personalised and tailored information, which 'is potentially a more effective way to encourage behavioural change' and lead to a reduction in residential direct energy consumption (Abrahamse et al., 2005, 2007). In addition a visit can be used as an opportunity to encourage householders to make a commitment to saving energy or to set goals in relation to energy conservation.

The advantage of tailored information provision over generic information campaigns is that householders should only receive tailored information that is relevant to them, rather than being bombarded with irrelevant information (Abrahamse et al., 2005). This tailored information therefore intends to address individual needs because it is personalised, but as Dowd and Hobman (2013) observes, it is difficult to provide highly individualised information cost-effectively. Examples of tailoring include providing advice on the specific insulation measures available to that household for the type of building that they live in, or giving specific advice on the operation of their boiler timer and heating controls. However, a review of home energy visits by Abrahamse et al. (2005) demonstrate varying levels of success in relation to behaviour change.

3.3 Low Carbon Transport and Cycling

This section introduces the literature that specifically pertains to the Green Zones cycling project. The methods used to evaluate this programme are detailed within Chapter 6. Chapter 8 details the results. This project intended to encourage low-carbon transport by encouraging cycling through the provision of accessible and secure street-level cycle parking. This programme was delivered as part of a wider initiative by Camden Council, called ‘Green Zones’. As a result, this section introduces the background literature on low carbon transport and behaviours.

The third and final phase of this research has focused on the encouragement of one mode of low carbon transport, cycling. The focus in this thesis will be on utilitarian cycling (cycling for transport and commuting) in London, rather than leisure cycling.

Motorised traffic and excessive private car use is a major contributor to environmental problems at a global scale and arguably a threat to the human environment (Bamberg et al., 2003, Bamberg et al., 2011, Gärling and Steg, 2007). In the UK, private transport accounts for 12.9% of all UK GHG emissions, whereas public transport journeys contribute merely 1.6% of emissions (DECC, 2013c). Therefore the requirement to reduce transport associated emissions is a key part of the fourth carbon budget, which alongside it's approach to surface transport, identifies that the development and provision of cycling infrastructure is as an important demand-side measure to reduce transport emissions (CCC, 2010).

Given the significant impact of private transport on carbon emissions and that two-thirds of all journeys made in the UK are less than 5 miles; the British Government have been increasingly concentrating their efforts on shifting these shorter journeys on to more pro-environmental and active modes of transport, including foot, bicycle and public transport, in an effort to reduce the carbon footprint of the UK, reach climate change goals and improve the health of the population (All Party Parliamentary Cycling Group, 2013, HM Government, 2012a).

Presently, in the UK, cycling accounts for 2% of all journeys, which is well below European neighbour's figures. In Germany, 14% of trips are made by bike, in the Netherlands, this figure is almost a third (Prime Minister's Office and Department for Transport, 2013).

However, in London, cycling on main roads has risen by 173% since 2001 (GLA & TfL, 2013d) and the Mayor of London, Boris Johnson, has asserted that he intends to double cycling over the next 10 years (GLA, 2013d). There are many benefits to cycling. Increased cycling levels reduce the overall amount of motorised traffic on the roads and therefore in turn reduce traffic congestion, noise and air pollution, to the benefit of all. In addition, cyclists themselves benefit from time and cost savings and improved health; with cyclists adding an average two years to their lives through improved health. (Cavill and Davis, 2007, Heinen et al., 2009). Increased cycling levels can also reduce traffic congestion. For the year 2013, it was estimated that traffic congestion cost the UK in excess of £12.5bn a year through fuel and time wasted and the increased costs in doing business; for London alone, this figure was in excess of £5bn (Centre for Economics and Business Research, 2014), therefore an increase in cycling which leads to a reduction in congestion has economic benefits.

Some London Boroughs, like Hackney, have made great progress in encouraging and increasing cycling rates. In Hackney 14.6% of all commuter trips are now being done by bicycle, overtaking the number of commuter trips done by private car (Office for National Statistics, 2013). In addition, in rush hour in London, there are now more bicycles than cars crossing over a number of inner London Thames bridges (All Party Parliamentary Cycling Group, 2013).

3.3.1 Influencing Cycling Behaviours

A number of factors can influence whether a person chooses to cycle, including urban form, provision of infrastructure and safety concerns (Garrard et al., 2008, Heinen et al., 2009). Firstly, urban form influences the distance to destinations and therefore the commuting times of trips. Given the exertion involved in cycling, generally this means that as distance increases the likelihood that a person will choose to cycle a trip diminishes (Heinen et al., 2009). Density also affects cycle rates, with dense urban areas being more conducive to cycling than other alternative modes of transport, mainly as a result of the greater number of destinations within walking and cycling distances (Litman and Steele, 2005). In addition, the amount and quality of infrastructure, such as bicycle lanes and paths, that support cycling also affects cycle rates. This of course also has an impact on safety (and perceived safety), which may discourage or encourage some people to cycle.

Behaviour change in transport, and therefore cycling, can be encouraged through the use of soft measures or hard measures. Hard measures include interventions that use financial disincentives, for example, congestion charging in London in the UK, or those that restrict. For example, in Paris, France, restrictions on HGV's in the city centre have improved cyclist safety records and perceptions of safety (British Cycling, 2013). Other hard measures include making physical improvements to infrastructure (Bamberg et al., 2011, Cairns et al., 2008). These improvements can intend to restrict or prohibit behaviour or, as often in the case of cycling infrastructure such as bicycle paths and lanes, be enabling.

Soft measures include interventions that intend to encourage voluntary behaviour change by addressing psychological motivations. Examples include, travel plans and mass information campaigns (Bamberg et al., 2011, Cairns et al., 2008). The division is therefore similar to the division in the energy use behaviours change literature (section 3.2.1) that terms the intervention strategies as informational and structural.

However, it is not only the barriers to cycling which might affect a person when on their bicycle that must be considered. The provision of secure, quality on-street and off-street cycle storage and parking, and other enabling infrastructure such as showers and lockers in workplaces can also encourage cycling (Heinen et al., 2009). In fact, for many people, dealing with their bicycle when it is not in use creates additional barriers to cycling, with the storing of bicycles when they are not in use, being an issue that is subject to constant negotiation (Aldred, 2012).

This issue is exacerbated within dense urban areas where many people live in shared accommodation and the prevalent type of housing is flats and apartments, all of which may not have appropriate storage facilities for bicycles. Coupled with the fear of bike theft for many urban cyclists, there is no alternative but to store bicycles inside living spaces where they can be perceived as both 'in the way, but also out of place in the indoor environment' (Aldred, 2012, Aldred and Jungnickel, 2013).

These issues are particularly rife in London, where a lack of secure and appropriate cycle parking (cycle storage) at the home has been identified as a key barrier to increasing cycling rates. In a survey conducted by Transport for London, it was found that only 11% of Londoner's have access to communal cycle parking and of the remaining 89% of residents who do not, 24% said that they did not have sufficient space within their property (including in hallways) to store a bike (GLA 2009)

To remedy this, within London, a number of resident bike user groups and boroughs have started to provide residential cycle parking. For example, secure bike parking has been installed in

Hackney, Lambeth and Camden (Lambeth Council, 2013a, b, London Cycling Campaign, 2008). However, these efforts are still relatively limited and their impact on increasing cycling rates is little documented.

3.4 Summary

This chapter has introduced the mixed-methods approach used to answer the research question in this thesis, which has made use of a combination of both qualitative and quantitative methods. The DEFRA 4 E's Framework and the Ladder of Interventions, which are utilised within this research to categorise levers of behaviour change used in sustainability projects, are also discussed.

This chapter continues by introducing the location of this research, which is the capital city of the United Kingdom, London (section 3.1). Next, the two specific pro-environmental behaviours encouraged by the two local authority sustainability programmes evaluated, the results of which are in Chapter 7, are introduced here: energy consumption and conservation behaviours and cycling behaviours. A brief background to the literature that pertains to these specific behaviours is provided (sections 3.2 and 3.3).

A full, detailed discussion of each of the methods used at each phases of the research, along with the results, is detailed in the following three chapters. A complete discussion and analysis of the findings from all first phase of research is provided within Chapter 7, the findings from the second and third phases of research are included within Chapter 8.

Chapter 4 Methods: Local Sustainability Programmes

The first phase of this research aimed to develop the evidence base and provide more structured evidence about the nature and extent of sustainability work that was being undertaken by local authorities, in London. The aim of this was to answer the first part of the research question and uncover how local authorities were working to encourage pro-environmental behaviour amongst their residents.

To answer this question, as indicated in Chapter 3, data was collected through a series of semi-structured, exploratory interviews with London local authority council officers. This chapter outlines the data collection methods and analysis methods. Results from these interviews are detailed within Chapter 7.

4.1 Data Collection Methods and Ethics

Given the limited pre-existing literature on pro-environmental behaviour change and local authorities, it was deemed that qualitative research methods would be the most appropriate method of data collection at this early stage to expand understanding. This is due to their 'characteristically exploratory, fluid and flexible, data-driven and context-sensitive' nature (Mason, 2002). Semi-structured, exploratory interviews were the chosen data collection method because at this stage, the research plan and route of enquiry, was still unclear. Exploratory interviews allowed for a broadening and deepening in understanding of the topic, which would inform the on-going research strategy.

An exploratory interview is described by Kvale (2007) as 'usually open with little pre-planned structure'. It involves the interviewer introducing an issue, an area to be charted or a problem complex to be uncovered and then follows up on the subject's answers, seeking new information about and new angles on the topic (Kvale, 2007). The purpose of the exploratory interview is to 'develop ideas and research hypotheses rather than to gather facts and statistics' (Oppenheim, 1992). The interviews were therefore inductive in nature and did not intend to 'corroborate or falsify a theory' (Gray, 2009). Instead, through the process of gathering data they attempted to 'establish patterns, consistencies and meanings' (Gray, 2009).

Semi-structured interviews were carried out with sustainability officers representing eight inner London local authorities. In total there are twelve inner London Boroughs, this research focused on inner London boroughs only (rather than all London boroughs) because of the similarities between the boroughs in terms of density, provision of outdoor green space, rate of car ownership and quality of public transport and provision of waste and recycling services. In addition, there are 32 London boroughs and to focus on them all would have made the scope of the research unmanageable.

Nine of the total twelve inner London authorities were invited to interview. In selecting these nine boroughs, one borough was omitted due to its high level of commercial activity; it had nearly double the number of active businesses than any other borough and therefore represents a rather unusual case (Greater London Authority, 2012). Two further boroughs were omitted due to their peripheral location and that they had the largest areas and lowest population densities. Of the nine boroughs invited to interview, eight agreed. One borough opted not to participate in this research. This borough was invited on numerous occasions, via phone calls and email but they ceased communications.

Face-to-face interviews were conducted over a period of seven months between 2011 and 2012. Interviews were undertaken with sustainability officers who had responsibility for delivering the council's sustainability programmes. These officers therefore had both present and past knowledge of the sustainability work delivered by the council. Sampling of the sustainability officers within a local authority was not possible because in almost all cases each local authority had only one or two people working in the field of sustainability, with the sufficient knowledge to be interviewed.

Interviews were undertaken with officers working under titles such as environmental sustainability manager, environmental performance manager, environment coordinator or climate change programme manager. For ease these officers are herein referred to as 'sustainability officers' or 'officers' and the department within which they work referred to as the 'sustainability department'.

Prior to the interviews and during informal discussions, interviewees were asked to confirm that they would be able to answer the questions posed to them and if they felt someone else in the council would be better placed to answer them. In one instance two people attended the interview and in another instance I was referred to another member of staff who had a more in-depth knowledge in different areas than the original interviewee. In one instance a former sustainability officer was also interviewed. This officer had been made redundant and this interview supplemented an interview already undertaken with a sustainability officer who was still in post.

Prior to the interview, interviewees were briefed on the nature of the study and provided with an information sheet that gave an overview of the research. This information sheet was emailed ahead of the interview, with the questions that would be asked. At the start of the interview, the information sheet, questions and a consent form were supplied in printed form (see Appendix 1). Interviewees were then briefed again on the nature of the research and some terms were clarified. For example, the term ‘sustainability project’ which is used throughout the interview was clarified as referring to ‘any planned intervention being undertaken by the local authority to reduce the environmental impact of the local authority and or the borough population’.

For ethical reasons, interviewees were then asked to consent to the interview being recorded and later transcribed and analysed. This is common practice in qualitative research (Gray, 2009, Kvale, 2007). They were then informed of the confidentiality of the information shared in the interview and this was discussed in reference to the consent form. Consent was given by each interviewee and countersigned by the interviewer before the interview. A copy of the signed consent form was later emailed to interviewees after the interview. All interviewees were informed that their identity would be kept confidential. At all interviews only myself and interviewees were present, the content was therefore kept private.

However, interviewees were also given the option of keeping the name of the council confidential, instead being only identified as ‘a borough located within London’. Half of the interviewees opted to keep the name of their employer confidential. As a result and to ensure the confidentiality of the officers who opted for their council to remain unnamed, all councils have been given an identifier: A, B, C, D, E, F, G and H. Throughout this thesis, the council identifier will be used to label quotations drawn on from the interviews. A summary of the sample of local authorities interviewed is detailed in Table 4.1. All of these local authorities have demonstrated a commitment to climate change by signing the Nottingham Declaration. To ensure the confidentiality of those interviewed, values have been grouped.

All interviews were undertaken within the place of employment of the interviewee. The interviewee was offered the opportunity to interview elsewhere if they so wished, UCL was offered as an alternative location but no interviewee opted to be interviewed away from their workplace. Interviewees spoke on average for an hour and seemed to enjoy sharing their experiences, some even noting how cathartic it was. All of the officers were very passionate about increasing the sustainability of the borough and seemed pleased to be able to help in this piece of research to further the sustainability agenda.

After the interviews, each interviewee was reconnected to with a follow-up project evaluation sheet. This evaluation sheet drew together information on the different sustainability projects discussed during the interview and offered interviewees the opportunity to verify the data collected was accurate. These project evaluation sheets are discussed in more detail in section 4.2.2.

Table 4.1 Summary of local authorities interviewed

	Census households, 2011 (number)	Population density, 2011 (per hectare)	Area that is green space, 2005 (%)	Total carbon emissions, 2011 (ktCO2)	Household waste recycling rate, 2011/12 (%)	Cars per household, 2011 (number)	Adults who cycle at least once per month, 2010/11 (%)
Average across sample boroughs	104100	114	20	1170	30	0.5	21
Average across Inner London boroughs	104750	106	23	1349	29	0.5	19
Average across Outer London boroughs	100300	50	37	1133	37	1.0	13
Total for London	3266200	52	38	39940	34	0.8	15
Total for England	22063400	4	87	354027	43	1.1	15

4.1.1 Interview Questions

The overall aim of these interviews was to identify and analyse the range of different sustainability programmes or interventions, herein referred to as 'sustainability projects', being undertaken within each of the local authorities. For the purpose of the interviews a sustainability project was defined as 'any planned intervention being undertaken by the local authority to reduce the environmental impact of the borough or the borough population'.

Interview questions were designed to encourage discussion around the different sustainability projects being delivered in each borough and elicit insights into the factors that contribute to effective sustainability projects, based on the interviewee's professional opinion. In addition, the interviews intended to provide insight into the types of relationships that exist between local authorities and residents, and how they interact to encourage pro-environmental behaviour. To this end, the format of the interviews revolved loosely around five questions that acted as introductions to the topics. These questions can be viewed in Appendix 1. Interviewee responses to these questions were then probed in an effort to encourage interviewees to elaborate on and clarify their answers. The interview questions covered three main themes:

1. The range of sustainability projects delivered in the borough
2. The success and effectiveness of these sustainability projects
3. The level of interaction between the borough population and the projects.

The semi-structured nature of the interview meant that interviewees could discuss the topics they felt were most important and pertinent, from their own experience of delivering sustainability projects. However, interviewees were asked to discuss all of the sustainability projects that they had worked on, regardless of the outcome of the project. This was possible because the number of projects was not so extensive; therefore interviewees had time to speak about them all. Where pre-existing literature on the sustainability work of the local authority was available, this was studied prior to the interview and used to prompt discussion on certain sustainability projects.

4.2 Data Analysis Methods

All of the interviews were transcribed verbatim, for analysis. The dates and length of the interviews is detailed with Table 4.2.

Table 4.2 Log of interviews with sustainability officers

Council[a]	Date	Number of people interviewed	Length of interview (hours:minutes)
Council A	24th October 2011	1	1:02
Council B	24th October 2011	2	1:00
Council C	27th October 2011	1	1:01
Council D	24th November	1	0:41
Council E	5th January 2012	1	0:54
Council F	10th February 2012	1	1:47
Council G	28th February 2012	1	0:58
Council F	2nd March 2012	1	0:44
Council H	4th April 2012	1	0:58

[a] Throughout this thesis, the council identifier will be used to label quotations drawn on from the interviews.

4.2.1 Initial Coding

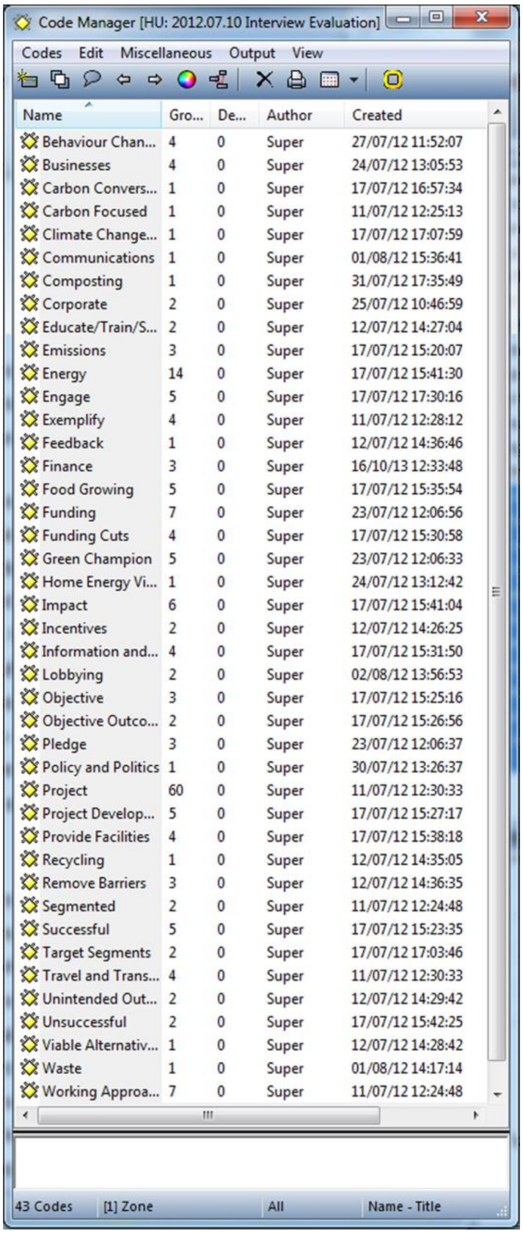
After transcription, all of the interviews were imported into Atlas.ti version 6.2. Atlas.ti. As (Silver and Lewins, 2014) identify, Atlas.ti is a Computer Assisted Qualitative Data Analysis (CAQDAS) software used to undertake qualitative research on data sets such as interviews, be they transcripts or videos. Such software supports the planning, managing and organisation of work by keeping an audit trail which allows users to illustrate their processes of analysis. They can also support the writing of analytical memos which keeps track of ideas as they occur and the reading of and commenting on data, which allow insights to be uncovered and data to be linked.

(Silver and Lewins, 2014) also identify that this software can be used to create a coding scheme and code and recode data. Coding allows the researcher to capture what is going on in the data. Atlas.ti was used because it offered a way to be more transparent in the analysis process and that the software allows for recoding which can be useful as the analysis develops. In addition, it supports code-based approach to qualitative data analysis, which was the methodological approach adopted in this research.

Coding is essentially labelling and can be described as the ‘means of categorising segments of data with a short name that simultaneously summarizes and accounts for each piece of your data’ (Charmaz, 2006), in practice coding involves taking text and labelling the text with a term or ‘code’ (Cresswell, 2003).

Each interview was worked through in turn and coded, a paragraph at a time, with the appropriate codes applied to the relevant text. As new codes were created, new definitions for each code were also recorded. Initially each interview was worked through in turn, coding each once, but the coding was an iterative process and therefore, after this initial stage of coding, each interview was worked through again in turn. This allowed for the refinement of reoccurring codes as the codes and their definitions developed and became more established.

This refinement of each code also led to the creation of new codes, the removal of some codes and the redefining of existing codes. For example, early on in the analysis, the code ‘finance’ was used to code any references related to cost, funding and money. Later this was broken into three codes, being ‘finance’, ‘funding’ and ‘funding cuts’, where funding identified discussion around outside bodies that were funding the different sustainability programmes and finance related to discussions around internal local government finance, protocols and business. ‘Funding cuts’ referred to discussions around lack of adequate funding for sustainability work. This process of rereading, recoding and redefining continued until the codes and analysis were consistent across the interviews.



Code Manager [HU: 2012.07.10 Interview Evaluation]

Codes Edit Miscellaneous Output View

Name	Gro...	De...	Author	Created
Behaviour Chan...	4	0	Super	27/07/12 11:52:07
Businesses	4	0	Super	24/07/12 13:05:53
Carbon Convers...	1	0	Super	17/07/12 16:57:34
Carbon Focused	1	0	Super	11/07/12 12:25:13
Climate Change...	1	0	Super	17/07/12 17:07:59
Communications	1	0	Super	01/08/12 15:36:41
Composting	1	0	Super	31/07/12 17:35:49
Corporate	2	0	Super	25/07/12 10:46:59
Educate/Train/S...	2	0	Super	12/07/12 14:27:04
Emissions	3	0	Super	17/07/12 15:20:07
Energy	14	0	Super	17/07/12 15:41:30
Engage	5	0	Super	17/07/12 17:30:16
Exemplify	4	0	Super	11/07/12 12:28:12
Feedback	1	0	Super	12/07/12 14:36:46
Finance	3	0	Super	16/10/13 12:33:48
Food Growing	5	0	Super	17/07/12 15:35:54
Funding	7	0	Super	23/07/12 12:06:56
Funding Cuts	4	0	Super	17/07/12 15:30:58
Green Champion	5	0	Super	23/07/12 12:06:33
Home Energy Vi...	1	0	Super	24/07/12 13:12:42
Impact	6	0	Super	17/07/12 15:41:04
Incentives	2	0	Super	12/07/12 14:26:25
Information and...	4	0	Super	17/07/12 15:31:50
Lobbying	2	0	Super	02/08/12 13:56:53
Objective	3	0	Super	17/07/12 15:25:16
Objective Outco...	2	0	Super	17/07/12 15:26:56
Pledge	3	0	Super	23/07/12 12:06:37
Policy and Politics	1	0	Super	30/07/12 13:26:37
Project	60	0	Super	11/07/12 12:30:33
Project Develop...	5	0	Super	17/07/12 15:27:17
Provide Facilities	4	0	Super	17/07/12 15:38:18
Recycling	1	0	Super	12/07/12 14:35:05
Remove Barriers	3	0	Super	12/07/12 14:36:35
Segmented	2	0	Super	11/07/12 12:24:48
Successful	5	0	Super	17/07/12 15:23:35
Target Segments	2	0	Super	17/07/12 17:03:46
Travel and Trans...	4	0	Super	11/07/12 12:30:33
Unintended Out...	2	0	Super	12/07/12 14:29:42
Unsuccessful	2	0	Super	17/07/12 15:42:25
Viable Alternativ...	1	0	Super	12/07/12 14:28:42
Waste	1	0	Super	01/08/12 14:17:14
Working Approa...	7	0	Super	11/07/12 12:24:48

43 Codes [1] Zone All Name - Title

Figure 4.1 Atlas.ti screenshot showing list of codes

In total, the process produced 43 codes (see Figure 4.1), each referring to specific types of discussion. For example, the code ‘impact’ referred to references of the impact of the sustainability work, the code ‘behaviour change’ referred to discussions about projects that explicitly encouraged behaviour change and the code ‘remove barriers’ referred to discussions that spoke about barriers to the sustainability work and how the local authority had attempted to remove these barriers. However this process was not just an exercise of code creation. Instead, this process intended to make sense of the data and link the data from each case. It essentially identified commonalities in what was going on in the different local authorities, to uncover the current state of affairs.

From this process of coding it was possible to identify commonalities emerging from the interviews. These commonalities offered insights into how the different sustainability department’s work, how their sustainability projects are conceived, the types of projects delivered and the driving forces that propel these projects forward. Commonalities were also identified in the various barriers that make sustainability work difficult, including the financial and political barriers. It was also observed that for all local authorities interviewed, there is a lack of an established methodology to measure both the performance and the environmental impact of their different sustainability projects.

4.2.2 Evaluation Criteria

An attempt was made to evaluate and compare the different sustainability projects, based solely on the information collected in the interviews, in order to better understand the factors (such as the delivery approach used) that influence the perceived effectiveness, success and environmental impact of the different projects. However, this proved not possible in practice because there was a lack of available, relevant and rigorous information and in particular a lack of comparable data, which could be used to evaluate the different sustainability projects.

During the interviews, sustainability officers were asked to discuss the different projects delivered within their departments. However, given the limited information available on the performance of the sustainability projects, generally, officers could only share insights pertaining to the projects by drawing on their own professional knowledge and experience of working on the programmes.

However, this approach obviously has its issues because the outcomes of a project are evaluated from the viewpoint of a single officer. This issue was compounded by a lack of clear objectives for many of the projects. An example of this would be that a number of projects had competing objectives. For example, a project to reduce energy consumption may target only residents from hard to reach communities (who generally have lower energy consumption habits). This would be in an effort to achieve a number of council objectives in a single project: to reduce energy consumption, to reduce fuel poverty and to encourage community cohesion.

These competing objectives make evaluation of environmental impact of the project challenging, because the outcome of the programme would be evaluated against these multiple objectives, rather than only against the reduction in environmental impact. As a result, officers may perceive the project as successful because it was successful in engaging and working with the community, but in terms of environmental impact, the project may be weak.

To counter this, when interviewees were questioned about the different sustainability projects, they were asked specifically to focus on the environmental impact. Interviewees were asked ‘could you tell me about the sustainability projects that [insert name] Council is currently delivering and the sustainability projects that [insert name]

Council has delivered in the past. Please focus on the projects that aim to reduce the environmental impact of the borough population' (see questions in Appendix 1).

Given these challenges, in this research evidence garnered in the interviews and supplemented by data collected through project evaluation sheets which provided an overview of the project and outcomes (see Figure 4.2). Evaluation sheets were created for all of the projects that were selected for analysis. The aim of these sheets was to verify the information collected in the interviews, they served as a common framework to structure the evaluation of each project. Evaluation sheets included information including a project description, project inputs and project objectives.

An example evaluation sheet can be seen in Figure 4.2. Each project was also evaluated against DEFRA's 4 E's model, to ascertain if the project made use of the mechanisms to enable, encourage, engage and exemplify. This was in an effort to identify any linkage between the outcome of the project and the extent of the 4 E's delivery approach adopted.

The delivery approach adopted was interpreted by observing for the use of the different elements that underpin the 4 E's model because these elements intend to ensure that a mix of interventions is employed to create the right conditions for behaviour change (see Figure 2.3). In practice, officers were asked to evaluate if each project enabled behaviour change by affirming on these sheets whether the project removed barriers to ensure ability to act, provided information to build understanding, provided facilities or viable alternatives, educated, trained or provided skills or provided capacity. They were also asked to affirm if they encouraged, engaged and exemplified through a number of different mechanism.

Intervention 5: Green Zones

Status: Ongoing

Project Description:

Green Zones originated in Brent and were adapted for this council. The programme aims to remove the barriers that the council can create for residents, and encourage them to take collective local green action. Residents identify a potential green improvement in their area, the council then works with the resident to support them to make that improvement happen. Zones created include things like providing secure cycle parking on an estate which has no cycle parking, creating food growing sites and providing recycling or composting facilities. The project aims to encourage communication with residents to find out what they think is wrong with their area and then encourage them further to act. The zones are resident led but facilitated by the council.

Officers observed that this project has been successful and that pro-environmental behaviour has been observed.

Objectives:

Objectives of the interventions	Was the objective met?
Support and empower residents to green and improve their local area	Yes
Reduce carbon emissions in the borough	Unknown
Remove barriers that residents face when greening their local area	Yes
Encourage collective green action	Yes

Input

1. Staff time to manage the programme
2. Funding for some incentives on occasion

Delivery approach:

Enable Systems and capacity: make it easier to act	Remove barriers, ensure ability to act	Yes
	Give Information and build understanding	Yes
	Provide facilities or viable alternatives	Yes
	Educate/train/provide skills	Yes
	Provide Capacity	Yes
Encourage Provide incentives and disincentives: give the right signals	Provide Incentives to encourage	Yes
	Use Disincentives to discourage	No
	Provide feedback	Yes
Engage Get people involved	Work with trusted messengers	Yes
	Use networks	Yes
	Coproduce with the community	Yes
	Use insight to target segments of the borough population	No
Exemplify Demonstrate shared responsibility	Lead by example	Yes
	Consistency in policies	Yes
	Demonstrate others are acting	Yes

Future of the project: The project is ongoing.

Resident participation: Interaction with this intervention by residents is very good.

Please score the project on the scale. Base this score on your knowledge of the project and your professional opinion:

How successful was the project in meeting its aims?

	Very Unsuccessful	Unsuccessful	Neither Successful nor Unsuccessful	Successful	Very Successful
Green Zones				x	

How effective was the project in encouraging pro-environmental behaviours amongst the borough population?

	Very Ineffective	Ineffective	Neither Effective nor Ineffective	Effective	Very Effective
Green Zones					x

Figure 4.2 Example evaluation template for 'Green Zones'

In addition to this mapping of projects against DEFRA's 4 E's, projects were also mapped against the Ladder of Interventions using data collected during the interviews and within the project evaluation sheets. Evaluation sheets were initially drafted using information from the interviews, and where possible secondary evidence, for example, council publications. These evaluation sheets were then sent to interviewees for verification. Interviewees edited and completed these sheets as they saw fit, changing inaccuracies and adding more detailed information. Interviewees were also asked to crudely score each individual project on a five-point scale. Firstly on how successful they felt each project was, and secondly on how effective they thought each project was at generating pro-environmental behaviour change. The simple scoring system used can be viewed on the example evaluation template, Figure 4.2.

Clearly, because these results are based on self-assessment during the verification process, the indicative scores are only perceptions. Therefore these results are indications of the perception of the performance of the project, rather than a definitive evaluation.

This scoring information on performance was then combined with the information collected on the use of the different elements of the 4 E's framework. The perceived effectiveness of each project at changing behaviour was correlated with a score based on the use of the different elements of the 4 E's framework where a single point score was given for each mechanism used i.e. if all mechanisms to enable were used, 5 points was awarded, if all mechanisms to encourage were used 3 points were awarded. The total possible score was 15.

The total performance scoring information was correlated against the DEFRA's four E's score to see if there was any relationship between the two factors. This approach was used because of DEFRA guidance that 'influencing behaviour is most effective when measures are combined from across these four broad categories of policy tools' (DEFRA, 2011a).

The correlation was calculated in Microsoft Excel. With correlation, if one variable is related to another then it will deviate from its mean in the same way as the other variable, if a correlation is perfectly positive then the coefficient will be +1, if there is no relationship then the coefficient would be 0 (Field, 2009: 166). If a strong positive correlation was observed then this would indicate that influencing intervention is most effective when measures are combined from across these four broad categories, however if little positive correlation between the 4 E's score and the performance score found, for all the projects overall, then this would indicate that a behaviour is not necessarily best influenced by a intervention that utilises all of the 4 E’s.

The results of this methodological approach are outlined within Chapter 7.

Chapter 5 Methods: Home Energy Visits

The second stage of this research aimed to estimate the carbon impact of a London based local authority home energy visit programme called RE:NEW. The RE:NEW home energy visit programme was conceived by the office of the Mayor of London and was launched in response to carbon reduction targets and in an effort to reduce carbon emissions from the residential sector.

The aim of this was to answer the second part of the research question. As indicated in Chapter 3, quantitative data was collected for a number of households that received a home energy visit. Data was collected by local authorities on the total number of energy saving measures installed in participant households. Using surveys, data on changes in programme participant's pro-environmental behaviour was collected as part of this research.

This chapter outlines in detail the data collection methods and analysis methods used. Results are detailed within Chapter 8.

5.1 The RE:NEW Home Energy Retrofit Scheme

RE:NEW is a home energy retrofit scheme that involves 'a trained energy advisor' visiting a resident's home and giving them a 'full energy audit, simple energy and water efficiency measures and behaviour change advice'. This involves the advisor explaining 'the customer can make changes to their behaviour to stop wasting energy and water' (Greater London Authority, c. 2013, Mayor of London, 2011d: 6). Along with providing advice, during a visit simple energy and water saving measures are also installed. These measures include radiator panels, low energy light bulbs, real-time electricity monitors, standby switches, 'save a flush' cistern water savers, shower timers, tap aerators, garden hose guns, letter box draught-proofers and aerating showerheads (Mayor of London, 2011c). In addition, the RE:NEW programme aims to convert these home energy visits into the installation of more substantial measures, which include measures such as loft and cavity wall insulation. This is encouraged through a system of referrals.

With reference to Ladder of Interventions (Table 2.2), the RE:NEW home energy visit intended to use ‘nudges’ to guide choice through the provision of free energy saving measures (non-fiscal incentives) and to provide information to encourage behaviour change. With reference to Figure 2.3 and DEFRA’s 4 E’s framework, RE:NEW intended to:

- Enable behaviour change by removing barriers through the provision of energy saving measures and by giving behaviour change advice and information
- Engage by using the council brand to encourage trust and by targeting specific wards
- Exemplify the local authority and GLA and lead by example through the pro-active delivery of the home energy visits
- Encourage through the provision of free energy saving measures

The publicity material for RE:NEW states that visits intend to help residents save money on their energy bills, make their homes warmer in the winter and ‘at the same time reduce the city’s carbon emissions’ (Climate Energy, 2012). As well as reducing CO_2 emissions, the programme also aims to contribute to reducing fuel poverty (GLA, 2014, Greater London Authority, c. 2013). Fuel poverty occurs when a household needs to spend more than 10% of its income on fuel to maintain a satisfactory heating regime (DECC, 2013a).

During the programme, RE:NEW was delivered within specific wards in each London borough. These areas were supposed to be targeted and primarily selected by the local authorities on the basis of carbon saving potential (Greater London Authority, c. 2013). Other contributing factors leading to their selection include the prevalence of residents in the locale that would be likely to be eligible for energy efficiency funding under programmes such as CERT (the Carbon Emissions Reduction Target) and the prevalence of vulnerable residents (Greater London Authority, 2013c, c. 2013).

In a recent evaluation report published by the GLA (2014), it was announced that between July 2011 and April 2012, which is the period of the roll-out phase of RE:NEW and excludes the pilot originally run in three boroughs between November 2009 and July 2010, 50,683 homes had been retrofitted under RE:NEW. The total programme cost to the Greater London Authority, for retrofitting these homes amounted to £5,721,500. An additional £1,087,500 was also levered into the programme from energy and water suppliers, Warm Front (a national scheme that provided grants to improve the heating and insulation in the home) and the boroughs (GLA, 2014). Overall, this gave a cost per visit of approximately £134. The report also estimated that each visit would save an average 171 kgCO_2 as a result of the installation of easy energy saving measures. This equates to approximately 3% of household emissions. Further measures were delivered in 3% of homes visited and it was estimated that they will save a total of 777 tCO_2.

5.1.1 Focus on Behaviour Change

Within the RE:NEW Good Practice Manual, which is a document aimed at giving guidance to help local authorities design 'a programme that will meet their objectives and local priorities' (Mayor of London, 2011d), 'behaviour' is mentioned, in total, thirty-eight times. 'Behaviour change' is specifically referred to twenty-seven times. This manual makes it clear that along with being an opportunity to install easy energy and water saving measures, a RE:NEW visit is intended to be used as a platform to give 'behaviour change advice [that] will provide customers with a means to reduce their energy and water use and associated utility costs' (Mayor of London, 2011d).

In addition, and although no local authorities participating in this particular research study applied for accreditation under CERT, RE:NEW was designed so that local authorities could apply for accreditation if they wished, for 'behaviour change advice is accredited under CERT and has been given a carbon score of 0.625t' (Mayor of London, 2011d). However, should a local authority apply for CERT accreditation for energy advice provided in the home, then certain standards must be met before credits can be claimed. This carbon saving score for home energy advice is based on an assumption that 'the average household would save 1% of electricity and 2% of gas for 7.5 years' which is a 'lifetime CO_2 saving score is 0.675 tCO_2', which is 90kgCO_2 per year (DECC, 2009).

The main aim of this programme was to reduce domestic CO_2 emissions and water use in London through a home visit from an energy advisor (GLA 2014). In general, the structure of each visit followed the basic outline of surveying the property, providing behaviour change advice, installing easy measures, referring households for further measures and then installing these further measures (GLA, 2014). The visit intended to encourage both curtailment and efficiency behaviours.

To encourage curtailment behaviours, information was provided about changes that householders could make to their behaviour ‘to stop wasting energy and water’ (Mayor of London, 2011d). This information intended to address the barriers related to knowledge, attitudes, perceptions and motivations (Steg, 2008, Steg and Vlek, 2009). Curtailment behaviours were also encouraged through the provision of tools such as in home energy display meters and shower timers.

In addition to this behaviour change advice to encourage curtailment behaviours, participants were also provided ‘tailored information’ which intended to encourage efficiency behaviours through structural measures, which would in turn reduce carbon emissions and energy bills (Barr et al., 2005, Gardner and Stern, 1996, Mayor of London, 2011d). Different types of structural energy saving measures available to householders, such as wall and loft insulation, were presented, and householders were offered a referral visit to explore these options further. Efficiency behaviours were also encouraged through the installation of simple energy saving measures such as radiator panels, tap aerators and draught excluders.

5.2 Data Collection Methods

This phase of research relates to the roll out of the RE:NEW home energy retrofit programme which ran during the period of July 2011 to April 2012, in particular it relates to the period of January to April 2012, when the programme and home visits started to gain momentum. The aim of this study was to estimate the impact of the programme in terms of carbon abated, for a number of households across three inner London boroughs (in total, 118).

Practically, work to assess and estimate the environmental impact of the RE:NEW programme was undertaken in partnership with three inner London local authorities. These three inner London local authorities, herein denoted by the letters A, B and C provided access to the sample population of RE:NEW participants and supported the surveying of residents. These councils were interviewed in Chapter 7 (methodology in Chapter 4) but the denotation in this chapter is different to ensure that the identity of the specific local authorities remain confidential.

During this phase of the research, the impact of the programme, in terms of carbon abated, was estimated for a sample of households (n_s = 118). Estimation of the impact of RE:NEW was two-fold. Firstly, reductions in carbon could be achieved from the easy measures installed during the visit and subsequent installation of more significant energy saving measures. Secondly, they could be achieved as a result of behavioural change. Therefore to estimate the impact of a visit, data had to be collected on both behavioural change and the installation of both easy and significant measures.

Data on measures installed in each household during each visit and referrals for more significant measures was collected by the local authorities and utilised in this research. This data on the number of easy energy saving measures installed during a visit was collected by the local authorities and was provided for the purposes of this research in raw data spreadsheets. The spreadsheets listed the number of and types of measures that were installed in each household in the sample.

In order to estimate the carbon impact of the behavioural change, additional data was required. Yet the project did not have monitoring mechanisms in place to assess and estimate the effect of the visit on participant’s energy use and wider pro-environmental behaviours, despite there being a strong emphasis on behaviour change (discussed in more detail in section 5.1.1). Given this, data on behaviour change was collected separately for the purposes of this research, through a two-stage panel survey (discussed in detail in section 5.2.3).

5.2.1 Natural experiments

The methodological approach used in the monitoring and observation of this local authority sustainability is therefore a natural experiment. A natural experiment is described by the Medical Research Council (2011) as a methodological approach to evaluating the impact of an event, intervention, or policy that is not under the control of researchers, and where the intervention is not undertaken for the purposes of research. The Scottish Government (c. 2014) describe natural experiments similarly, as 'observational studies which can be undertaken to assess the outcomes and impacts of policy interventions'.

There are a number of advantages and disadvantages of natural experiments. The advantages are that they can offer a 'pragmatic, cost-effective research design' and 'provide an opportunity to answer research questions that it may not be possible to address in any other way’; in addition, they can 'provide a useful tool for policy evaluation' but there are disadvantages (Scottish Government Social Research Group, c. 2014). The disadvantages are that because natural experiments are observational studies, it can be 'difficult to draw clear casual inferences' and there are also likely to be differences in the baselines and bias through self-selection (Scottish Government Social Research Group, c. 2014). These disadvantages will be considered and where possible they will be mitigated, in this research.

5.2.2 Study Area

Household information on the sample populations from Local Authorities A, B and C, and the corresponding ward populations where RE:NEW was delivered are detailed within Table 5.1In relation to the selection of the RE:NEW target areas, local authority A selected two adjacent wards, and authorities B and C opted to target a single ward each. RE:NEW guidance asserted that areas should be should be 'selected based on the maximum potential for carbon' abatement (Mayor of London, 2011d). In addition, borough priorities may mean that councils select areas based on indicators such as demographics, tenure and areas of fuel poverty. In the case of these three local authorities, the RE:NEW wards were selected because the areas had a high prevalence of fuel poverty, which can be affected by the building type, for example, solid wall properties can be very expensive to heat which can increase the risk of fuel poverty.

Overall, the sample population over the three boroughs was not representative of the general population (see Table 5.1). In comparison with the local ward population, study participants were more likely to be female. In addition, in each sample, at least 40% of respondents were from households that are multiple occupancy homes with children. The London average for households that are multiple occupancy homes with children is 31%. However, this is not very surprising given that RE:NEW visits were mostly conducted in the daytime, when home makers caring for children, are more likely to be at home than other types of household.

Table 5.1 Household demographical for RE:NEW study area

		Local Authority A		Local Authority B		Local Authority C		London
		Sample	Ward	Sample	Ward	Sample	Ward	All
Built Form	House	40%	21%	15%	14%	8%	6%	48%
	Flat or Maisonette	60%	77%	85%	84%	92%	84%	50%
	Other	0%	2%	0%	2%	0%	10%	1%
Tenure	Owner Occupied	63%	33%	30%	22%	23%	31%	48%
	Council	33%	27%	11%	23%	35%	2%	13%
	Privately Rented	5%	29%	4%	26%	6%	44%	25%
	RSL	0%	10%	56%	24%	35%	21%	11%
	Other	0%	2%	0%	5%	0%	3%	3%
Household Composition	Single occupancy	44%	22%	41%	38%	42%	51%	32%
	Multiple occupancy with children	44%	33%	44%	22%	42%	13%	31%
	Multiple Occupancy without children	12%	26%	15%	26%	17%	25%	28%
	Other	0%	19%	0%	15%	0%	11%	9%
Household Size	1 Person	44%	37%	37%	38%	41%	38%	32%
	2 People	33%	30%	30%	32%	29%	32%	29%
	3 People	9%	14%	14%	14%	13%	14%	16%
	4 People	7%	12%	12%	9%	11%	9%	13%
	5 People	5%	4%	4%	4%	4%	4%	6%
	6 People	0%	2%	2%	2%	2%	2%	3%
	7 People	2%	1%	1%	0%	1%	0%	1%
	8 or More People	0%	0%	0%	0%	0%	0%	1%
Gender	Male	49%	48%	30%	49%	38%	52%	49%
	Female	51%	52%	70%	51%	63%	48%	51%
Approximate Ward Density (Number of Persons per Hectare)		140		150		200		50

For all wards, the privately rented sector was heavily underrepresented in comparison to the ward average. In addition, in local authorities B and C, Registered Social Landlord (RSL) and council properties were overrepresented, respectively. Owner occupied properties were overrepresented in the sample from local authority A. As for the type of property that study participants lived in (i.e. house, flat), this was representative of the ward except in the case of local authority A, which had a greater proportion of houses in the study than there were on average in the ward.

5.2.3 Using Surveys to Collect Data

A panel survey (or questionnaire) was used to collect self-reported data on participant's pro-environmental behaviour, at the point of the home energy visit and again six months later. A panel design was selected so that changes in behaviour could be assessed. These reported changes could then be used to estimate the carbon abated as a result of this behaviour change. A panel design involves measurement of the experimental group (those that have had the intervention), at two points in time; between these two points in time the group is exposed to an intervention (De Vaus, 2004). In this case the intervention is the RE:NEW visit.

The term questionnaire can be used to describe different data collection methods, including structured interviews, however here we refer to self-administered postal surveys. Questionnaire surveys collect structured data on the same variables and characteristics from a number of cases and can contain check lists, attitude scales, projective techniques and rating scales (De Vaus, 2004, Oppenheim, 1992). The questionnaire survey collects systematic data that allows for systematic comparison of cases (De Vaus, 2004). Therefore, usually the questionnaire survey is selected as the appropriate data collection tool because ‘the questionnaire has a job to do: the function is measurement' (Oppenheim, 1992).

Surveys were selected as the most appropriate tool for data collection in this study, for a number of reasons. Surveys are a relatively low-cost to administer and can reach a lot of people in the data collection process; there are also established methods for the processing of the data for analysis (De Vaus, 2004). The most significant disadvantages of self-completion surveys include the often low response rates and the bias that is introduced by those who ‘choose’ to respond.

To improve response rates a couple of techniques can be utilised. Postal surveys should include a freepost return envelope and come from a trusted source that can offer confidentiality or anonymity, in addition, the postal survey should look professional and not like junk mail (Oppenheim, 1992). In addition, offering an incentive, such as entry into a small prize has been observed to increase response rates (Fink, 2009). Finally, explaining why the participant has been chosen to take part in the study also helps to increase response rates (Oppenheim, 1992), as does keeping the surveys be brief.

To improve survey response rates a couple of these techniques were used. The survey was a postal survey and therefore, in an effort to increase response rates, all surveys included a freepost envelope. In two cases, the local authority provided the free post envelope so that the survey could be returned to the council. In the third case UCL provided a free post envelope to return the survey to UCL. In addition all respondents were entered into a small prize draw to win a £20 gift voucher.

Self-reported surveys, which collected data specifically for the purposes of this research, by the researcher, were used to ascertain if the visit encouraged participants to change their behaviour. In total 1500 households were posted surveys over the three local authorities. These participants were recruited through the local authorities who supplied the addresses of residents that had taken part in the RE:NEW programme.

The survey design was a panel survey with two stages. As mentioned, the survey design was a panel survey with two stages. The stages of the survey and their relationship with the wider RE:NEW programme are detailed in Figure 5.1.

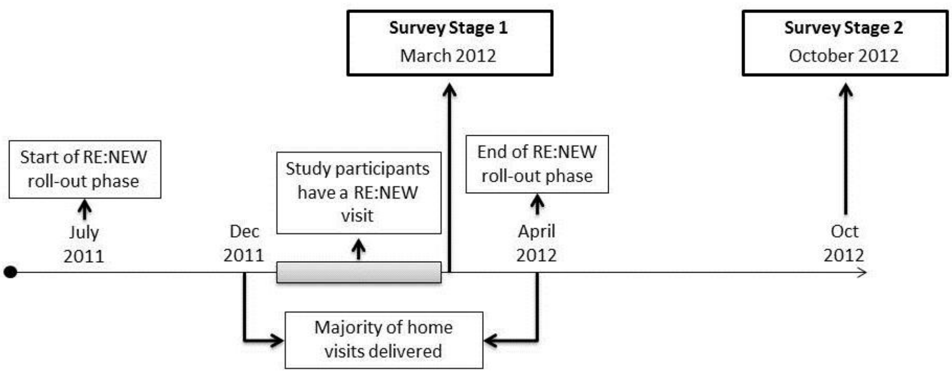


Figure 5.1 Survey stages

5.2.4 Survey Questions

Both stages of the survey sought to obtain a record of respondent's responses to a number of environmentally themed statements and the frequency with which they undertook a number of pro-environmental behaviours, such as 'I turn off unused appliances such as televisions and computers and do not leave them on standby' and 'I only fill the kettle with the water I need'. The behaviours surveyed are detailed within Table 5.3 and include a number of energy and water consumption conservation behaviours.

The same questions, which ask respondents to report the frequency with which they undertook different water, energy and wider pro-environmental behaviours and their attitudes towards the environment, were asked at both stages of the survey.

The behaviours are detailed in Table 5.3 and each behaviour has been attributed a reference number between B1 and B13. The environmentally themed attitude statements are detailed within Table 5.2. Information on the scales used to measure these items in the survey is detailed within the corresponding tables.

Table 5.2 Environmentally-themed survey attitude statements

Item type	Survey item	Original item in DEFRA survey
Attitudes towards the environment	I find it difficult to change my lifestyle to become more environmentally-friendly	I find it hard to change my habits to be more environmentally-friendly
	I am a ‘green’ person	Being green is an alternative lifestyle it's not for the majority
	I think that it is important that we all try to reduce our environmental impact and protect the environment	The environment is a low priority compared to other things in my life
	I’m only interested in ‘green’ behaviour if it can save me money	It's only worth doing environmentally-friendly things if they save you money
	I think there is little point in changing my lifestyle to reduce my environmental impact if others don’t do the same	It's not worth me doing things to help the environment if others don't do the same
Survey Scale: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree,		

Table 5.3 Behavioural survey questions

Headline behaviour		Survey item within questionnaire	Original item in DEFRA survey (2009)
Homes: Energy	Better energy management	If I am cold I'll put a jumper on or use a blanket instead of turning up the heating (B8)	Turning down thermostats (by 1 degree or more)
		I turn off unused appliances such as televisions and computers and do not leave them on standby (B11)	Leave your TV or PC on standby for long periods of time at home
	Better energy management and more responsible water usage	I set my washing machine to economy or low temperature cycles (B12)	Washing clothes at 40 degrees or less
Homes: Water		I only fill the kettle with the water that I need (B13)	Only boiling the kettle with as much water as you need
	More responsible water usage	I try to cut down on the amount of water I use at home (B9)	Making an effort to cut down on water usage at home
Personal Transport	Use more efficient vehicles	I use public transport, walk or cycle for everyday journeys (B1)	Switching to walking or cycling instead of driving for short, regular journeys / Switching to public transport instead of driving for regular journeys
	Use car less for short trips	I use my car for short journeys (B2)	
	Avoid unnecessary flights (short haul)	I take overseas holidays that involve flying (B3)	Taking fewer flights
Homes: Waste	Increase recycling	I separate and recycle my rubbish (B4)	Recycling items rather than throwing them away
	Waste less (food)	I actively try to reduce my waste (B7)	Wasting less food / Composting your household's food and/or garden waste
		I use my own reusable shopping bags for my grocery shopping (B10)	Taking your own shopping bag when shopping
Food & Purchasing	Adopt lower impact diet	I grow my own food (B5)	Growing your own fruit and vegetables
	Eat more food that is locally in season	I buy food that is local and in-season (B6)	Buying fresh food that has been grown when it is in season in the country where is was produced
Survey Scale: 1 = Never, 2 = Rarely, 3 = Some of the time, 4 = Frequently, 5 = Always,			

The behaviours and attitude statements have been largely adapted (as shown in Table 5.2 and Table 5.3) from DEFRA's survey of public attitudes and behaviours towards the environment (2009), which is a survey that has been carried out a total of six times since 1986. The survey items relate to the five priority behaviour groups of DEFRA and 12 headline behaviours (DEFRA, 2008). However, this questionnaire focuses on habitual and everyday pro-environmental behaviours, rather than one-off and occasional purchasing behaviours. Therefore three of the headline behaviours, related to the one-off installation of insulation, micro-generation and purchasing of energy efficient appliances, have been excluded from the survey.

The original items from the DEFRA study of public attitudes, prior to adaptation for inclusion in this survey, are also detailed Table 5.2 and Table 5.3. DEFRA behaviours were adapted into statements for the questionnaire so that they were in a format that would allow respondents to easily affirm the frequency with which they undertook the behaviours.

All scales used in the surveys had an option for participants to indicate if the question was not applicable to them. Finally, questions were asked about fuel poverty. This was requested by the local authorities and these results have not informed the analysis in this thesis. The original surveys for each stage can be viewed Appendix 2.

It is worth noting that these questionnaires were undertaken at the start and the end of the heating season. DECC's Energy Follow Up Survey found that the majority of households heat their home on a regular daily basis in October and finish sometime in March or April

(BRE, 2013). Therefore behaviours related to heating should have been at the forefront of participant's minds.

Using self-reporting to measure environmental behaviour and attitude in questionnaires is common (Barr et al., 2005, Gatersleben et al., 2002, Whitmarsh and O'Neill, 2010), however it can be deemed controversial for it does not measure the actual reduction in energy consumption. Some studies demonstrate that self-reported data is an unreliable indicator of actual behaviour with evidence of over-reporting of the extent of conservation behaviours, and weak correlation between actual and reported behaviours (Fuj et al., 1985). However, other studies have found that in relation to energy use, self-reports do correlate with actual energy consumption (Warriner et al., 1984). However, as Barr et al. (2005) mention, in their study that used a similar method of self-reporting, linking energy savings to specific behavioural changes that are habitual in nature, rather than to the structural measures that were installed at the point of the visit, would be near impossible. As a result, self-reports remained a realistic method for collecting data on habitual energy behaviours.

5.2.5 Study Constraints

As discussed, the survey design was a panel survey with two stages which sought to obtain a record of respondent's responses to a number of environmentally themed statements and the frequency with which they undertook a number of pro-environmental behaviours. Ideally, the survey would have been administered to residents prior to a RE:NEW home energy visit. However, this first stage of the survey was administered just after the RE:NEW home energy visit and this was one of the most significant constraints on this study.

It was not possible to survey participants prior to the home energy visit because RE:NEW visits were offered on an opt-in basis. Therefore it was not known which residents would participate in the programme until the participant had received a visit, especially as the majority of participants (68% of the sample) received a 'by chance' visit, as a result of a house-to-house door knocking exercise. The remainder of the sample obtained a visit by responding to a letter (23%) or by other means of communication (9%). It was not possible to require the contractor to survey participants immediately prior to the visit, for when this study was developed the contracts between the contractor and the local authorities had already been negotiated and agreed.

Once a visit had taken place the contact details of participants were stored with the contractor delivering the individual visits. Therefore, to support the surveying of participants the local authority had to request this information explicitly from the contractor, which added a slight delay. As a result, the survey respondents were asked to retrospectively indicate the frequency with which they undertook the number of pro-environmental behaviours. Specifically at stage one, they were asked to 'indicate how often you did these actions, prior to the home energy visit'. At stage 2 they were asked to 'indicate how often you do these actions'. Although this approach was not preferable, it was the only practical method available, through which data on behaviours at stage one could be recorded. This approach was also preferable to simply asking participants if they felt their behaviour had changed as a result of the visit, which would have required retrospective recall over 6 months previous. Recall over this time frame is more likely to be inaccurate.

Therefore, both stages of the survey asked participants to recall the frequency of a number of behaviours. A participant's ability to accurately recall behaviour is affected by the type of behaviour that they have been asked to recall, with more mundane and repetitive behaviours being more difficult, and the time elapsed since the event, with more recent events being recalled more accurately (Schwarz and Oyserman, 2001). It is recommended that to aid accurate recall it is best to restrict the task to a short and recent reference period, and use a recall cue; in this case the recall cue was the home energy visit and the event was recent enough that the likelihood of accurate recall is improved (Schwarz and Oyserman, 2001). Therefore, although recall of events does rely on some estimation, given the short time period between the visit and the reporting of stage one behaviours, this method is still suitable for collecting data on behaviour.

A second constraint on this study was that the surveys were not permitted to make any direct reference to 'RE:NEW' by name. Instead the surveys referred to 'your recent home energy visit'. This was because of concerns raised by the collaborating local authorities that the Greater London Authority (GLA) may not support a study into one of their initiatives. However the GLA was informed of the study before it commenced and this was not a problem. In addition, it is unlikely that householders would have been confused as the phrase 'your recent home energy visit' is descriptive and it is unlikely that householders would have had more than one home energy visit in the preceding weeks.

5.2.6 Control group

A control group survey was also employed. This control group was also surveyed at both stages. The control group was comprised of households from the same wards as the households who had been eligible to take part in the RE:NEW programme but these households had not taken part in the programme. The aim of the control group was to control for natural changes in the behaviour of the population as a result of other variables. For example, the population may change water consumption patterns because of a national drought campaign. The control group would reflect this and therefore any observed differences between the sample and control groups could be used to identify areas for further investigation.

The control group survey was very similar to the survey used for the main sample group. This survey asked the same questions pertaining to the frequency with which respondents undertook different water, energy and wider pro-environmental behaviours and their attitudes towards the environment. Again these questions were asked at both stages. The original survey for each stage can be viewed Appendix 3.

5.2.7 Sampling

The sample size was decided in collaboration with the participating local authorities. It was agreed that 500 households per local authority would be a sensible number of households to survey. The local authorities could not be convinced to sample all of their residents and given that they held the residents contact data this was accepted. This number was agreed because it represented a reasonable proportion of the total number of households that were expected to take part in the programme. During the roll-out of RE:NEW, the three collaborating local authorities visited approximately 4,400 homes in total. Therefore the 1500 surveyed represented 34% of those receiving a visit.

In addition, based on a population of 4400, an estimated variance in population of 50%, a sampling error of 5% and 95% confidence interval, it was calculated that the sample would need to be 353. Assuming an estimated response rate of 25% people the total sample size would need to be 1413, which was less than the proposed sample of 1500. However when the sample size was calculated using an estimated response rate of 10%, to account for both stages of the panel survey (first stage at 25% and second stage at 40%), it gave a sample size of 3533. To see sample size calculations based on James E. Bartlett et al. (2001), see Appendix 4.

The cost of posting the surveys (which fell on the local authority) and administrative aspects of providing return envelopes featured in the sample size decision and it was decided by the local authority that it would not be viable to survey 3533 participants. Instead a higher sampling error would have to be acceptable, therefore undertaking the same calculation with a sampling error of 10% and response rate of 10% gave a sample size, at stage one, of 960. Given that the 1500 figure had already been suggested, even though this was higher than the calculated sample size, it was agreed that this figure would continue to be used in case response rates were lower than predicted.

The first stage of surveys was posted to the sample group in March 2012, towards the end of the roll-out. Although on paper RE:NEW had been running since July 2011 and was set to reach completion in April 2012, in reality the programme did not gain momentum until the end of 2011. Given the sample size of 500 households for each local authority, it was necessary to wait until sufficient numbers of households were participating in the programme, and this only happened towards the end of January 2012. In addition the personal information and addresses of those that had already participated in the study had to be requested by the local authority from the contractor that was conducting the visits. In total, 335 households completed and returned the survey at the first stage (22% response rate). After data cleaning, the number of useable surveys returned was 305. This was therefore lower than the calculated sample size of 353, when allowing for a sampling error of 5%. However the sample size was sufficient when allowing for a sampling error of 10%.

Approximately six months later, between October and November 2012, those households that had returned the first survey were sent a second survey. 157 households completed and returned the stage two survey (47% response rate on sample of 335, 10.5% response rate compared to original sample of 1500). It was not possible to issue follow up surveys to residents because this would require re-access to residents, which had not been negotiated with local authorities at the start of the study. Local authorities were keen for the study to conclude by this time. After data cleaning, the useable number of surveys returned was 118. The process of data cleaning is explained in section 5.3.1. Detailed information on samples and response rates can be seen in Table 5.4.

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Table 5.4 Survey sample size and response rates

Local authority	Group	Survey stage	Sample size	Number of respondents	Response rate	No of responses that were useable	Percent of responses that were useable
A	Sample	1	500	110	22%	102	93%
		2	110	53	48%	43	81%
	Control	1	50	8	16%	6	75%
		2	8	6	75%	3	50%
B	Sample	1	500	99	20%	92	93%
		2	99	39	39%	27	69%
	Control	1	50	7	14%	5	71%
		2	7	2	29%	1	50%
C	Sample	1	500	126	25%	111	88%
		2	126	65	52%	48	74%
	Control	1	50	10	20%	10	100%
		2	10	9	90%	6	67%

The small control group of one hundred and fifty households were posted control group surveys. This represented fifty households in each of the three local authorities participating in the study. Addresses were selected from the appropriate wards at random and residents were posted surveys. This was done by taking the maps of the ward and blindly choosing random roads to survey. These surveys were not addressed to the individual by name because this information was not available. Also, because access to the full database of home energy visit participants was not possible for data security reasons, there was a risk that a control group survey could be sent to a resident that had actually taken part in the RE:NEW programme. Therefore in the control group survey, respondents were asked to confirm whether they had indeed taken part in the programme. This was the first question on the control group survey (see Appendix 3). Participants that verified that they had taken part in the RE:NEW programme were excluded from the control group and the study.

As mentioned above, at the first stage 150 households were posted the control group survey. In total, twenty five households completed and returned the stage one survey (17% response rate). After data cleaning, the number of useable surveys returned was twenty one. Approximately six months later, during October and November 2012, these households were then sent the stage two survey. Seventeen households completed and returned the stage two survey (68% response rate on sample of 25, 11% response rate compared to original sample of 150). After data cleaning, the useable number of surveys returned was ten. The process of data cleaning is explained in section 5.3.1.

It is worth noting that in an effort to elicit as many responses as possible, during the second stage of the surveys for the control group, reminder surveys were posted to non-respondents. This method was employed because the control group was so small. More detailed information on control group response rates can be seen in Table 5.4.

5.2.8 Ethics

Participation in the survey was voluntary and responses have been maintained as confidential. The research team did not have access to personal information of respondents, unless participants volunteered. To ensure the confidentiality of residents, partnering local authorities did not share addresses or personal information of their residents. Instead all personal information was retained by the local authority and a system of 'household identifier numbers' was employed, to facilitate the administration of the panel data.

Practically, this meant that the local authorities printed the names and addresses of participants, onto envelopes in their council offices.

Participants were then allocated a household identifier number and these numbers were shared with me. When it came to mailing the survey, surveys were brought to the council offices with a household identifier written on each survey. At the council offices, the surveys were matched with their corresponding envelopes and then once collated, the envelopes were retained by the local authorities who then proceeded to post the surveys to the sample. The household identifiers were used to match responses from each stage and also to identify the measures installed during that participants visit.

5.3 Data Analysis Methods

Data analysis aimed to answer the following two questions:

1. What is the impact of small easy energy saving measures installed during a home energy visit?
2. What is the impact of any associated pro-environmental behavioural changes?

The impact of the home energy visit is two-fold. Firstly, small easy measures, e.g. radiator panels, could be installed to save energy. Secondly, there could be pro-environmental behaviour change. Therefore to estimate the impact of the home energy visit, the carbon impact of the different small measures installed during the visit would need to be estimated, as would the carbon impact of any reported pro-environmental behaviour change. The impact of behaviour change would be estimated by comparing the frequency of behaviours reported at the first and second stage of the survey. When summed together, the total estimate of carbon impact of the visit for each household can be calculated. The method for this is detailed within section 5.3.3.

5.3.1 Data Cleaning

After the completion of both stages of survey data collection, the data was compiled into a database. This data was then prepared for analysis using both Microsoft Excel 2010 and SPSS version 21. An important initial step in cleaning the data involved identifying the participant households that had responded in both stage 1 and stage 2. Only participants that responded in both stages were carried forward for data analysis. It was also important to check, due to the transient nature of residents within inner London, that the person responding to both surveys had undergone the home energy visit and that the same household still continued to live in the property six months later.

Key questions in the survey aimed to ascertain that participants did indeed meet these requirements. The first question in the Stage one survey asked participants to confirm that their home had recently undergone a home energy visit (see Appendix 2). Also, the first question in the Stage two survey asked participants to confirm whether they remembered completing and returning a similar looking survey six months prior (see Appendix 2). Participants, in all but a 13 cases, for reasons explained below, were excluded from the analysis if they could not confirm that they met both of these requirements.

In these 13 cases, participants who did not confirm that they remembered completing and returning a similar looking survey earlier this year were still included in the analysis and this is because they were the same participant. This was verifiable where the participant had volunteered their name during both stages of their surveys. Cross-checking revealed that indeed the survey had been completed by the same person. As a result, it was assumed that these respondents had simply forgotten that they had filled in the stage one survey because the survey had been completed six months prior.

5.3.1.1 Reverse coding

Of the thirteen behavioural variables measured in the surveys, two had to undergo reverse coding. All behaviours were scaled in relation to the frequency with which they were performed. For eleven of the behaviours, the behaviours were positive behaviours, in that an increased frequency in that behaviour was likely to lead to less environmental impact from the behaviour. Two of the behaviours did not fit this. These two behaviours were ‘I use my car for short journeys’ (B2) and ‘I take overseas holidays that involve flying’ (B3). For these behaviours an increased frequency correlated with a negative environmental impact, therefore to be able to observe patterns in relation to a positive environmental impact, it was helpful to reverse code these two variables. Therefore an increase in the frequency of a behaviour equates to a reduction in environmental impact and a decrease in the frequency of a behaviour equates to an increase in environmental impact.

5.3.1.2 Missing values

As with all surveys, missing values were experienced. Missing values were coded into three categories. Responses identified by respondents as ‘not applicable’ were attributed the code ‘9’. Missing responses, where the respondent did not give any answer, were attributed the code ’10’. Where data was simply not available, the missing values were described as ‘not available’ and attributed the code ’11’. This code was only applicable to household data for the control group. This was because some of their demographic data was missing because they had not had a visit and therefore information on their household attributes had not been collected.

Analysis was undertaken to ascertain if there were any variables that had a high proportion of missing values (greater than 5% of cases). For participants that responded in both stages, there were three variables that had a high proportion (greater than 5%) of missing values. These variables were the behaviours: ‘I use my car for short journeys’, ‘I grow my own food’ and ‘I set my washing machine to economy or low temperature cycles’. These behaviours and the corresponding number of ‘not applicable’ and ‘answer not given’ missing responses are detailed below in Table 5.5. The data is for all 118 households, across the three boroughs. All other variables had less than 5% of cases missing.

Table 5.5 Variables with missing values

	Stage 1		Stage 2	
Behaviour	**Percentage of responses that were ‘not applicable’**	**Percentage of responses that were ‘answer not given’**	**Percentage of responses that were ‘not applicable’**	**Percentage of responses that were ‘answer not given’**
I use a car for short journeys (B2)	53 (41%)	2 (2%)	38 (30%)	2 (2%)
I grow my own food (B5)	26 (20%)	1 (1%)	20 (16%)	1 (1%)
I set my washing machine to economy or low temperature cycles (B12)	9 (7%)	1 (1%)	10 (8%)	0 (0%)

With reference to these three variables, the number of truly missing values (code 10, answer not given) represented less than 2% of all cases. Instead the majority of missing values was caused by respondents identifying that the question was not applicable to them. Reasons why these questions may not be applicable include that the respondent may not own a car, that the respondent does not have outdoor space and therefore perceives that food growing is not an option for them and finally that the respondent does not own a washing machine. In fact, in some instances respondents noted these reasons on their returned surveys.

To assess the nature of these and all other missing values and to ensure that the missing data is not due to an underlying problem, such as an ill-defined question or sensitive question, which may reduce the representativeness of the data, Little’s MCAR test (Little and Rubin, 2002) which is a chi-squared test for missing completely at random, was undertaken using SPSS version 21. Analysis was undertaken on a complete data set that included all variables for both the treatment and control groups at both stages. Data on household attributes were not included in the analysis because this was a complete data set without missing values.

The data was assessed using the 'missing value analysis' function within SPSS. This data identifies the proportion of missing values and what percentage of the sample they represent. The data output also provides the Little's MCAR chi-squared test statistic, the degrees of freedom and the significance of the result. A non-statistically significant result means that the null hypothesis is not rejected and that the data is missing completely at random.

It was found that the test was not statistically significant, therefore the null hypothesis that the missing values occur completely at random, is not rejected (Little's MCAR test: $\chi2 = 1075.557$, df = 1020, p = 0.111). Full results can be seen Appendix 5.

5.3.1.3 Attrition bias

Attrition bias can occur with panel data if participants drop out of the study before its completion. Although participants dropping out of a study may influence the power of the results, it is not necessarily a problem unless the attrition of the original sample becomes a potential threat of bias. This can happen if participants who drop out of the study are systematically different from those who remain in the study. If this happens then the result may be that the remaining sample is different from the original sample, resulting in bias (Salkind, 2007, Torgerson and Torgerson, 2008).

As detailed within section 5.2.7, during the first stage, 305 were returned. The second stage elicited a response of 118 follow-up surveys. In order to ascertain if there were any attrition biases, the stage one survey responses of those respondents who completed both stages of the survey were compared with those respondents who had only completed the first stage survey. This comparison of the two groups was undertaken using the Mann Whitney U-test. This test was used because it is a non-parametric test that can be used on ordinal data to test for differences between two independent samples. It tests whether the two medians are equal rather than the two means. It could therefore be used to test for a difference between the two groups: those who completed both stages of the survey and those respondents who had only completed the first stage survey.

Table 5.6 Results of Mann Whitney test on survey attrition

Behaviour	Statistics for stage one only respondents	Statistics for both stage respondents	Mann Whitney rest results
I separate and recycle my rubbish (B4)	Mean = 4.31, Median = 5	Mean = 4.61, Median = 5	U = 9068.500, z = -2.612, p < .01, r = -0.157
I actively try to reduce my waste (B7)	Mean = 3.94, Median = 4	Mean = 4.27, Median =4	U = 8596.000, z = -2.696, p < .01, r = -0.151
I try to cut down on the amount of water I use at home (B9)	Mean = 4.03, Median = 4	Mean = 4.29, Median = 5	U = 9130.500, z = -2.221, p < .05, r = -0.160
I turn off unused appliances such as televisions and computers and do not leave them on standby (B11)	Mean = 4.22, Median = 5	Mean = 4.54, Median = 5	U = 8952.500, z = -2.763, p < .01, r = -0.128

It was found that there was attrition bias with those that dropped out after the first stage performing the different energy water and wider pro-environmental behaviours with less frequency than those that completed both stages of the survey. This difference was significant for four behaviours, the behaviours and results of the test are detailed within Table 5.6. Full results can be seen Appendix 6. The implications of these results are discussed in more detail in section 8.1.4.

5.3.2 Statistical Tests

One of the aims of this study was to ascertain if the RE:NEW home energy visits had an impact on participants' energy and wider pro-environmental behaviours. To do this, the Mann Whitney U-Test, which is a non-parametric equivalent of the independent t-test, was used to calculate if there were significant differences in the amount that RE:NEW participants, known herein as the sample group (n_s = 118), changed the frequency with which they undertake a range of pro-environmental behaviours, compared to residents that had not taken part in the programme, herein referred to as the control group ($n_c = 10$). The Wilcoxon signed-rank test, which is a non-parametric equivalent of the dependent t-test was used to calculate if there were significant differences in the amount that the sample group of RE:NEW participants changed the frequency with which they undertake a range of pro-environmental behaviours, between stages 1 and 2.

Both tests were undertaken in SPSS version 21. All tests had the significance level set at 0.05, at which the null hypothesis would be rejected (Field, 2009: 51). These tests were selected as commonly accepted non-parametric alternatives to the independent and dependent t-tests (Field, 2009). Non-parametric tests were required because the data was ordinal.

The Mann Whitney test (Mann and Whitney, 1947) works on the principle of ranking data and is used to evaluate if two groups are different. This test was selected because it is a non-parametric test and therefore makes fewer assumptions about the distribution of the data (Field, 2009). It is suitable for ordinal data and can be used to test for differences between two independent samples. In this case, the sample and control groups were the two independent samples. With the Mann Whitney test, the hypothesis being tested is whether the two medians are equal, rather than the two means, as would be the case with an independent t-test (McCrum-Gardner, 2008). Due to it being a non-parametric test, it is also suitable for use when sample sizes are imbalanced.

The Mann Whitney test was run twice. These tests intended to ascertain if there was any statistical difference between the sample group and the control group. Firstly at stage one and secondly at stage two. This was in an effort to ascertain if, at stage one the groups were comparable, and at stage two, to demonstrate whether the groups were different in terms of reported changes in behaviour. To do this, the Mann Whitney test was used to compare the frequency with which the sample group undertook the different pro-environmental behaviours in comparison to the control group.

The Wilcoxon signed-rank test (Wilcoxon, 1945) has been used in this analysis, alongside the Mann-Whitney test, to test for any significant difference between the paired results for each group. The Wilcoxon signed-rank test is the non-parametric test equivalent of the dependent t-test and can be used to investigate change in repeated measures (Field, 2009). With the Wilcoxon signed-rank test, the hypothesis being tested is whether the median difference is zero, rather than the mean difference, as would be the case in the paired t-test (McCrum-Gardner, 2008). The test is based on the difference in the scores of paired measures, and like the Mann-Whitney test, it uses ranking. The difference is that with the Wilcoxon signed-rank test the sign of the difference between the two paired measures is then assigned to the rank. It is worth noting that the Wilcoxon signed-rank test does not compare groups in the way that the Mann Whitney test does. Instead the Wilcoxon signed-rank test is run separately for each group and the comparison occurs between the paired results; it is effectively a pre-post-test.

The Wilcoxon signed-rank test was used to ascertain if the observed 'change in behaviour' was significant. The 'change in behaviour' refers to the difference in reported frequencies of the behaviour between the first survey and the second survey. For example, at survey stage one, the behaviour may be reported to be undertaken with a frequency of ‘3’ which corresponds to ‘some of the time’. At survey stage two, the same respondent may report that they now undertake the behaviour with a frequency of ‘4’ which corresponds to ‘frequently’, therefore the change in behaviour would be +1 (4 minus 3). Conversely, the behaviour may change from a ‘4’ which corresponds to ‘frequently’ to ‘2’ which corresponds to ‘rarely’. In this case the change in behaviour would be -2 (2 minus 4). These scores are then used to rank the data.

5.3.3 Calculating the Carbon Impact of the Visit

This section of the analysis intended to estimate the carbon impact of the reported behavioural changes and the easy measures installed during each RE:NEW visit, for each household in the sample. This is in an effort to attribute a carbon figure to each visit. Although this is not a straightforward task, this analysis attempts to understand the impact of a home energy visit for participants in this sample, so that our understanding of the impact of local authority sustainability programmes can progress.

As Berners-Lee and Clark (2010) point out, one common dilemma within environmental studies is that the carbon footprint is impossible to pin down accurately and this is also true in this case. Therefore, this study does not intend to give a complete and highly accurate picture of the impact of a visit, for that is not possible. Instead, the calculations will estimate the carbon impact of each visit, based on the most realistic and practical estimates available. Therefore to deal with this uncertainty the method has been made transparent and it must be made clear here that although the behavioural changes reported and included in this model cannot be attributed directly to the home energy visit (because causality cannot be determined), these behavioural changes are related to energy and water consumption and therefore the aim of this piece of the analysis is to give a picture of the changes in energy and water consumption within the household over a six month period, following the energy visit, as a result of both the installation of easy measures during the visit and any behavioural change. It is worth adding that only behavioural changes related to energy and water pro-environmental behaviours are included in this analysis (B8, B9, B11, B12, B13).

To calculate the impact of the associated pro-environmental behaviour changes, the behavioural changes reported in the surveys have been modelled from an 'impact' oriented perspective (Stern, 2000). The advantage of this approach is that it observes and quantifies changes in behaviour in terms of environmental significance. This is important because different behaviours have different environmental significance and therefore a change in frequency from 'frequently' to 'always' for two different behaviours cannot be considered equal. To illustrate, if a participant decides to reduce the temperature to which they heat their home by 1°C then this will have a reasonably large carbon impact of 45 kgCO_2/year. In comparison if a participant decides that they will set their washing machine to economy or low temperature cycles then this action has a much lower impact in relation to carbon, saving only 6 kgCO_2/year.

This approach of analysing the impact of the home energy visit on behaviour, in terms of environmental significance therefore intends to avoid pitfalls observed by Olsen (1981) and Gatersleben et al. (2002). Gatersleben et al. (2002) observes that self-reported surveys do not always reflect actual environmental impact because respondents who report a large number of small conservation actions can receive a high score on an action index. However, these small actions undertaken may have had only a marginal environmental impact. The approach used in this study therefore avoids the error of summing self-reported behaviours into indices that are not representative of the environmental impact of the behaviour change, by equating changes to the environmental impact of the associated behaviours.

Further, by expressing the behavioural change in terms of quantifiable and meaningful units (in this case carbon avoided) the results will have more meaning for policy makers (Gatersleben et al., 2002). This supports the secondary aim of this study, which is to support local authorities in their implementation of more effective sustainability programmes.

Carbon factors were attributed to each easy measure and energy or water saving behaviour. Savings are based on a number of existing literature sources (see Table 5.7). RE:NEW guidance detailed that the carbon savings attributed under the RE:NEW programme have been calculated based on figures from Ofwat (the water services regulation authority), Ofgem (Office of Gas and Electricity Markets) and the EST (Energy Saving Trust) (Mayor of London, 2011b). However, a direct citation to the source of each figure was not available. Therefore this research has attempted to verify these figures by drawing on additional sources of information, where possible.

Using the values in Table 5.7 and information on the measures installed during the visit for each sample household (supplied by the local authorities in a spread sheet, detailed within results Table 8.1), the carbon impact resulting from the measures installed during the visit was estimated. Modelling of the behavioural changes was less straightforward, but using a number of existing literature sources and estimation, a total potential saving for each energy and water saving behaviour was estimated. See Table 5.8 for information on the assumptions, information sources used and the carbon impact of behavioural changes.

Table 5.7 Carbon and water savings attributed to easy measures

Measure installed	Carbon and water savings		Source of information
	$kgCO_2$ / yr	litres H_2O/ house/ yr	
CFLs/ lightbulbs	6.74	0	(Mayor of London, 2011b)
Tap aerators	33.00	7000	(EA, 2009)
Radiator panels (Solid and uninsulated cavity walls - type 1)	4.13	0	(OFGEM, 2008)
Radiator panels (All wall types, including insulated - type 2)	2.48	0	(OFGEM, 2008)
TV and PC standby switches	22.18	0	(OFGEM, 2013)
Real time monitors	64.40	0	(OFGEM, 2013)
Save a Flushes	3.41	4563	Ofwat reported savings within (Mayor of London, 2011a)
Showertimers	6.91	913	Ofwat reported savings within (Mayor of London, 2011a) and (EA, 2009)
Showerheads	82.93	10950	Ofwat reported savings within (Mayor of London, 2011a) and (EA, 2009)
No of Letterbox draught proofers	79.86	0	(Mayor of London, 2011b)
Garden Hose Guns	0.55	730	Ofwat reported savings within (Mayor of London, 2011a)

Table 5.8 Carbon savings attributed to behavioural change

Behaviour description	Information and assumptions informing calculation	Potential total carbon saving if frequency of behaviour changed from ‘never’ to ‘always’	Source of information
If I am cold I’ll put a jumper on or use a blanket instead of turning up the heating (B8)	Turning down thermostats by 1°C 15 m homes saves 4.1 $MtCO_2$ in the year 2022	273 $kgCO_2$ per household year	(Parliamentary Office of Science and Technology, 2012)
I try to cut down on the amount of water I use at home (B9)	Three actions including I 'wash up in a bowl instead of under a running tap', 'I turn tap off whilst brushing teeth' and 'I use the washing machine to do 3 loads a week instead of 4' can save 180 $kgCO_2$ per person per year	180 $kgCO_2$ per person per year	(EA, 2009)
I turn off unused appliances such as televisions and computers and do not leave them on standby (B11)	Average standby power in the home is 1.5 KWh/day which equates to a total standby consumption of 294 $kgCO_2$ per year	294 $kgCO_2$ per household year	(DEFRA, 2012, Energy Saving Trust et al., 2012)
I set my washing machine to economy or low temperature cycles (B12)	Washing clothes at a lower temperature in 8 m homes saves 0.3 $MtCO_2$ in the year 2022.	37.5$kgCO_2$ per household year	(AEA Technology Plc, 2008, Parliamentary Office of Science and Technology, 2012)
I only fill the kettle with the water that I need (B13)	A kettle is assumed to use 0.085 $kgCO_2$ per full boil. The average size of a kettle is 1.7 litres. Assuming the kettle is overfilled by 1.3 litres, twice daily, energy wasted equates to 47.5 $kgCO_2$ per year.	47.5 $kgCO_2$ per person per year	(Berners-Lee, 2010)

Next, the frequency with which behaviours were reported to have been performed was quantified. Assumed frequency for behaviours and how they mapped onto the survey scale were modelled as follows:

- ‘Never’ means this behaviour is never performed and the frequency is 0%
- ‘Rarely’ means this behaviour is performed between 0% and 33 % of the time
- ‘Some of the time’ means this behaviour is performed between 33% and 67% of the time
- ‘Frequently’ means this behaviour is performed between 67% and 100% of the time
- ‘Always’ means this behaviour is performed 100% of the time

Finally, using the mid-point for these frequencies and the values from Table 5.8, the carbon impact of reported behavioural changes was calculated. For example, a shift in the frequency with which behaviour 8 is performed, from ‘some of the time’ to ‘frequently’ frequently’ would be modelled as equating to a shift in frequency from 50% of the time to 84% of the time. Now, given that the potential carbon saving for this behaviour is 273 kgCO_2 per household per year, the carbon saving from the shift would be modelled as equating to 92 kgCO_2 per household year.

5.3.4 Cluster Analysis

After the construction of the model, cluster analysis was run on the sample (n=118) in an effort to group participants. Participants were clustered according to the answers they gave at stage one in relation to the environmentally themed statements on attitudes, non-responses on these five questions led to a reduction in the sample size (n=112). These environmentally themed statements are detailed within Table 5.2 and are referred to as the 'attitudes towards the environment' questions. The analysis did not take into account any other variables beyond these five attitude statements and the analysis was run in SPSS Version 21. A hierarchical cluster analysis was undertaken, using Ward's method (Squared Euclidean Distance).

Ward's method is an agglomerative clustering method, this means that each case begins as its own cluster and clusters are then merged in such a way as to reduce the variability within a cluster (Field, 2000). Ward's method is a commonly used approach in hierarchical clustering which aims to reduce the overall within-cluster variance (Mooi and Sarstedt, 2011). Ward's method is recommended when the dataset does not include outliers (Mooi and Sarstedt, 2011). This dataset does not include outliers given that the ordinal data can only give scores between 1 and 5, therefore Ward's methods was used. The results produced three clusters.

The complete results of this methodological approach are outlined within Chapter 8.

Chapter 6 Methods: Encouraging Cycling

The second sustainability programme evaluated in this research, which represents the third phase of the research, is Camden Green Zones. Green Zones is an initiative run by Camden Council that intended to support residents to take pro-environmental action in their community by offering tailored support, resources and materials to residents so that they can green their local area (Camden Council, 2013).

The aim of this was to continue to answer the second part of the research question. As indicated in Chapter 3, travel data was collected using GPS for a number of Camden residents who live in an estate called Lissenden Garden. These residents were offered a secure and accessible cycle parking space through the Green Zones programme. This travel data was used to ascertain whether provision of secure cycle parking caused residents to cycle further or more frequently.

This chapter outlines in detail the data collection methods and analysis methods used. Results are detailed within Chapter 8.

6.1 Camden Green Zones

Green Zones is a Camden Council-led initiative that was launched in December 2011 (Camden Council, 2013). During the launch event of this initiative, local authority sustainability officers that were presenting the project to residents, described how Camden believed that residents had good ideas ‘about how we [the council] could do things better or how you might [residents] want to green your area and engage your neighbours’ (Ware, 2011b).

Green Zones was based on this idea and revolved around the premise that residents are experts in their own neighbourhoods. Given this, Green Zones asked that residents identify environmental issues in their local areas and the barriers that they perceive prevent the adoption of wider pro-environmental behaviour. It also asked that residents propose solutions to these issues using their expert local knowledge. The council asserted that the programme intended to open doors for residents so that they could actually deliver these ideas within their own local area (Ware, 2011b).

In practice this has meant that Green Zones worked with residents to remove barriers to pro-environmental behaviour and to implement residents 'green' or environmental ideas. Green Zones worked specifically on an opt-in basis and aimed to encourage all kinds of pro-environmental behaviours. As of November 2013, Camden Council had approximately 50 completed zones and had 26 active zones (Oram, 2013). Examples of existing Green Zones include the provision of local food growing spaces, the provision of composting facilities in buildings of multiple occupancy, the delivery of energy saving and curtain lining workshops, the provision of cycle parking and the provision of improved recycling facilities.

To describe how the Green Zones programme functions in practice, two recycling-focused example Green Zones will be discussed. Both of these example Green Zones were created when two local residents separately approached Camden council to address low recycling rates in their immediate local areas. The reasons given by these residents, for the low recycling rates in their neighbourhoods, differed. In the first neighbourhood, residents perceived that low recycling rates were a direct result of a lack of on-site waste recycling facilities. In the second neighbourhood, residents perceived that there was little incentive for residents to recycle their waste.

Together, the residents and the council worked together to remove these perceived barriers to additional recycling. In the first zone, residents were provided with on-site waste recycling facilities and the council coordinated weekly collections of the recycling. In the second zone, the council organised a pilot to test the effectiveness of introducing a financial incentive that was proportional to the volume of waste recycled by that estate. Therefore, the response to both of these Green Zones was different and specifically based on these two individual residents' local knowledge.

However, Green Zones does not just encourage waste recycling but all types of pro-environmental behaviour, including local food growing, energy efficiency, sustainable travel including walking and cycling and biodiversity. However, given the widespread variance in these activities and across the different zones, the council realised that it was going to be very difficult to estimate the environmental impact of each zone. Indeed, during an interview with Camden Council this challenge of 'trying to turn it [the programme] into a carbon impact' (Ware, 2011a) was discussed.

Camden Council proposed that one approach to monitoring the Green Zones programme would be to generically measure impact by recording how many people the programme reached, provided recycling facilities to, etc., but it was observed that 'the challenge from there was trying to find the time and funding to analyse and bring together that information once it's there, which is a whole other problem' (Camden Council, 2012).

Given this observed problem and the lack of time and funding within the council to analyse the programme it was agreed that the programme would be monitored as part of this research. However, given that the zones work to encourage a wide range of pro-environmental behaviours, monitoring and estimation of the environmental impact of the programme was undertaken for a single Green Zone. This Green Zone intended to encourage cycling by means of the provision of secure cycle parking on a mansion block residential housing estate in North London, called Lissenden Gardens.

6.1.1 Lissenden Gardens Cycling Green Zone

The selected Green Zone intended to encourage cycling amongst residents of Lissenden Gardens, through the provision of accessible and secure cycle parking. To estimate the environmental impact of this intervention, the extent of cycling amongst residents of Lissenden Gardens, before and after the provision of the cycle infrastructure, was monitored. Cycling rates were monitored using GPS with inferred mode. Changes in cycle distances were then used to estimate the environmental impact of any observed change in cycling behaviour, as a result of the intervention.

With reference to Figure 2.3 and DEFRA's 4 E's framework, this Green Zone intended to:

- Enable behaviour change by removing barriers to cycling and by providing facilities in the form of the cycle parking
- Engage by using the Green Zones programmes and the council brand to reach out to networks and co-produce the outputs of the project with the tenants association

- Exemplify the local authority through the pro-active delivery of the cycle parking and by working with the residents association who gave their time for free
- Encourage through the provision of the cycle parking

With reference to Table 2.2, the Lissenden Gardens Green Zone intended to use ‘nudges’ to design the physical environment to enable choice (non-fiscal incentive). This is a ‘hard measure’ for it aims to create a change in behaviour through the provision of enabling infrastructure. Potential behaviour change outcomes of the provision of secure and accessible cycle parking include a shift in transport mode, whereby trips formally taken using public transport or cars are replaced by cycle trips or an increase in the length of time or distance of cycle trips. However to ascertain the impact of the provision of cycle parking, accurate data on the travel patterns of those provided with parking is required.

Lissenden Gardens is a residential housing estate in North London, comprised of approximately 250 flats spread over 5 floors and multiple buildings (see Table 6.3 and Figure 6.2) It is located in the north of the borough of Camden, in London, adjacent to Gospel Oak train station and Parliament Hill Fields open space. Lissenden Gardens was built in the 1890’s and is made up of three mansion blocks which are situated around a tennis court. The three blocks include Lissenden Mansions, Parliament Hill Mansions and Clevedon Mansions. The flats of these three mansion blocks are managed by Camden Council and they house a mix of leaseholders and council tenants.

The Green Zone was proposed by Lissenden Gardens’ Tenants Association (LGTA), who observed that there were a lot of cyclists on their estate but the majority of cyclists were forced to carry their bicycles up the stairs due to an absence of a lift within their buildings (it is not secure to leave bicycles locked on the street overnight). The buildings of Lissenden Gardens are five storeys high and this need to carry bicycles up stairs was perceived by residents as a barrier to increasing cycling rates on the estate.

As a result of this observation, in September 2012, Lissenden Gardens TA started a Green Zone through Camden Council. The aim of the Green Zone was, through the conversion of some unused garages, to provide secure, accessible, street-level cycle parking for residents that did not live on the ground floor, and who were forced to carry their bicycles up and down the stairs.

The residents secured their own funding for this venture but required the services of Camden Council in procuring and organising the construction of the new cycle parking. This was partly due to a lack of expertise amongst residents, in relation to procurement and construction procedures. A council officer was assigned to the Green Zone and work began. Unused outbuildings, garages and sheds were scoped for the purpose of housing the cycle parking. For this initial part of work (there were visions that the project could continue to supply more cycle parking in later projects), one large garage and three adjacent smaller sheds were allocated by the council, with the intention that the three smaller sheds could be knocked together into a single larger one.

Figure 6.1 Location of Lissenden Gardens Green Zone
(taken from streetmap.co.uk)

Figure 6.2 Aerial Image of Lissenden Gardens Green Zone
(taken from www.google.co.uk/maps)

Despite the project being conceived in September 2012, the construction of the cycle parking did not take place until the start of July 2013. This time lapse was a result of necessary engagement with residents at Lissenden Gardens and because of the limited availability of the contractor who was procured to install the cycle parking. Residents and specifically cyclists at Lissenden Gardens were consulted on the cycle parking and their preferences for the type of parking provided and its security. Consultation through the Lissenden Gardens Tenants Association (LGTA) commenced in early February 2013. After this, a call for applicants for cycle parking spaces was opened, with residents being allocated spaces on a first-come first-served basis.

At the end of June 2013 the three small sheds were knocked together (see Figure 6.3), the doors to the garage and sheds were strengthened for increased security and the cycle parking racks were installed. Within the three smaller sheds, 8 cycle parking spaces were provided and a further 18 spaces were provided in the larger garage. In total, 26 secure cycle parking spaces were created. At this point, it was planned that the cycle parking spaces would be allocated to residents, keys to the storage would be supplied and the cycle parking would be put to use. However, there were concerns over the structural integrity of the structure of the shed and garage by Camden Council and the Tenant's Association, because of some cracks in the brickwork. At this stage, a proper survey of the buildings had not been undertaken by the council. As a result, the project experienced a severe delay.

Figure 6.3 The 'small' cycle parking at Lissenden Gardens

To undertake the remedial work, a Camden Council builder and surveyor were booked to visit the cycle parking in early August 2013 but the visit did not take place. A surveyor was rebooked for early September 2013 but again, the visit never took place. Eventually the remedial works necessary on the building were completed in mid-September 2013 but given that the nights were getting darker due to the approaching winter, it was decided by the LGTA that the cycle parking would not open until new lighting had been installed. This decision was supported because a lack of good lighting could deter cyclists from using the cycle parking and interfere with the study.

Lighting was eventually installed and the cycle parking was opened on 27th November 2013. However, this was followed by yet another delay. It was realised that the contractor that installed the cycle parking had failed to install locking hoops (which allow cyclists to lock their frames to the stand, rather than just a wheel, which is not secure). As a result Camden Council had to recall the contractor to retrospectively fit the locking hoops. These were finally installed on 7th January 2014 and the cycle parking was opened (see Figure 6.4). This information is detailed graphically in Figure 6.4. These many delays were generally as a result of contractor incompetence, understaffing and council bureaucracy.

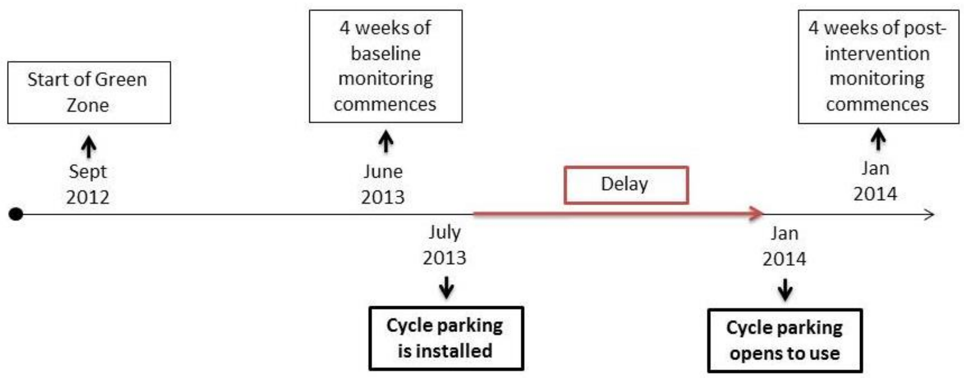

Figure 6.4 Programme timeline

Clearly, this delay in the project was not ideal for a number of reasons. Firstly, it meant that participants started to lose interest in the study and that the sample group started to view the cycle parking project less favourably overall. Secondly, it meant that the second stage of monitoring had to be undertaken at a very different time of year, when the weather was very different. In addition, circumstances in people's lives may have changed in the preceding 6 months, which could have altered their cycle miles (change in health, location of workplace, etc.).

However, due to the use of control group and the decision to use statistical tests which do not use a pre-post design (discussed later in section 5.3.2), it is felt that these changes would not excessively detriment the study and that the results would remain valid, however the impact of the small sample must be taken into consideration. In addition, much work was undertaken to continue to engage with all study participants and to keep them abreast of developments in the provision of the cycle parking and the study overall.

To do this, study participants were sent regular email updates on the expected opening of the cycle parking. In addition, questions from participants were also answered and when they could not be, these questions were passed to the LGTA or the council. The council were also worked closely with and meetings, emails and phone calls took place to encourage them to solve the issue and reduce the delay.

6.2 Data Collection Methods

The Lissenden Gardens cycling Green Zone ran from September 2012 to February 2014. The aim of this study was to ascertain whether the provision of secure cycle parking caused the sample group to cycle more often and more frequently, and if so, to estimate the impact of the programme in terms of carbon abated. To do this, a natural experiment (see section 5.2.1 for information on natural experiments) was undertaken that involved monitoring the travel behaviours and patterns, notably the cycle miles, of a number of recruited Lissenden Gardens' residents that were cyclists. A sample (treatment) and control group were employed.

Baseline travel behaviours for both groups were monitored for a period of four weeks, prior to the construction of the cycle parking. Once the cycle parking was open and in use, post-intervention measurements were collected. This final stage of monitoring also ran for four weeks. This pre- and post-intervention data on travel behaviours (distance travelled by mode) was then used to ascertain whether the provision of cycle parking caused cyclists in the sample group to cycle more than those in the control group, and to calculate the carbon impact of the intervention.

6.2.1 Sampling

As discussed, a natural experiment was used to monitor the impact of the provision of cycle parking on the cycle behaviours of a number of residents at Lissenden Gardens but the monitoring of travel patterns, particularly cycling, is weather dependent and therefore to control for such variances, and other local changes such as road closures, the provision of new infrastructure such as cycle lanes, the impact of the economy or prominent pro-cycle campaigns, the study has made use of both a sample and control group.

Although it was appreciated that a maximum sample size of 28 participants is small, prior to the recruitment of the study participants, it was hoped that the number of cyclists that signed up for a cycle parking space would be greater than the number of spaces available.

If this happened, it was agreed that the LGTA would explain that they would offer the parking spaces via a lottery and this would have created two random groups of cyclists from Lissenden Gardens, where some cyclists would have been allocated a space and some not. It was envisaged that these two groups, if willing to participate in the study, could constitute sample and control groups. However, the number of cyclists that applied for a cycle parking space did not exceed the number of available spaces until after the first stage of monitoring had commenced. By autumn 2013, the cycle parking spaces were oversubscribed by three people.

Nonetheless, the experiment still made use of both a sample and control group. The size of the sample group was limited by the number of people that applied for cycle parking. All residents that applied for a cycle parking space were contacted about taking part in the study. They were informed that participation was voluntary and that their identity and spatial information would be kept confidential. In total, 26 residents applied for a cycle parking space, of this eight agreed to take part in the study, representing 31% of the population. It is appreciated that this sample size is small, but due to the nature of the natural experiment it could not be increased.

However, baseline data from two participants corrupted during the study, meaning that the GPS data files were corrupt. This happened for one in the first half of the experiment and one participant in the second half. A third participant also lost their tracker, though they noted that they did not cycle in either stage of the experiment. This therefore reduced the size of the sample group by three people, to five people.

An additional five resident cyclists who lived in Lissenden Gardens, yet did not require a cycle parking space, were recruited to be in the control group. Volunteers were recruited through advertising of the study at tenants association meetings, on hallway notice boards and through word of mouth. The control group volunteers did not request cycle parking spaces because they either lived on the ground floor or a ground floor neighbour allowed them to park their bicycle in their private garden.

With the corrupted data in consideration, the sample and control groups were coincidently equal (n_s = 5 and n_c = 5). Clearly this sample is small but given the nature of the Green Zones programme it was not possible to obtain a larger sample. When the council agreed to work with the researcher to evaluate a Green Zone, the different Green Zones that were starting were considered and Lissenden Gardens was selected because it was the most suitable for evaluation, due to the nature of the Green Zone and because it had multiple participants involved.

Many other Green Zones were not suitable and had even smaller numbers of participants involved than at Lissenden Gardens. For example, one individual was supported to start a social enterprise to ensure that car tyres remained fully inflated so as to reduce fuel used in the borough, another resident posted water saving devices through people's doors. At another Green Zone, one resident worked to get a recycling bin installed in their block of 15 flats and another zone set up a community garden.

The latter two were considered for evaluation because they did interact with the wider community but it was deemed that these would not be so easy to evaluate. For example, to evaluate recycling habits, a baseline measurement of existing recycling would need to be measured. However, this would have been difficult to obtain because if recycling was already being undertaken by those living in these flats, then it would have been via on-street communal facilities about 200m from the home. It would not have been easy to require residents in these flats to have their recycling levels monitored when they would have been depositing any recycling at different times on different days. This would have been too onerous for participants. Therefore obtaining a baseline would have been very difficult.

Evaluating the impact of a community garden is also challenging. Firstly, it is difficult to identify the boundaries of the project, to tell what its environmental impact is and where carbon savings would have come from. The carbon impact of local food growing compared to purchased food could have been estimated but this would have been very difficult. Participant's food consumption and purchasing habits before the food growing site was used would have needed to have been monitored, which would have been very onerous for participants. In addition, if food was not grown then the environmental impact of increased biodiversity would have been very difficult to monitor, as would estimating the impact on carbon reduction as a result of more plants, trees and grassland.

Given these challenges the cycle parking Green Zone at Lissenden Gardens was selected for evaluation. This was because the group of residents that the Green Zone reached was clear, there was also a clear mechanism for contacting them and involving them in the study and the means to monitor environmental impact was not so onerous that participants would opt not to take part in the study. Therefore, although the sample was small, the Lissenden Gardens cycle parking study was the most suitable Green Zone available for evaluation.

Table 6.1 Study participants

	Participant	Sex	Age	Working pattern	Type of cyclist	Frequency of cycling trips
Sample Group	1	M	25-39	Full-time employed	Commuter cyclist	More than 3 times a week
	2	M	40-59	Full-time employed	Not cycling frequently due to storage issues	Once a month
	3	M	60+	Retired	Utilitarian cyclist	Once a fortnight
	4	M	25-39	Full-time employed	Commuter cyclist	More than 3 times a week
	5	F	40-59	Full-time self employed	Commuter cyclist	Between 1 and 3 times a week
Control Group	101	F	60+	Retired	Utilitarian cyclist	Between 1 and 3 times a week
	102	F	40-59	Part-time employed	Commuter cyclist	Between 1 and 3 times a week
	103	M	40-59	Full-time employed	Commuter cyclist	More than 3 times a week
	104	M	40-59	Full-time employed	Commuter cyclist	More than 3 times a week
	105	M	60+	Retired	Utilitarian cyclist	More than 3 times a week
Corrupted Group	X1	F	40-59	Full-time employed	Not cycling frequently due to storage issues	Less than once a month
	X2	F	25-39	Part-time employed	Not cycling frequently due to storage issues	More than 3 times a week
	X3	F	25-39	Full-time employed	Not cycling frequently due to storage issues	Less than once a month

As discussed, the sample and control groups were coincidentally equal (n_s = 5 and n_c = 5). In relation to cycling habits, the control group were committed commuter and utilitarian cyclists, whereas in the sample group, only 3 of 5 participants were cycling more than once a week. This was largely due to the need to carry bicycles up and down the stairs and the impracticality of this given participants' changing circumstances (having young children who also need to be carried up the stairs, or becoming elderly, which made carrying the bicycle more challenging). Detailed information on the study participants, including gender, age, working patterns and cycling habits, for both the sample and control groups, is detailed within Table 6.1

6.2.2 Using GPS to collect travel data

To ascertain whether the provision of cycle parking infrastructure caused residents that took part in the programme to cycle more, travel patterns (behaviours) and cycle miles were monitored through a natural experiment (see section 5.2.1 for detail on natural experiments). Cycle miles, before and after the intervention were monitored for the sample and control group. Information on cycle miles was collected using GPS data loggers.

The majority of studies that intend to understand how people travel have historically relied on a number of standard data collection processes such as travel diaries. However, travel diaries, require study participants to record their trips and origin and destination information manually and although they have been in use since the 1970's, problems with diaries and inaccuracies highlighted by GPS data suggest that there is an increasing need to look to alternatives (Stopher et al., 2007, Stopher and Greaves, 2007).

A more recent alternative to travel diaries is GPS-based travel diaries, where study participants are asked to carry a GPS device and then manually record trip information such as mode of transport. However studies have shown that there are problems with the quality and accuracy of such data collected in travel diaries, as a result of under-reporting and misreporting (Bolbol et al., 2012, Bricka and Bhat, 2006) To reduce the burden on participants and the need to complete detailed travel diaries alongside GPS data collection (Schuessler and Axhausen, 2009), in the last decade there have been development in research that attempts to infer travel mode from GPS data, which replaces the requirement for participants to complete travel diaries (Bolbol et al., 2012).

GPS trackers were used to monitor participants' travel behaviours. GPS was selected over travel diaries because they are less burdensome for participants and if carried diligently by participants they can give good estimates of the distance and time travelled for all transport modes (Stopher et al., 2009). In addition, a GPS tracker is not subject to fatigue or self-reporting errors that lead to the under-reporting of trips (Stopher et al., 2009, Stopher et al., 2007). Under-reporting may be a particular issue in this study for it has been found that the trips that are most likely not to be reported in travel diaries are those that are short and a stop on the way to another location (Wolf et al., 2004).

It is likely that short trips are those that could be affected by the intervention. Say, it is common for cyclists to make short diversions on a journey, for example on the way home from work. In addition, a cyclist may not carry their bike down five flights of stairs just to go for a short trip and may instead take the bus or walk, but the same cyclist might start to use their bicycle for such trips if it became more accessible through the provision of street level cycle parking. In addition, any observed changes in cycle patterns, as a result of this intervention are likely to be minimal, and therefore to observe the effect of the intervention, it is essential that a robust record of travel patterns is collected. GPS data collection permits the collection of robust and reliable travel data that is not reliant on participants keeping records. In addition, eight weeks in total is a long time to ask a participant to record their travel patterns in a travel diary.

Finally, GPS with inferred mode collects data on all transport modes; which facilitates calculation of the carbon impact of replaced trips, which allows for a more complete picture of the environmental impact of the intervention to be estimated.

Existing travel behaviours and cycle miles of both the sample and control groups were measured concurrently. Prior to the construction of the cycle parking, baseline measurements were collected for a four week period running from 3rd June 2013 to 30th June 2013, inclusive. After the construction of the cycle parking, post-intervention measurements were collected, again for another four week period, running from 13th January 2014 to 10th February 2014.

Four weeks of monitoring for each stage was selected because of the small sample sizes used in this study. Stopher et al. (2008) found that that multi-day data can result in significant sample size reductions, for example, using GPS data over 7 days, reduces sample size needs by about 65% in comparison to a conventional one-day diary survey and 15 days of GPS data can reduce sample size needs by about 70%. Though in the research by Stopher et al. (2008), data from a sample size of 79 individuals collected over 28 days was compared against data collected from a larger sample of about 500 persons over 7 days. These samples are clearly much larger than those used in this study. Despite this, Stopher et al.

(2009) do observe that multi-day data can help overcome variances as a result of weather, seasonality and individual variation, which is relevant to this study.

Point (location) data was collected at a rate of every 60 seconds, which has been deemed suitable for studies such as these, in cities such as London (Bolbol et al., 2012). In addition, this meant that trackers could store the full four weeks data and that the data only needed to be downloaded at the mid-point of the study, which reduced inconvenience for participants. Collecting data every 60 seconds also reduces the drain on the battery life of the trackers, which reduces the burden on participants' to charge the trackers. Participants were encouraged to charge their trackers alongside their mobile phones. The trackers required charging from the mains electric supply (in the same way as a mobile phone) every one to two days.

Data was collected using GTrek II GPS recorders (see Figure 6.5), which are small GPS data loggers that can fit in a participant's pocket. The GTrek manual notes that the 'GTrek data logger receives data from orbiting satellites and converts the data streams into useful information. It then save this data until it is transferred from the device to the GTrek program where meaningful data is produced' (GTrek Satellite Tracking Systems, 2011). Therefore the tracker records whenever it is above ground; it does not record when underground.

These trackers were selected because they can store 125,000 data points, which is equivalent to 86 days data when collected at a rate of a point every 60 seconds (GTrek Satellite Tracking Systems, 2011). In addition, the device is lightweight, at only 60 grams, which is more convenient for participants, and it supports the quick reviewing of data within Google Maps as well as providing point data in a raw format which is suitable for the analysis undertaken in this research (GTrek Satellite Tracking Systems, 2011).

Figure 6.5 GTrek II GPS recorder

Before the first monitoring period started, it was necessary to ensure all study participants, from both the sample and control groups, had their GPS trackers available for use and that they had been briefed in how to use this. Practically, this involved meeting with each study participant face-to-face. Each participant was provided with a user guide and also an information sheet on the study (Appendix 11), these were discussed with the participants and each participant was shown individually how to use the trackers. Participants were informed that they would need to switch the trackers on at the start of the monitoring period and they would be reminded of this the day before, via text or email, depending on their preferences.

Participants were asked to keep the trackers turned on at all times and to carry them with them as much as reasonably possible, during the study period. They were informed that they could switch them off if they were remaining stationary for a long period of time, for example when at home or at work, to conserve the battery.

During the face-to-face meeting participants could ask questions on the study and the means by which their data would be kept confidential was explained to them. They were informed that they could opt out of the study at any point and when they were content they were asked to sign a study consent form (Appendix 11).

During this face-to face meeting, for all but two participants study participants were asked to complete a placement questionnaire. This survey asked about existing travel habits. This information was used to inform the algorithms that inferred the transport mode, notably, the survey asked if they owned a car and whether they were motorists, this was used to inform the algorithm. Two busy participants opted to complete the survey online to reduce the length of the face-to-face meeting, however the questionnaire was exactly the same, it was just an online version.

At this stage participants were also provided information on how to return their trackers during the mid-stage of the study, and at the end of the survey. Participants were provided with envelopes and informed that at the end of the first monitoring period, they would be contact via text or email and notified to place their trackers in the envelopes provided and to post them through the doors of a specific member of the LGTA. This member had volunteered to keep the trackers so that they could be collected in one go. This approach was taken because it was easier for participants to post the tracker through a neighbour's door, and was safer than using the regular post service.

After the mid-stage monitoring data was removed from the trackers and they were re-set for the second and final stage of monitoring, these trackers were returned to participants by being posted through their front doors. They were returned finally at the end of the survey, in the same way as at the mid-stage monitoring point.

6.2.3 End of Study Survey

At the end of the Lissenden Gardens Green Zone, once all the cycle parking had opened and was in use, and once both stages of monitoring was complete, when the final trackers were collected, an end of study survey was undertaken.

As discussed in section 5.2.3, a questionnaire can be used to describe different data collection methods, including structured interviews and surveys, but essentially questionnaire collect structured data on the same variables and characteristics from a number of cases and can contain check lists, attitude scales, projective techniques and rating scales (De Vaus, 2004, Oppenheim, 1992).

Given this, questionnaires were used as a method of data collection to gather information on the impact of the Lissenden Gardens Green Zone on participant's behaviour, at the end of the study. Surveys were selected as the most appropriate tool for data collection at this point given that the project had taken a long time to reach fruition and some study participants were starting to experience study fatigue. An online questionnaire was viewed as the most effective, least intrusive method to gather data.

Table 6.2 End of study survey questions.

Questions	Possible answers
Did you cycle during the first stage of monitoring, when carrying the tracker in May/June 2013?	Yes / No
Did you cycle during the second and most recent stage of monitoring, when carrying the tracker in Jan/Feb 2014?	Yes / No
How easy did you find it to keep the device charged?	Very Easy / Quite easy / Ok / Quite difficult / Very difficult
How easy did you find it to remember to carry the device?	Very Easy / Quite easy / Ok / Quite difficult / Very difficult
Did you ever forget to carry the device?	Yes / No
On average, how frequently do you use your bicycle?	Never / Less than once a month / Once a month / Once a fortnight / Between one and three times a week / More than three times a week
What do you use your bicycle for?	Commuting to work, college, etc / Shopping / Leisure or weekend cycling / Keeping fit / Other, please give details.
Why do you choose to cycle?	Fitness or health concerns / For pleasure and enjoyment / Environmental concerns related to car use / Convenience and speed of cycling / To save money / Roads too congested for bus or car / To avoid relying on public transport / Lack of car parking in London / Ideological reasons
What discourages you from cycling more?	Lack of cycle facilities at my destination i.e. lockers, showers / Lack of daylight hours / Distance to destination too far / Concern over safety of on-street parking at destination (concern of theft) / Fear of HGVs / Generally dangerous traffic conditions / Concerns over personal safety when cycling / Dangerous weather conditions / Unpleasant weather Avoiding getting sweaty / Other personal reasons (too busy, too tired, etc.) / Other, please give details
Questions asked only of those who received a new cycle parking space:	
Have often do you now park your bicycle within the new cycle parking?	Never / Rarely / Sometimes / Frequently / Always
Has the provision of the new cycle parking encouraged you to cycle more?	Yes / No
Could you explain why the cycle parking has or has not changed	Free text

your behaviour and encouraged you to cycle more?	
How could the cycle parking be improved further?	If it was more secure / If it was in a more accessible location / If it had better lighting / If it was easier to use / If it was more spacious / Other, please give details.

The short survey undertaken gathered views from participants as to whether they made use of the secure and accessible cycle parking, and more generally on their views of the barriers to cycling. The questions asked can be viewed in Table 6.2. Participants whose data was corrupt were also included in this survey. Out of the original 13 participants, 10 participants responded to the survey. One sample group participant, one control group participant, and one participant with corrupt data opted not to take part in the survey. Questions pertaining specifically to the new cycle parking provision were only asked of those that were given a new cycle parking space i.e. not the control group.

6.2.4 Gaining Access and Ethics

It is worth noting that one of the biggest challenges with this particular phase of the research was the need to gain access to the project and build a relationship not only with the local authority but also with the residents involved in the project. Although a necessary stage of the research, gaining access and building trust and relationships was very time-consuming. As Flick (2007) observes, finding access can be a long and difficult process and is not just a step at the beginning of your field study, instead it is based on trust between the field and the researcher (Flick, 2007).

This held true in this phase of the research and this project required careful project management and organisation. In particular it was very important to carefully manage the numerous stakeholders including local authorities, residents groups and individual residents involved in the project, This phase of the research involved interaction with 13 (reduced to 12) study participants, Camden Council officers and employees, the LGTA and other UCL researchers who were assisting with the analysis of the spatial data. In addition, the delays in the project caused tension amongst stakeholders. Despite this, a close working relationship was developed with the LGTA and Camden Council and both parties strongly supported and facilitated this work. This was achieved by meeting with members of the LGTA, attending numerous evening tenants' association meetings, visiting participants and discussing the study through with them in their homes and meeting with the local council.

6.3 Data Analysis Methods

Data analysis aimed to answer the following questions:

1. After the provision of accessible and secure cycle parking, did the sample (treatment) group cycle more frequently?
2. After the provision of accessible and secure cycle parking, did the sample (treatment) group cycle further?
3. What is the carbon impact of any observed changes in travel habits, as a result of the intervention?

To assess whether the provision of accessible and secure cycle parking caused the sample group to cycle significantly more and/or further than the control group, statistical methods were used, namely the analysis of covariance test (ANCOVA). This test is discussed in more depth in section 6.3.2. Once this had been determined, changes in travel habits for all modes of transport, namely cycle, bus, car, tube (London Underground) and train, were estimated. This information was then used to establish whether the programme led to a reduction in carbon impact, in relation to travel habits, for the sample group. This method used published existing and accepted carbon conversion factors for different modes of transport, which are discussed in more detail later.

6.3.1 Data Processing

After the completion of both stages of survey data collection, the data from each participant's GPS logger was prepared for analysis. Software used in this process included ArcMap 10.1, R 2.14.2, Python 2.7 Microsoft Excel 2010 and SPSS 21. Data collected by the GPS trackers was downloaded and the mode of travel was inferred. This processing of the data was undertaken using three different algorithms that were developed in an earlier research project at UCL, undertaken by Dr. Adel Bolbol and supervised by Prof. Tao Cheng. These algorithms and their capabilities are spoken about at length in Bolbol (2013). Modes of transport identified and inferred in this processing of the data included cycle, walk, bus, train, tube and car. The inferring of transport modes was undertaken as follows.

Prior to processing the raw GPS data, collected from participants, in R and Python, the data was first projected using ArcMap onto the British national grid co-ordinate system. Once the data had been projected, the data was cleaned and processed to deal with the limitations of using GPS, namely low positional accuracy and signal loss. To clean the data, previous research practices were drawn upon. Schuessler and Axhausen (2009) propose that erroneous fixes can be detected using different indicators, namely altitude, speed and acceleration. Therefore, based on the topography of this particular study area, during the data cleaning process, fixes with altitudes of over 1000m or negative altitudes were deemed unrealistic and were dismissed from the data. Schuessler and Axhausen (2009) also suggest that fixes with speeds of over 50 m/s (usually caused by position jumps) be dismissed and those with unrealistic accelerations. Therefore, during the data cleaning process, fixes with accelerations of over 10 m/s^2 and fixes with speeds of over 50 m/s were deemed likely to be erroneous and were removed from the data set.

The first stage of processing to infer the mode was undertaken in R 2.14.2, as mentioned, using an algorithm developed in an earlier research project at UCL by other researchers. This algorithm uses speed and acceleration between fixes to differentiate the different modes of transport and makes use of a machine learning approach, to infer mode by learning from existing data, specifically travel data collected in London (Bolbol, 2013, Bolbol et al., 2012). In practice, this meant that the data sets were run through the algorithm, this took about 12 hours per data set, and based on the speed and acceleration of each fix, which is detailed as an individual row of data in the raw data output from the GPS tracker, that row of data is then attributed a mode of transport, for example, bus, walks, cycle, etc, by the alogorith.

After this stage of the analysis, Python 2.7 was used to calculate the distances of each fix from different modes of transport. This second stage therefore used maps of existing travel network data and network matching techniques to improve the accuracy of the bus and tubes modes in inferred, in particular, but also rail. In practice, this meant that each fix (or line of raw data) was checked against point data embedded within existing transport network maps, to see if these fixes were actually situated within the locality of a mode of transport. If they were then these different modes were ranked in terms of proximity, and then based on the previous and next fixes, and the modes of transport in the vicinity, a mode was attributed or not attributed. Data sets took about 5 hours to run through the script.

The third and final stage of processing was undertaken in R 2.14.2 and this process integrated the results of the first and second stages, to generate final results. These final results were that each data point was attributed a mode of transport. Overall, processing of results took on average 5 days per participant, per stage of monitoring.

Once the data had been processed final filtering and checks were undertaken. Data was manually processed to identify all trips that the algorithm had identified. This involved an exercise of manual map matching, which was undertaken in ArcMap to ensure that the algorithm had appropriately categorised each journey. This involved going through the final data outputs (spreadsheets) for each participant and identify all non-walk trips. The start and stop fixes for each trip was then recorded and these fixes were highlighted onto a map, which also showed the local transport network maps. The mode that each individual trip had been attributed was then checked, for example, if a journey had been inferred as 'car' yet travelled through a park and therefore could only be a 'cycle' trip, or followed a railway line and was clearly a train journey or where a trip is categorised as bus but went off bus routes, then it was reassigned a new mode. An example of some mapped journeys can be seen in Figure 6.6. This process of manual checking took between 1 and 2 days per participant. Overall, processing of results took on average 5-7 days per participant, per stage of monitoring.

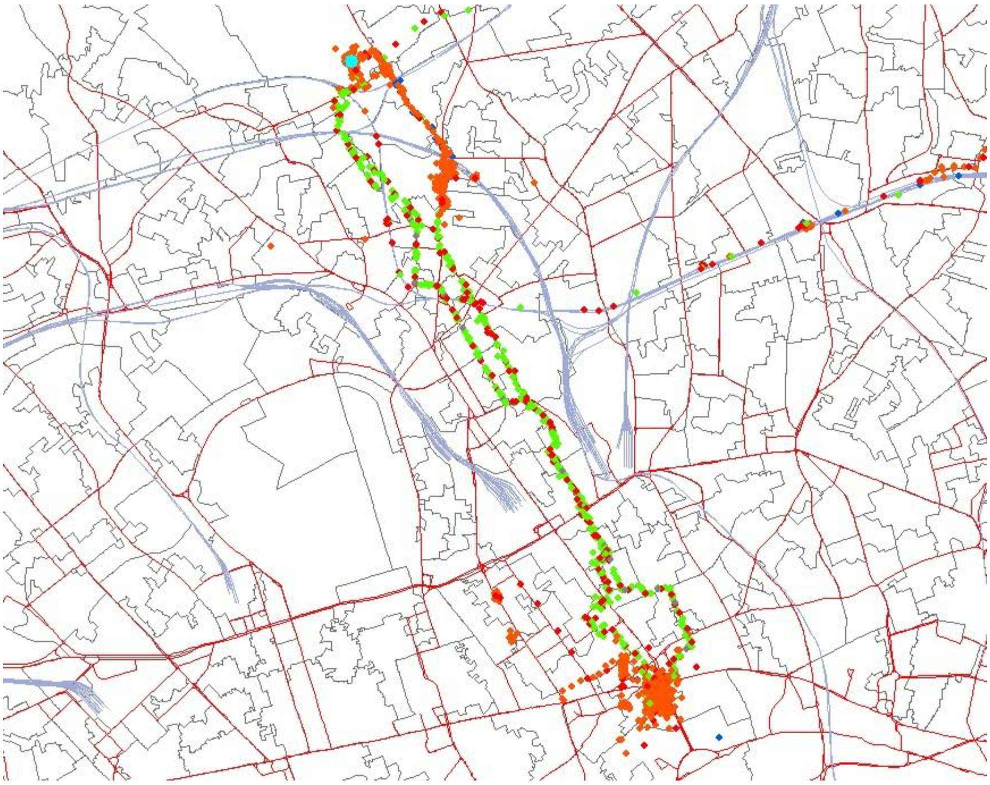

Figure 6.6 Example of output data checked in ArcMap

Key: green = cycle, red = bus, orange = walk, grey = car, blue = train or tube

Once the data was processed, it became clear that data was not collected on all 28 days. Some participants informed me that they were away overseas for some of the study period, with work. Others admitted that they did forget to carry the trackers for the odd day or two. Therefore, this left a situation where it was not known if no data was recorded because the participant had not travelled away from home, because they did not have the tracker with them, or they were overseas. Therefore, on days where no data is recorded, or where the point data collected was 'stationary', the day has been recorded as a 'non-travel day'. Non-travel days have been excluded from the analysis. All days where GPS points for walking, cycling, bus, train, car or underground were collected were categorised as 'travel days' and these were used in the analysis. From the data collected on travel days, a number of indicators of cycling prevalence were developed for the purpose of analysis. These are explained in Table 6.3.

Table 6.3 Description of indicators of cycling prevalence

Indicator	Calculation	Description of indicator	Main challenge with indicator
Average cycle metres per cycle journey	This is calculated as the total distance (metres) travelled by cycle during the study period divided by the total number of cycle journeys during the study period.	Variable is an indicator of the length of cycle journeys.	Cannot demonstrate an increase in overall number of cycle journeys. For example, if the number of journeys doubled but the average distance stayed the same the indicator would not change.
Average number of cycle journeys per travel day	This is calculated as the number of cycle journeys during the study period divided by the total number of travel days during the study period.	Variable is an indicator of the frequency of cycle journeys.	Cannot demonstrate an increase in overall distance of cycle journeys. For example, if the number of journeys stayed the same but the average distance increased the indicator would not change.
Average cycle metres per travel day	This is calculated as the total distance (metres) travelled by cycle during the study period divided by the total number of travel days during the study period.	Variable is an indicator of both the frequency of cycle journeys and the length of the journeys.	Difficult to ascertain if any change in the indicator is as a result of change in journey length, or frequency of journey.

These figures have been developed for they help average the data to account for the variability in day to day travel behaviour, prevalence of data collection by participants and for weather. However, there are weaknesses with each of these indicators and these are identified in Table 6.3. As a result, statistical analysis has been undertaken for each of the variables in turn.

6.3.2 Statistical Tests

One of the main aims of this phase of the research was to ascertain if the intervention of providing accessible secure cycle parking had an impact on the sample (treatment) group's cycle patterns and if this intervention caused the sample group to cycle more and/or further, in comparison to the control group. To do this, the analysis of covariance test (ANCOVA) was used to test the following hypotheses:

H_0 = Null hypothesis: There is no difference in the cycle behaviour of the sample and control groups after the intervention.

H_1 = Alternative hypothesis: There is a difference in the cycle behaviour of the sample and control groups after the intervention.

Note that cycle behaviour (or cycle patterns) such as distance travelled and frequency of cycle journeys, are identified through the indicators of cycling prevalence, described in Table 6.3.

ANCOVA is an extended version of ANOVA (analysis of variance) and is a regression method. It can be used to determine if there is a significant different in two means. However, in comparison to ANOVA, ANCOVA makes use of continuous variables known as covariates, which are not part of the main experiment but have an influence on the dependent variable, to adjust the mean of the dependent variable (Field, 2009). In this case, the dependent variable is the post-intervention indicator of cycling prevalence i.e. average cycle metres per cycle journey or average number of cycle journeys per travel day, as shown in Table 6.3. The covariate is the pre-intervention indicator of cycling prevalence, essentially, the 'baseline'. Tests were undertaken in SPSS version 21. All tests had the significance level set at 0.05, at which the null hypothesis would be rejected (Field, 2009: 51).

ANCOVA was selected because it has an advantage. Given that it was not possible to randomise the sample and control groups because of the type of natural experiment that was being undertaken, ANCOVA ensured that any post-test differences observed between the sample and control groups, were as a result of the intervention and not as a result of any differences between the two groups. Therefore, by using covariates, ANCOVA considers the differences in the baseline cycle patterns of all participants and takes this variation into account. It does this by using the baseline indicator to adjust the mean of the post-intervention indicator. ANCOVA therefore allows for differences in participant's baseline cycle patterns, to ascertain whether the provision of secure cycle parking causes the sample group to be 'statistically significantly different' in its cycle patterns (frequency of journeys or length of journeys) in comparison to the control group.

Clearly, due to the time of year of measurement of the two phases (phase one in June and phase two in January), it was likely that there was a natural reduction in the prevalence of cycling between phase one and two due to the colder and wetter weather in phase two. To be clear, the fact that measurements were taken at different times of year, when cycling patterns would have been different due to differences in weather is not an issue in ANCOVCA analysis and this is because the measurements in June are used as covariates in the analysis. i.e. this is not a pre-post intervention comparison.

The pre-intervention means are used as covariates to account for differences in people's cycle behaviours (i.e. some people cycle more or less than others) and to adjust the post-intervention means of the sample and control groups so that they can be compared for significance but after being adjusted for in a way that accounts for differences in baseline cycle behaviours. Therefore, because the ANCOVA test compares the post-intervention means of the sample and the control group, for periods when each group would have been subject to the same weather conditions, the differences in weather are accounted for in this test because both groups are exposed to the same weather conditions at the same time.

Given this, a 'statistically significant difference' between the cycle behaviours of the sample and control groups could be obtained even if there was a reduction in cycle miles, as long as there was a lesser reduction in cycle miles between the two phases, than for the control group.

For example, and to illustrate this, if it is hypothetically assumed that the average cycle metres per travel day for the sample group, before the intervention is 3700m and for the control group it is 6000m and it is also assumed that weather has an equal effect on the average cycle metres per travel day, in both stages and for both groups, because data was collected during the same periods for both groups, it can be assumed that the effect of weather reduces post-intervention average cycle metres per travel day by 25% for all participants. If it is then also assumed that the effect of the cycle parking for those in the sample group leads to an increase in average cycle metres per travel day of 20%, then the average cycle metres per travel day for the sample group reduces to 3330m and for the control group to 4500m. This assumed and hypothetical information is shown clearly in Table 6.4

Table 6.4 Hypothetical example of pre- and post-intervention means

Group	Participant	Pre-intervention average cycle metres per travel day (m)	In January, weather reduces post-intervention cycle metres per travel day by 25%	For the sample group, cycle parking increases post-intervention cycle metres per travel day by 20%
		Cycle metres per travel day		
Control	X1	6000	4500	4500
	X2	5000	3750	3750
	X3	4000	3000	3000
	X4	8000	6000	6000
	X5	7000	5250	5250
Sample	Y1	3500	2625	3150
	Y2	3000	2250	2700
	Y3	5000	3750	4500
	Y4	3000	2250	2700
	Y5	4000	3000	3600

In this hypothetical situation, the average cycle metres per travel day has reduced for both groups, but by a lesser extent for the sample group, due to the positive effect of the cycle parking. In this situation, ANOCVA would find that there is a significant difference in the average post-intervention cycle metres per travel day between the two groups, which could be attributable to the intervention. This would be after controlling for the effect of differences in the pre-intervention average cycle metres per cycle journey.

6.3.3 Estimating the carbon impact

When this research was originally conceived it was considered that if the provision of secure and accessible cycle parking encouraged participants who use the parking to cycle further or more frequently, then this could lead to a modal shift in transport. For example, if a participant decides to change their travel patterns to cycle to the supermarket twice a week, instead of getting the bus or taking their car, then this would represent a modal transport shift. In order to be able to identify any possible modal shifts, monitoring of all travel by participants, for all modes, was undertaken.

Given this, to calculate the carbon impact, carbon emissions per passenger kilometre travelled were attributed to each mode of transport. These figures were drawn from a number of existing literature sources. Data from Transport for London was drawn on strongly, given the locality of the research. The emission factors for car and rail are those recommended by the British Government in their company reporting methodology (DEFRA & DECC, 2012) and the factor for cycling was drawn from the European Cyclists' Federation because the British Government do not recommend any values (see

Table 6.5 for detail). These sources of data were selected because they were perceived to be the most reliable for these modes of transport.

Table 6.5 Carbon emissions by mode of transport

Mode	gCO_2 per passenger km	Source
London Underground	68	(Transport for London and Mayor of London, 2012)
London Bus	75	Transport for London and Mayor of London, 2012)
DLR	61	Transport for London and Mayor of London, 2012)
London Overground	45	Transport for London and Mayor of London, 2012)
Bicycle	16	(European Cyclists' Federation, 2011)
Rail	53	(Office of Rail Regulation, 2009)
Average Car	170	(DEFRA, 2012)

The carbon impact was calculated for each participant individually, by taking the observed average metres per journey for the relevant mode and multiplying this with the observed average number of journeys per travel day for the same mode. This was then multiplied by the appropriate modal carbon factor in

Table 6.5. For example, to calculate the carbon impact of cycling, for each participant the ‘average cycle metres per cycle journey’ was multiplied by the ‘average number of cycle journeys per travel day’, this was then converted into km and then multiplied by the factor of 16gCO_2 per passenger kilometre. This process was undertaken for all participants and all modes, before and after the intervention.

The complete results of this methodological approach are outlined within Chapter 8.

Chapter 7 Results: Local Sustainability Programmes

The first phase of this research aimed to develop the evidence base and provide more structured evidence about the nature and extent of sustainability work that was being undertaken by local authorities, in London. The aim of this was to answer the first part of the research question and uncover how local authorities were working to encourage pro-environmental behaviour amongst their residents.

To answer this question, as indicated in the methodology chapter, (Chapter 4), data was collected through a series of semi-structured, exploratory interviews with inner London local authority council officers. This chapter presents the results from analysis undertaken of the interviews and will include an assessment of the breadth of sustainability work being undertaken by the local authorities, as identified in the interviews and how these projects mapped against the Ladder of Interventions (see Table 2.2) and DEFRA's 4 E's framework (see Figure 2.3). Linkages between project performance, as perceived by the local authority sustainability officers, and the types of intervention or E's used to deliver the project, are identified.

In addition, the commonalities and differences between the local authorities, uncovered from the transcripts through coding and inductive logic are discussed. This discussion of these commonalities will occur in four parts. The first part will give insight into how the different sustainability departments work. The second part will focus on the sustainability projects, how they are conceived, the types and range of projects delivered and the driving forces that propel these projects forward. The third part will focus on the 31 projects and the analysis of these projects against DEFRA's 4 E's and the Ladder of Interventions. The fourth part will focus on the key findings from the interviews, drawing on observations and commonalities from the interviews which relate to themes such as barriers, for example, financial and political barriers. Finally the fifth section will focus on the most significant finding from the interviews, that there is a lack of monitoring and evaluation undertaken by local authorities to measure both the performance and the environmental impact of their different sustainability projects.

7.1.1 Variances in Working Approach

It was found that the working approach of the local authority sustainability departments interviewed varied in both their focus of work and in their organisation. Four of the authorities had a strong focus on carbon reduction work with authorities A and G focusing solely on carbon management and energy efficiency work. Authorities B and F also worked with a strong focus on carbon management and energy efficiency work, yet their remit was slightly broader and also encompassed a wider range of sustainability projects, they also provided a strategic lead on the council's wider sustainability work.

Various reasons were given to explain why some local authorities focused solely on carbon management and energy efficiency. One common reason for this focus was that with energy-focused projects officers 'can demonstrate the savings or the cost-avoidance' (Local Authority F) therefore this demonstrates a financial case for the work, as well an as environmental case. As a result, energy and carbon reduction work is 'recession-proof' (Local Authority F), which was particularly important at the time of the interviews, for Britain was in the middle of a recession caused by the global financial crisis.

In addition, the increasing focus on energy efficiency work in councils has been driven forward by increasing political focus on fuel poverty

(Local Authority G, Peters et al., 2012). This was best exemplified in an interview with Local Authority F, where it was observed that 'before the last election, we had sustainability as a big priority, green issues were quite high up there on the [political] agenda. But it's different times…our new corporate priority is very much around poverty, worklessness and housing and those kind of issues, so there's a really strong link there for energy and fuel poverty' (Local Authority F).

Therefore energy efficiency work has the added benefit of not only delivering reductions in carbon emissions but it can also address fuel poverty. However, it was noted that focusing on fuel poor residents is not necessarily the most effective way to reduce carbon emissions (Local Authority F). For fuel poor residents have a lower than average environmental impact, because they consume less energy and therefore contribute less to emissions.

The remaining four local authorities focused their work on the broader spectrum of sustainability (of which carbon reduction is an element) and provided an overarching strategic lead within the council. Two of these four, authorities C and D, delivered their own sustainability projects and engagement work. The remaining two (E and H) also undertook their own engagement work but collaborated more with other departments within the council to deliver sustainability projects. This was due to the limited number of employees within these two sustainability departments. The staffing allocated to the sustainability teams of these eight authorities also varied, with some local authorities employing a single person to oversee their sustainability work and others employing numerous staff, though some departments were reducing in size at the time of interviews, as a result of the recession.

One factor contributing to this difference in working approach is the political control of the council. This was demonstrated by observations that a change in political control of two councils generated changes in the councils working approach and commitment to environmental action and climate change (Local Authority F and G). However, given the small sample size of this series of interviews and the diversity in working approach, it was not possible to draw robust conclusions as to the impact of particular political control on the working approach.

Irrespective of the political control of the authority, it is necessary to also mention that almost all officers discussed the negative impact of the recession on the resources allocated to their department. Some departments had experienced redundancies, whilst others were expecting redundancies in the near future. Many departments had little or no budget to support their projects or had experienced reductions in their budgets. One officer expressed this by saying ‘funding is a problem, funding's a problem for everything in local government generally at the moment ' (Local Authority H). The most commonly stated reason for these limited resources was that sustainability work is not a priority for councils in a time of shrinking budgets.

7.1.2 Sustainability Projects

In total, 57 sustainability projects were identified in the transcripts. Of this 31 projects were selected for analysis and these projects were selected because they met two criteria which were essential for this research: that the council was the primary provider of the project and the project interacted directly with the borough population. Projects that focused on businesses or the local authority’s estate were excluded, as were projects that were primarily led by other organisations such as local community groups. A full list of the 31 projects and their descriptions is detailed thematically within Table 7.1. The council identifiers are not included in this table to ensure the confidentiality of the local authorities interviewed.

Table 7.1 Local authority sustainability projects

Type of project	Description of project	
Outreach, education and knowledge campaigns	1	An annual outreach event organised by the environment team and held in either a local venue or park with lots of different environmental organisations represented
	2	The 'climate change bus' engages with residents and demonstrates different energy saving measures like draft excluders and window film. Advice sheets and freebies are also given out from the bus and the location of the bus is chosen so as to target local residents.
	3	A course educates residents about climate change. It is aimed at residents who are environmentally aware and interested. The course involves committing to five weekly 2-hour sessions.
	4	Introduction of recycling wardens that door-knock and talk to residents about local recycling facilities, whilst finding out what the issues were with them. This information was then fed back to the Council.
	5	An annual event for interested residents where they could tell the council what they thought the council should be doing to help residents to become more sustainable.
	6	A visitor centre that provides education classes to schools and adults on nature conservation and also growing food.
	7	Transport festival to encourage modal shift onto lower impact transport modes.
	8	A centre that provided educational classes to schools to learn about recycling and waste.
Energy and emissions (action is integral to these projects and usually delivered through community groups)	9	The Council worked with residents to understand how they could become more sustainable and what they could do in their homes and as a community to achieve a sustainable lifestyle. The Council provided in-home displays to understand energy consumption and guidance on how to reduce their energy use.
	10	Behaviour change project to reduce carbon emissions. Provided highly personalised face to face advice and engagement, to build networks of people who would then engage their peers and neighbours and share advice about to reduce energy consumption and bills.
	11	Started by community groups who recruit other residents and then set targets for water reduction, energy reduction and carbon reduction overall, as a group. Targets are monitored through self-monitoring.

	12	Residents project to deliver a green deal pilot project to retrofit four solid-walled homes.
Energy outreach, education and advice services	13	An energy advice telephone and email service. Residents can access the service and get detailed and practical information on energy consumption, bills, changing boiler controls, etc.
	14	A drop-in service that provided in-depth energy advice and provision of easy energy saving measures from a high street drop-in centre.
	15	Service that provided in-depth energy advice and provision of easy energy saving measures in the home
	16	An energy advice telephone and email service. Residents can access the service and get detailed and practical information on energy consumption, bills, changing boiler controls, etc.
Food Growing	17	This programme developed small community allotments in areas that are not being used to their full potential, or in spaces that are abandoned. The council manages this through some small grants and there are more than 300 plots in the borough with plans for more.
	18	The project target was to create 60 food growing sites. The council now has over 120 formal food growing and bee sites. There are also smaller, informal sites in the borough.
	19	Strategy to develop over 100 food growing sites on local estates and in schools.
	20	A working group created to support the creation of food growing sites and overcome their biggest barrier which is property ownership of the land. The council has achieved their target of 20 new spaces by 2012.
Funding Sources	21	A one off fund of £50,000, available to community groups or organisations that wanted to implement 'green' projects to help reduce the borough's carbon emissions.
	22	A pot of funding that supplied grants of up to £2,000 to voluntary groups to deliver projects that will save energy in a certain area of the borough.
	23	A small pot of funding (£5000 per year) available to residents, that gives awards of a few hundred pounds to support different environmentally themed community initiatives.
Zones (action is taken within a specific area)	24	The programme aims to remove the barriers that the council can create for residents, and encourage them to take collective local green action. The council the works with residents and supports them to implement potential green improvements in their local area.
	25	A two year project to reduce carbon emissions within an area of 4000 properties and 600 businesses, by 20% by 2012. The project was funded by the GLA, who initially provided £300,000.
	26	A project to reduce emissions by 20% by 2012, starting in 2010. The zone focused mostly on housing and installing various energy saving measures in residents properties, including loft insulation, cavity wall insulation and solid wall. The project was funded by the GLA.

Green champions and pledges	27	The borough has approximately 500 individual green champions who were recruited through community development work and are encouraged to deliver their own environmental initiatives. However, they are supported by the council, who can provide advice about how to reduce their community's environmental impact.
	28	Project uses soft initiatives including a resident's green champion scheme and a green pledge system to encourage pro-environmental behaviour. The numbers of pledges are in the thousands. There are 750-1000 resident green champions. There is also an annual green champion's award ceremony.
Air pollution and transport	29	To encourage schools to have a travel plan and to keep them up to date the council offers incentives such as training, including cycle training and pedestrian training, theatre, routes, etc.
	30	An anti-vehicle-idling scheme with a focus on parents outside school gates.
Composting	31	Project installed an accelerated compost machine on an estate as part of a trial for a new food waste collection service.

The 31 projects varied between councils, however there were overlapping themes. As previously mentioned, projects were selected for analysis in this research if they met two criteria: that the local authority was the primary provider of the project and that the project interacted with the borough population. Not all local authorities interviewed worked directly with the borough population and in the case of one local authority, none of their projects were selected for analysis because they did not deliver any projects that interacted with residents. Their work focused only on reducing council associated emissions. Despite this, across the boroughs there was still a wide range of projects that engaged and interacted with residents to support them in adopting lifestyle changes and reducing their environmental impact.

Of all 31 projects selected for analysis, two types of project were most common, accounting for just over half of all projects in equal measure. The first type was outreach projects that aimed to educate the population and encourage understanding. Outreach projects included events held in the public arena, with the aim of reaching out to the wider community, and events that interested citizens could elect to attend, such as film nights. Outreach work was also undertaken through door-knocking and school education programmes. These projects therefore used the provision of information to lever behaviour change and enable behaviour change.

The second type of project focused on reducing energy use in the home, this was achieved through the provision of energy advice helplines and ‘energy doctor’ home visits. Both of these services involve speaking with a trained energy advisor (energy doctor) who provides residents with tailored behaviour change advice on how they can reduce their energy and water consumption. In addition, more specific advice can also be provided, for example on how to make more efficient use of heating controls.

A home visit may also involve the installation of simple energy saving measures such as radiator panels, low-flow shower heads, in-home electricity consumption displays and tap aerators and advice may be provided on potential structural and significant energy saving measures such as building insulation and the funding available for such measures. These projects therefore use different tools to lever behaviour change. These include fiscal and non-fiscal incentives (funding for insulation measures and the provision of free energy saving measures), salience (increasing the prominence of energy use through in-home energy consumption displays), enablement through changes to the physical infrastructure (insulation) and the provision of information through advice services,

Energy use and emission reduction was also encouraged through, what will be termed here, ‘action-oriented’ projects, which engaged residents on energy consumption. There were examples of such projects in at least four boroughs. Action-oriented projects require residents to take on the task of reducing their energy consumption whilst being supported by the local authority through face-to-face engagement. Such projects are normally delivered within existing community groups but residents are encouraged to monitor and record their own progress. Action-oriented projects therefore make use of a number of levers to encourage behaviour change, including use of social norms and salience through group monitoring and reporting of energy use, and the provision of information.

These energy related projects therefore sought to encourage some of the behaviour changes related to energy consumption that have been modelled within analysis by the CCC (2010). For example, where appropriate, these projects encourage residents to reduce the temperature to which they heat their homes. This is a behaviour change identified within the analysis of the CCC (2010: 198). Energy related projects also often involved the provision of in-home electricity use displays which intend to make residents aware of their electricity consumption. As a result, they may encourage other identified behaviour changes, such as switching off unnecessary lights (CCC, 2010: 106). In addition, such projects often encourage residents to reduce their hot water use by providing free low-flow shower heads and encouraging shorter shower times, through the provision of free shower timers, which is a further behaviour identified by the CCC (2010: 209).

It is worth noting that most local authorities assisted local businesses to reduce their energy use and carbon emissions but these projects were excluded from analysis because they did not meet the project selection criteria. However, it is worth mentioning that the work to encourage businesses to reduce their emissions represents an interesting case. Businesses generate a significant proportion of emissions, and in 2011, the industrial and commercial sector generated more carbon emissions than any other sector in London, attributing 44% of carbon emissions to the city (Greater London Authority, 2013a).

However, although it would seem logical to focus efforts on these significant emitters, the work by local authorities to support businesses to reduce emissions is restricted. This is because it is not politically acceptable to the electorate to spend council money on businesses (Local Authority G). However work continues, largely as a result of European funding that is allocated specifically to reducing carbon emissions of businesses and because of the dedication of some officers and local businesses (Local Authority C, G H and F).

The next most prevalent type of project aimed to encourage local food growing through the provision of local food growing spaces. This was promoted through the Capital Growth scheme, a partnership initiative between London Food Link, the Mayor of London Boris Johnson and the Big Lottery's Local Food Fund. The programme aimed to create 2012 local food growing sites in London, by the end of 2012 and provided funding to support this aim (Capital Growth 2012). The key behavioural change levers in these projects were therefore enablement, through the provision of the allotments. The allotments were also a non-fiscal incentive for residents. These projects are therefore related to one the behaviour changes modelled within analysis by the Committee on Climate, specifically, the reduced consumption of carbon-intensive foods (CCC, 2010).

The next most common types of project offered by councils included resident funding schemes and ‘zone’ projects. Through the provision of fiscal incentives, funding schemes work to financially support and empower residents to deliver their own environmentally themed community projects to reduce the environmental impact of the borough. Zone projects are best described as projects that engage and encourage residents from a specified geographical area to reduce their environmental impact.

Activities within a zone are wide ranging and can include, for example, the improvement of recycling facilities, the development of a community garden or food growing site, the delivering of curtain lining workshops or hosting a bring and take event. The zones are a holistic approach to stimulating pro-environmental behaviour change and tend to be delivered in collaboration between the local community and the local authority. As a result, they make use of a number of behavioural change levers including non-fiscal incentives, enablement through changes to both the social and physical infrastructure and the provision of information.

The final type of project in the sample includes green champion programmes. Such programmes aim to support residents and build capacity in the community by encouraging residents to deliver their own environmental initiatives. These programmes make use of social norms and salience to lever behaviour change and aim to enable pro-environmental behaviour by fostering the social environment. Finally, the remaining programmes analysed aimed to reduce congestion, air pollution and waste going to landfill.

7.1.3 Assessment of Projects

As discussed in 4.2.2, evaluation sheets were created for all of these 31 projects that were selected for analysis. The aim of these sheets was to verify the information collected in the interviews, they served as a common framework to structure the evaluation of each project (see Figure 4.2). Each project was evaluated against the 4 E's within DEFRA's framework (see Figure 2.3) and the Ladder of Interventions (see Table 2.2). The results of this analysis is detailed within Table 7.2. The results detail the levers used to change behaviour in each project, as identified in the Ladder of Interventions, and the corresponding score for this lever, whereby the score for the most restrictive measure is allocated. The project performance score is also recorded, which identifies a score for observed success of the project and a score for the perceived effectiveness of project. A total score, which is these two scores summed, is also provided. Finally the 4 E's scores are given, where a single point score was given for each mechanism used i.e. if all mechanisms to enable were used, 5 points was awarded, if all mechanisms to encourage were used 3 points were awarded. The total possible score was 15.

The total performance scoring information was correlated against the DEFRA's four E's score. However, only a weak correlation between the use of the mechanisms in the 4 E's model and the perceived effectiveness of the project at changing behaviour, could be found ($r^2 = 0.15$). This result therefore indicated that the extent of the mechanisms of the 4 E's that were used did not affect the performance or effectiveness of the local authority sustainability project, as perceived by the sustainability officers delivering the programmes.

Table 7.2 Local authority project analysis

		Ladder of Intervention (LOI)			Perceived performance			DEFRA's 4 E's				
Type of project	Project ID	Primary lever	Secondary lever	LOI score	Observed success of project	Observed effectiveness of project	Overall performance score	Enable score	Encourage score	Engage score	Exemplify score	Total score
Outreach, education and knowledge campaigns (action may not happen)	1	Provide Information		9	3	1	4	1	1	2	2	6
	2	Non-fiscal Incentive	Provide Information	5	4	3	7	1	1	0	2	4
	3	Provide Information		9	3	3	6	4	1	4	0	9
	4	Enable choice (physical)	Provide Information	7	4	3	7	3	1	1	0	5
	5	Provide Information		9	4	3	7	1	1	2	2	6
	6	Provide Information		9	4	4	8	2	0	2	2	6
	7	Social norms / salience	Provide Information	8	4	1	5	1	1	1	1	4
	8	Provide Information		9	4	4	8	3	0	2	2	7

Energy and emissions (action is integral to these projects, usually delivered through community groups)	9	Non-fiscal Incentive	Provide Information	5	1	2	3	2	1	3	0	6
	10	Social norms / salience	Provide Information	8	2	2	4	1	1	2	1	5
	11	Social norms / salience	Provide Information	8	2	2	4	2	1	3	2	8
	12	Fiscal Incentive		4	5	4	9	2	1	3	2	8
Energy outreach, education and advice services (action may not happen)	13	Provide Information		9	4	4	8	2	0	0	1	3
	14	Enable choice (social / physical)	Provide Information	7	5	5	10	4	1	1	3	9
	15	Enable choice (physical)	Provide Information	7	4	4	8	3	1	3	2	9
	16	Provide Information		9	4	4	8	3	0	1	1	5
Food Growing	17	Non-fiscal Incentive	Enable (physical)	5	5	4	9	5	1	3	1	10
	18	Non-fiscal Incentive	Enable choice (physical)	5	5	5	10	3	1	2	3	9
	19	Non-fiscal Incentive	Enable choice (physical)	5	4	4	8	3	1	2	3	9
	20	Non-fiscal Incentive	Enable (physical)	5	3	5	8	2	1	2	1	6
Funding Source	21	Fiscal Incentive		4	4	4	8	2	1	2	2	7
	22	Fiscal Incentive		4	4	3	7	4	1	3	1	9

	23	Fiscal Incentive		4	5	4	9	1	1	1	1	4
Zones (action is taken within an area)	24	Enable choice (social / physical)		7	4	5	9	5	2	3	3	13
	25	Non-fiscal Incentive		5	4	4	8	5	1	4	2	12
	26	Non-fiscal Incentive	Provide Information	5	4	4	8	3	1	3	3	10
Green champions and pledges	27	Enable choice (social)	Social norms / salience	7	5	5	10	5	2	2	2	11
	28	Enable choice (social)	Social norms / salience	7	4	4	8	0	1	3	1	5
Air pollution and transport	29	Non-fiscal Incentive	Enable choice (physical)	5	5	4	9	4	1	2	1	8
	30	Regulation		2	4	4	8	0	1	0	1	2
Composting	31	Enable choice (physical)		7	4	4	8	4	1	3	2	10

Key to the LOI (ladder of Interventions) score: 1 = Eliminate choice by prohibiting goods or services, 2 = Restrict choice and options available to individuals, 3 = Guide choice through financial disincentives to make some behaviours more costly, 4 = Guide choice through financial incentives to make some behaviours financially beneficial, 5 = Guide choice through non-fiscal incentives and disincentives which reward or penalise certain behaviours, 6 = Guide choices through changing the default policy or options, 7 = Enable choice by designing or controlling the physical or social environment, 8 = Use social norms and salience to provide information about what others are doing, 9 = Provide information

7.1.4 Analysis of Commonalities and Key Findings

Analysis of the interview transcripts and evaluation sheets of the 31 projects analysed indicated that there was limited variance in perceived project effectiveness and performance. This was identified using the information collected on the evaluation sheets, where officers were asked to score each project in terms of its overall perceived success and effectiveness at changing behaviour (see Figure 4.2).

As shown in Figure 7.1, in terms of the perceived effectiveness of the project at changing behaviour, all bar two types of project obtained an average score of over 3.5 out of 5. A score of 3 was defined as 'neither effective nor ineffective at changing behaviour', scores of 4 and 5 were defined as 'effective' or 'very effective at changing behaviour' (see example evaluation sheet for scoring information, shown in Figure 4.2). Two types of project demonstrated weaker performance, scoring 2.8 and 2.5 out of 5. These projects were outreach and knowledge campaign projects and action-oriented energy projects, respectively. A score of 2 was defined as 'ineffective' at changing behaviour. These scores can be seen on the evaluation sheets, shown in Figure 4.2.

The perception of officers of weaker performance was observed in outreach projects and knowledge campaign projects. Poor performance was also perceived in three of four action-oriented projects. An explanation for these observations, and the reoccurring reasons that officers gave to explain variances in perceived project outcomes, will be discussed in more detail in the next section.

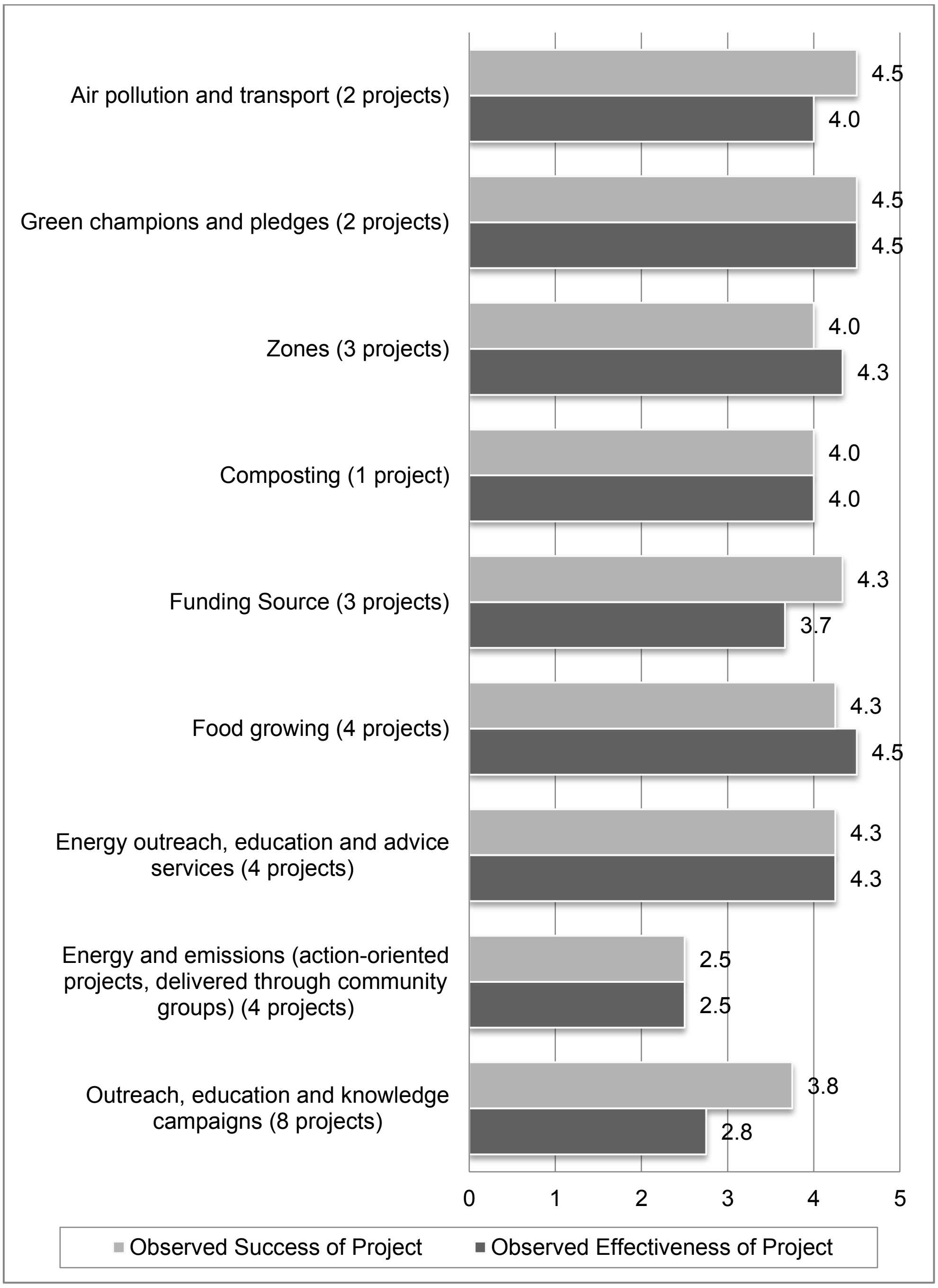

Figure 7.1 Perceived performance of project by type

7.1.4.1 Action-oriented projects

In the case of the poorly performing action-oriented projects, three of the four projects were described by officers as 'unsuccessful' or 'very unsuccessful' overall and all were described as ineffective at changing behaviour (Local authorities B, E, F). One officer stated ‘it’s all very well saying we’ve got an [action-oriented project] but what they actually deliver is not necessarily getting the behavioural change’ (Local Authority F). One explanation for this poor project performance included low penetration rates and the inability of the programme to engage existing networks and community groups (Local Authority E).

Another reason given for lack of success in two of the projects was that the built-in project monitoring mechanism was intrusive and residents were asked to share too much information too frequently (Local Authorities B and E). It was observed that there is a difficult balance to achieve in collecting detailed monitoring information through residents, whilst at the same time trying to change people’s behaviour (Local Authority E). Another officer echoed this, confirming that action-oriented projects are ‘difficult to measure and monitor and justify’ (Local Authority F).

However there was one well-performing action-oriented project (residents’ project to deliver a green deal pilot project to retrofit four solid-walled homes) which did not fit this trend. Reasons to explain why this project was more successful are varied. Firstly, it was delivered in a different way. There was funding attached to the project through the community and as a result, the aims of the project were developed in collaboration between the local authority and the residents, rather than just by the local authority. Secondly, due to unrealistic timescales attached to the funding, the council started to lead the work. This diminished the role of the residents and caused the resident’s green group to feel as if the council had taken over the project (Local Authority G) but conversely, the council felt that, in their opinion, this shift meant that the project utilised the capacity and experience of local authority officers, which in turn contributed to the project being more successful than it would have been otherwise.

7.1.4.2 Political and corporate support

Commitment to addressing unsustainability and climate change amongst local authorities was varied. This variance may be caused by a lack of statutory framework to incentivise action on unsustainability and climate change, which means that commitment and action is voluntary. Conversely it may be as a result of the level of political or corporate support. Half of the authorities' interviewed stressed that political support and commitment from the upper echelons of the council is critical to a positive project outcome. This finding echoes those from previous studies (Allman et al., 2004).

One officer typified this remarking that 'politics is massive, seniority of support is massive' (Local Authority F). At this particular local authority, the political party in power was observed to have an impact on sustainability work with the local authority mentioning that 'the single biggest impact on behaviour change projects or sustainability projects in the borough was because of a change in party' (Local Authority F). This change in party led to a reduction in the size of their sustainability team and the breadth of their remit. Of course, the financial crisis would have also contributed to this decision.

However the relationship between the political control of the council and the extent and type of sustainability work undertaken by each council, was not necessarily correlated. Instead, in terms of generating project outcomes, it was observed that political support for action on sustainability and climate change was more important than the political party in power. One interviewee observed that 'if you have someone up there [in the upper echelons of the council] who does not believe, who is a climate sceptic then nothing will go ahead, it’s like a barrier, a wall, that’s it’ (Local Authority A). Another officer mentioned that when pitching potential projects to councillors they ‘basically talk in economic terms. I rarely mention climate change because that’s a bit of a red rag to a bull for some of the members’ (Local Authority H).

Finally, one council spoke about the negative impact that a lack of political commitment to sustainability within their council had on their work. They noted that ‘the council wants to be seen to be doing something but does not really want to have to worry about sustainability too much’ (Local Authority E). This lack of support for sustainability work meant that achieving results within the authority was difficult because sustainability was not a high priority amongst senior management. This acted as a barrier to the successful execution and delivery of projects by officers (Local Authority E).

It was also observed that along with ensuring the support of more senior members of staff and having support from the political parties in power, it is also important to follow council procedure. One officer observed this, reflecting that ‘I think the projects that have not been successful, they have not got the proper buy in and you have not gone through the correct channels’ (Local Authority D). However, once support from councillors and senior officers is garnered, it was clear that this can prove very effective and can even protect a project against funding cuts (Local Authority A, D and F).

7.1.4.3 Financial matters

The majority of sustainability projects that focused intensively on reducing carbon emissions in the borough were projects that reduced emissions arising from the councils own estate. These projects generally focused on reducing emissions from council buildings (such as council employees' offices) and council housing. Projects that focused on reducing emissions from council buildings were excluded from analysis because they did not meet the analysis criteria and interact with the borough population. Projects that sought to reduce emissions and improve the efficiency of the councils housing stock were included because this work interacted with tenants.

Interestingly, despite such projects being focused on reducing carbon emissions, it was noted that such major infrastructural projects that seek to reduce emissions from council housing stock have to demonstrate financial savings for the council or its tenants, rather than carbon savings. One officer described how for such projects they had to "create these horrendous business cases with minute detail" (Local Authority D). Another observed that "anything that has a financial implication essentially has to be approved by the director of finance" (Local Authority E). Another officer reiterated this, commenting that "it all has to go through financial case….I had to basically say, this will make us X over this many years. They were not that interested in the other arguments" (Local Authority H).

However, given that councils are held accountable for the ways in which they spend tax payer funds, it was mentioned that there is a need 'to be so careful about ensuring that anyone working in this vague area is delivering financial savings' (Local Authority G). As a result, projects that deliver carbon savings but fail to represent a cost benefit generally do not obtain approval for delivery. However when such projects do go ahead, officers observed that they do deliver significant carbon savings (Local Authority E).

Beyond the business cases required for carbon projects, officers also aired their general opinions about funding. These opinions corresponded with those aired in similar recent studies (Allman et al., 2004, Peters et al., 2012). Officers spoke about a lack of funding, with one officer mentioning that their department has ‘never had a budget so I’ve had to get external funding, create business cases that take sort of two months’ (Local Authority D). Other officers reiterated this (Local Authority H).

However it should be noted that not all councils felt under-funded. Some felt that although the funding supplied to them was inadequate, they could obtain extra funding that made their funding sufficient, by selling their expertise to provide consultancy services and through other funding sources, for example the EU (Local Authority F). In addition, other councils made up for inadequate funding by enlisting the support of local community groups (Local Authority D).

Issues pertaining to the nature of funding were also voiced. One officer felt that there was an issue with funding in general, and explained that ‘I just think that the way the whole sector is funded just does not work, it’s just one off projects that are two years and then go away’ (Local Authority F). This officer felt that projects lack a long-term perspective and that ‘proper political support and long term funding’ would be necessary if behaviour change work was ever going to be successful (Local Authority F). Another officer also raised concerns pertaining to the nature of funding and how it has changed as a consequence of the localism bill and the ‘big society’ agenda (Local Authority H). More funding is now awarded through resident groups, rather than through the local authority and one officer raised concerns about this, explaining that they thought ‘the way the funding has been distributed is a little unrealistic', given the capacity of the community (Local Authority G).

7.1.4.4 Engaging residents and working with the community

Many officers spoke of the challenge of engaging with residents on their work and there was apparent disparity in the ability of the authorities to engage with residents and work in collaboration with resident groups. Some authorities felt they engaged with residents very successfully, whilst others found engagement more challenging. One officer admitted that engaging residents is 'something we struggle with actually' (Local Authority G).

Other authorities felt that they were 'very good at knowing when to get involved [with their community] and when not' (Local Authority C) and this led to a good working relationship with the community. One officer felt that their collaborative sustainability projects were 'successful because of the officers involved and the residents trust the officers' (Local Authority D). This local authority were therefore successful in breaking down the commonly observed barrier of a lack of trust and managed to effectively develop meaningful relationships with citizens and community groups (Fudge and Peters, 2009, Peters et al., 2013, Peters et al., 2012).

Conversely another authority felt differently on this matter and commented that it is not always easy to engage residents because there is always going to be a sub-set of the community who will not engage with the local authority 'because it is a local authority and some people just do not want to engage with local authority, do not trust them' (Local Authority B). Officers also spoke of the difficulties in engaging particular sectors of the community, notably working professionals (Local Authority C, D), which corresponds with similar observations from a number of other recent studies (Fudge and Peters, 2009, Peters et al., 2012).

Despite this, the majority of officers acknowledged that engagement with the community can lead to very successful and effective sustainability projects. In addition, all officers were positive about working in partnership with the community on sustainability projects, with one officer sharing that they felt that ‘the majority of people who are interested in environmental issues are open minded and even enthusiastic about the idea of working with the council’ (Local Authority E). Another officer, whose local authority works successfully in partnership with many community groups, expressed that their department ‘would not be anywhere without [the] community’ (Local Authority D) and that they were ‘really lucky with our green communities’ (Local Authority D).

7.1.5 Monitoring and Evaluation of Programmes

Finally the difficulties of evaluating projects were spoken of. The most significant finding from these interviews was the distinct lack of reliable, robust and comparable information available on the performance of the sustainability projects. Officers were aware of this and spoke about it during the interviews.

Officers spoke about the difficulties they faced in assessing projects, notably those that aimed to engage with the public. During the interviews, one officer reflected ‘I think it’s really hard to actually assess how well the [engagement programmes] work’ (Local Authority H). Another officer discussed the challenges they faced in quantifying the impact of the engagement work they delivered, such as workshops, into comparable measures such as carbon. One officer deliberated that ‘I think there are ways and means to measure it [the carbon impact], what I do not think councils do tend to do, is measure their kind of, the impact of the work' (Local Authority C).

This inability to quantify the impact of the projects was also observed to impact on the lifetime of projects and the funding available to them. With one officer sharing a theory that they thought food growing projects had become less of a priority within the council because they 'cannot be proven to have a carbon impact. We cannot turn around and say that because we started a food growing site it's likely to have saved this much carbon' (Local Authority C). Another officer also mentioned the barriers they faced in quantifying the impact of projects, noting that it is 'really, really difficult even to measure the impact that we're having just because the data was not there' (Local Authority E).

However, one local authority did undertake work to measure the impact of their sustainability projects and behaviour change programmes and noted in their interview that 'it became very apparent that if we were going to do effective behaviour change then we had to spend almost as much time on monitoring and evaluation as we did on the actual project' (Local Authority F). This council did begin to develop some policy relevant results, finding that 'practical sessions made the biggest difference' (Local Authority F), in terms of encouraging pro-environmental behaviour change. They also concluded that events that aim to engage the public on sustainability issues were important for bringing residents together but they were not necessarily something a sustainability department should be organising and funding, because such events did not make a difference to the borough's environmental impact (Local Authority F). Unfortunately, given the current economic climate, this behaviour change work has since ceased in this local authority.

Beyond this single local authority, these interviews have demonstrated that there is a lack of monitoring, data collection and evaluation of sustainability projects within local authorities. Monitoring and evaluation is rarely built into the project design and where it is, there is often an over-reliance on using the data collected by residents to monitor their own performance (as in the case of the action-oriented energy projects). It was observed that such projects that rely on residents to collect and share data with the council can become intrusive and this can cause residents to disengage with the project all together (Local Authority B and E). Additionally, the data that is collected is often low quality and not useable for evaluation of the overall project.

7.1.6 Impact on Future Research Strategy

This study demonstrates that although local authorities are delivering a vast range of sustainability programmes within their boroughs, there is a lack of monitoring and data collection in relation to the performance of these sustainability projects. This acts as a barrier to the evaluation of effective sustainability programmes by the local authorities and within this research. It also means that it is not possible to quantify the environmental impact of the projects, nor delve into the more complex question of ‘what works?’ Previous research has identified the importance of the need to focus on environmentally significant behaviour that is defined by impact (Steg and Vlek 2009, Stern 2000). However, these interviews demonstrate that this is not happening in practice.

One potential reason for this lack of monitoring is a lack of capacity within the local authority. This reason was also proffered in the House of Lords Inquiry into behaviour change, where it was noted that expert witnesses “questioned whether there were the requisite levels of skill in designing and evaluating interventions at a local level" (House of Lords, 2011). It seems that this view may be supported by these interviews.

To answer the second research question and ascertain the impact of local authority sustainability programmes and any associated pro-environmental behavioural changes, this chapter concludes that there is a need to collect robust and reliable data on project performance. This study recommends that the impact of projects be quantified into carbon emissions abated, or in terms of their 'carbon-significance'. Carbon is an appropriate measure for quantifying the impact of projects within the British context because this approach works with the advanced legislative framework of the Climate Change Act (DECC, 2008). Additionally, carbon is a currency that is meaningful to both scientists and policy makers alike (Gatersleben et al., 2002) and for politicians, climate change is a more 'manageable policy concept' than the holistic concept of sustainable development (Porritt, 2009: 17, Restorick, 2011).

In terms of evaluation, quantification of the carbon impact of sustainability programmes would facilitate easy comparison of different interventions. It would also assist development of understanding as to the potential contribution that such projects could make towards reducing emissions and meeting national targets legislated under the Climate Change Act (DECC, 2008). In addition, quantification would support local authorities in demonstrating the impact of their work which may encourage additional support for funding or improved commitment from the upper echelons of the council for their work. It will also enhance understanding as to the effectiveness of different policy levers at encouraging behaviour change.

Given this finding that there is a lack of monitoring and evaluation of sustainability programmes, this chapter concludes that monitoring of sustainability programmes be undertaken in an effort to ascertain their environmental impact. Where possible, this monitoring should make use of objective measures and controls and it should be built into the project design to facilitate both pre- and post- intervention monitoring.

7.2 Conclusion

The first phase of research presented in this chapter has sought to provide more structured evidence about the nature and extent of sustainability work being undertaken by local authorities in London. This is in an effort to answer the research question and understand how local authorities are currently working to encourage pro-environmental behaviour amongst their residents, through their sustainability programmes.

Through a series of interviews with sustainability officers within London, this chapter has revealed that despite a lack of regulation, local authorities within London are presently working voluntarily to encourage pro-environmental behaviour amongst their residents and reduce carbon emission in their boroughs, in a variety of ways. Through a number of policy levers ranging from the provision of information to fiscal incentives, behaviour change is being encouraged. Indeed some of the behavioural changes modelled by the CCC, within their carbon budgets are currently being encouraged by local authorities through their sustainability programmes. However, evaluation and assessment of the effectiveness of these programmes is limited.

There is a lack of reliable, robust and comparable information available on the performance of the sustainability projects and evaluation of projects is limited and weak. This chapter has demonstrated that this lack of evaluation acts as a barrier to the development of in-depth understanding as to which programmes are most effective at encouraging behaviour change, and which are delivering reductions in terms of environmental impact. As a result, the potential contribution that such projects could make towards reducing emissions and meeting national targets is ambiguous.

This chapter therefore concludes that there is an evident need to build monitoring and evaluation into the design of local authority sustainability projects. This finding is developed upon in the next two stages of the research in this thesis, which involves the monitoring of two local authority sustainability programmes.

Chapter 8 Results: Evaluation of Sustainability Programmes

In this thesis, two local authority sustainability programmes have been monitored and their impact, in terms of carbon abated, has been estimated. The results of the evaluation of the RE:NEW Home Energy Visit programme and the Lissenden Gardens Green Zone are reported in this chapter.

8.1 Results: Home Energy Visits

This section introduces the first of the sustainability programmes, the home energy visit programme, RE:NEW and draws together the outcomes of the visits, results of the survey, statistical tests and the model of carbon impact which was later analysed using hierarchical cluster analysis.

In relation to the easy measures installed during the visit, the most significant measures, in terms of abating carbon, were letter box draught proofers, low-flow showerheads and real time energy use monitors, where a real time energy use monitor refers to a display device that is situated within the home and shows the current rate of electricity consumption via a meter which clips onto the electricity meter. The rate of energy consumption can be shown in cost, if the price per kWh is programmed into the device. The total number of easy measures installed during visits, in the sample homes, is detailed within Figure 8.1.

Table 8.1 Total number of 'easy measures' installed

	Total number or percent of measures installed per borough				Average number of measures installed per home		
Local authority / Measure installed	A	B	C	All	A	B	C
CFLs/ lightbulbs	53	31	52	61%	1.23	1.15	1.08
Tap aerators	9	16	24	31%	0.21	0.59	0.50
Radiator panels (Solid and uninsulated cavity walls - type 1)	75	12	72	33%	1.74	0.44	1.50
Radiator panels (All wall types, including insulated - type 2)	0	6	0	3%	0.00	0.22	0.00
TV and PC standby switches	32	15	31	66%	0.74	0.56	0.65
Real time energy monitors	33	23	23	67%	0.77	0.85	0.48
Save a Flushes	21	6	19	37%	0.49	0.22	0.40
Showertimers	31	16	18	55%	0.72	0.59	0.38
Showerheads	29	8	28	54%	0.67	0.30	0.58
No of Letterbox draught proofers	4	6	2	10%	0.09	0.22	0.04
Garden Hose Guns	19	6	3	24%	0.44	0.22	0.06

Note that the average number of measures installed in the home is calculated by dividing the total number of measures by the number of participating households in each borough. The number of households can be seen in Table 5.4. In relation to referrals for additional and more significant measures such as wall and loft insulation, from the sample group, not a single referral was made for virgin loft insulation. One future referral was recorded for virgin loft insulation. In relation to regular loft insulation (top-ups), no referrals were made. One referral for cavity wall insulation was made and four future referrals for cavity wall insulation were recorded. Given that the sample size is 118 households, these referrals are quite limited.

In relation to behaviour change, the advice that was given during each visit, for a number of specified topics, was recorded. On average, 46% were given advice on using their heating controls and 19% was given advice on understanding their bills. In terms of making structural changes to the property, 10% of households were given advice on DIY insulation, 17% of households were given advice on solid wall insulation and 9% of households were given advice on renewables. Additionally, 17% were given advice on secondary glazing and 37% of households were given advice on low energy lighting. With regard to the self-reporting of pro-environmental behaviours, which were collected explicitly for this research, the frequencies of reported behaviours for the sample group, at both stages of the survey, can be seen in Table 8.2 and Table 8.3.

Table 8.2 Frequencies of behaviours at stage one

			Stage 1							
			Frequencies in Percent					Mean	Median	Standard Deviation
		Survey scale:	1	2	3	4	5			
Energy behaviours		If I am cold I'll put a jumper on or use a blanket instead of turning up the heating (B8)	1	7	23	36	33	3.9	4	.96
Energy behaviours		I turn off unused appliances such as televisions and computers and do not leave them on standby (B11)	0	4	9	15	72	4.5	5	.84
Energy and Water Behaviours		I set my washing machine to economy or low temperature cycles (B12)	6	2	16	18	59	4.2	5	1.13
Energy and Water Behaviours		I only fill the kettle with the water that I need (B13)	1	4	7	20	68	4.5	5	.86
Water Behaviours		I try to cut down on the amount of water I use at home (B9)	0	3	15	32	50	4.3	5	.84
Wider pro-environmental behaviours	Transport	I use public transport, walk or cycle for everyday journeys (B1)	2	4	6	21	68	4.5	5	.92
Wider pro-environmental behaviours	Transport	I use my car for short journeys (B2)	51	19	19	6	4	4.1	5	1.16
Wider pro-environmental behaviours	Transport	I take overseas holidays that involve flying (B3)	13	30	35	11	12	3.2	3	1.17
Wider pro-environmental behaviours	Waste	I separate and recycle my rubbish (B4)	3	3	6	9	79	4.6	5	.91
Wider pro-environmental behaviours	Waste	I actively try to reduce my waste (B7)	2	2	14	33	50	4.3	4	.89
Wider pro-environmental behaviours	Waste	I use my own reusable shopping bags for my grocery shopping (B10)	2	6	12	30	50	4.2	5	.99
Wider pro-environmental behaviours	Food	I grow my own food (B5)	56	14	19	8	3	1.9	1	1.16
Wider pro-environmental behaviours	Food	I buy food that is local and in-season (B6)	3	11	38	30	18	3.5	3	1.00
Survey Scale: 1 = Never, 2 = Rarely, 3 = Some of the time, 4 = Frequently, 5 = Always,										

Table 8.3 Frequencies of behaviours at stage two

		Survey scale:	Stage 2 Frequencies in Percent 1	2	3	4	5	Mean	Median	Standard Deviation
Energy behaviours		If I am cold I'll put a jumper on or use a blanket instead of turning up the heating (B8)	3	3	24	32	37	4.0	4	1.03
Energy behaviours		I turn off unused appliances such as televisions and computers and do not leave them on standby (B11)	2	3	8	24	64	4.4	5	.90
Energy and Water Behaviours		I set my washing machine to economy or low temperature cycles (B12)	5	6	10	15	65	4.3	5	1.14
Energy and Water Behaviours		I only fill the kettle with the water that I need (B13)	1	3	9	16	72	4.5	5	.84
Water Behaviours		I try to cut down on the amount of water I use at home (B9)	1	3	16	34	46	4.2	4	.90
Wider pro-environmental behaviours	Transport	I use public transport, walk or cycle for everyday journeys (B1)	2	3	10	23	63	4.4	5	.90
Wider pro-environmental behaviours	Transport	I use my car for short journeys (B2)	57	20	15	4	4	4.2	5	1.07
Wider pro-environmental behaviours	Transport	I take overseas holidays that involve flying (B3)	15	34	36	7	8	3.4	3	1.09
Wider pro-environmental behaviours	Waste	I separate and recycle my rubbish (B4)	3	4	3	9	81	4.6	5	.94
Wider pro-environmental behaviours	Waste	I actively try to reduce my waste (B7)	1	2	21	26	50	4.2	5	.91
Wider pro-environmental behaviours	Waste	I use my own reusable shopping bags for my grocery shopping (B10)	4	4	13	26	53	4.2	5	1.09
Wider pro-environmental behaviours	Food	I grow my own food (B5)	59	13	22	4	2	1.8	1	1.06
Wider pro-environmental behaviours	Food	I buy food that is local and in-season (B6)	3	8	46	27	16	3.4	3	.97

Survey Scale: 1 = Never, 2 = Rarely, 3 = Some of the time, 4 = Frequently, 5 = Always,

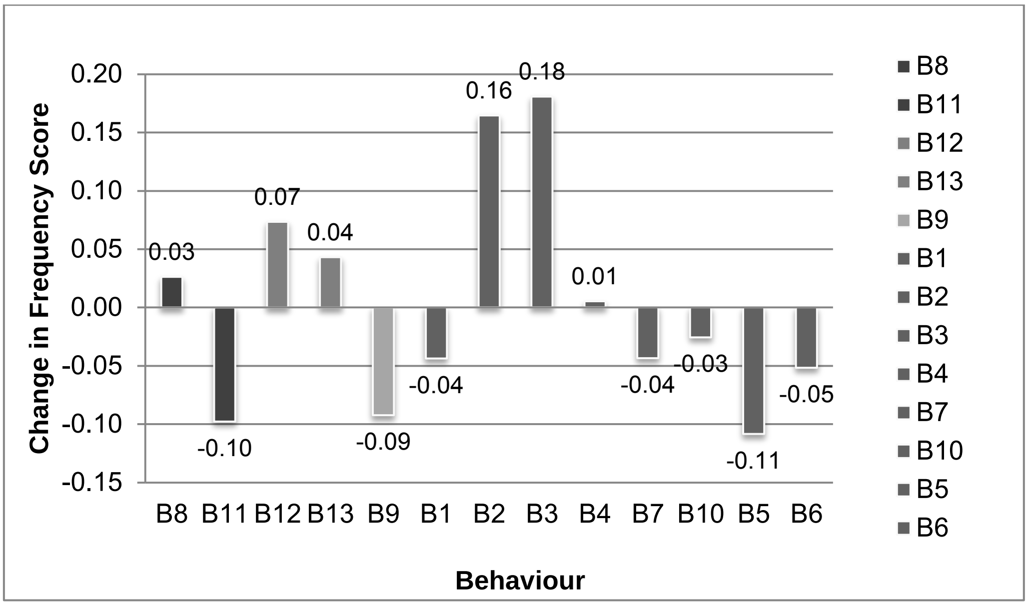

Figure 8.1 Change in frequency of behaviours between stages

The change in reported frequency, with which the sample group undertook the different energy, water and wider pro-environmental behaviours, was limited (see Figure 8.1). The largest observed change in behaviour was for behaviour 3 (I take overseas holidays that involve flying) which was a positive change in the mean score of 0.18 of a single point. To relate this to the level of activity, a single point equates to a change a shift in scale of one, for example from ‘frequently’ to ‘always’ or from ‘rarely’ to ‘some of the time’. Therefore, this shift in mean score of 0.18 and all other reported changes, were small and insignificant. It appears that participants’ behaviour remained relatively steady throughout the six month period between the two stages of the survey. These results are discussed in depth in discussion chapter (Chapter 9) in section 9.3.1.

8.1.1 Results from Statistical Tests

To test for significant differences between the sample and control group, in relation to the frequency with which different behaviours are performed, the Mann Whitney was used to test the following hypotheses:

H0 = Null hypothesis: There is no difference between the sample and control groups in relation to the reported frequency with which a behaviour is undertaken, at stage one.

H1 = Alternative hypothesis: There is a difference between the sample and control groups in relation to the reported frequency with which a behaviour is undertaken, at stage one.

It was found that the frequency with which the sample group undertook the selected pro-environmental behaviours at stage one, did not differ significantly from the control group for twelve of the thirteen behaviours, rendering the groups comparable on all but this one behaviour. Full results can be seen in Appendix 7. The one behaviour where a significant difference was observed between the two groups was for the behaviour 'I turn off unused appliances such as televisions and computers and do not leave them on standby' (B11). The frequency with which the sample group undertook this behaviour (Mean = 4.54, Median = 5) differed significantly from the frequency with which the control group undertook the behaviour (Mean = 3.30, Median = 3), as reported at survey stage one. $U = 195.500$, $z = -4.184$, $p < .001$, $r = -.371$.

Comparing the two groups at stage two, (behaviour 11 was excluded from this analysis as the groups were not comparable at stage one), a similar result was found, except there was no significant difference between the two groups for any of the behaviours. When excluding behaviour 11 at stage one, the results suggest that there is no real difference between the two groups and the retrospective reported frequencies of behaviours at both stages of the survey. This suggests that prior to the home energy visit the sample and control groups were comparable. Additionally, after the home energy visit, the groups still remained the same and therefore the visit did not have an impact on the sample group's energy, water or wider pro-environmental behaviours. No change was observed between the sample and control groups both initially after the visit, or again six months later.

Given this, causality between a home energy visit and a change in behaviour cannot be determined and therefore it would be unreasonable to continue to include wider pro-environmental behaviours in the analysis of the impact of home energy visits. However, subsequent analysis in this chapter has continued to include energy and water behaviours despite statistically insignificant results from the Mann Whitney tests. This is because of the significant focus on these consumption behaviours during the home energy visits.

To test for significant 'changes in behaviour' in the sample group, between the first stage and second stage, the Wilcoxon signed-rank test was used to test the following hypotheses:

H_0 = Null hypothesis: There is no significant change in behaviour between survey stage one and two.
H_1 = Alternative hypothesis: There is a significant change in behaviour between survey stage one and two.

It was found that the change in the frequency with which the sample group undertook the five energy and water behaviours was not significant (see Appendix 8). The results are as follows:

i. 'If I am cold I'll put a jumper on or use a blanket instead of turning up the heating' (B8)

   The change in frequency with which participants undertook this behaviour at survey stage one (Mean = 3.93, Median = 4.00) did not differ significantly from the frequency at survey stage two (Mean = 3.96, Median = 4.00), T = 676.00, not significant (p = 0.532), r = -.041

ii. 'I try to cut down on the amount of water I use at home' (B9)

   The change in frequency with which participants undertook this behaviour at survey stage one (Mean = 4.29, Median = 5.00) did not differ significantly from the frequency at survey stage two (Mean = 4.20, Median = 4.00), T = 419.00, not significant (p = 0.253), r = -.078

iii. 'I turn off unused appliances such as televisions and computers and do not leave them on standby' (B11)

   The change in frequency with which participants undertook this behaviour at survey stage one (Mean = 4.54, Median = 5.00) did not differ significantly from the frequency at survey stage two (Mean = 4.44, Median = 5.00), T = 163.00, not significant (p = 0.234), r = -.081

iv. 'I set my washing machine to economy or low temperature cycles' (B12)

   The change in frequency with which participants undertook this behaviour at survey stage one (Mean = 4.23, Median = 5.00) did not differ significantly from the frequency at survey stage two (Mean = 4.30, Median = 5.00), T = 285.00, not significant (p = 0.627), r = -.035

v. 'I only fill the kettle with the water that I need' (B13)

The change in frequency with which participants undertook this behaviour at survey stage one (Mean = 4.50, Median = 5.00) did not differ significantly from the frequency at survey stage two (Mean = 4.54, Median = 5.00), T = 223.50, not significant (p = 0.626), r = -.033

Based on these results the null hypothesis cannot be rejected. It stands that there was no significant change in the frequency with which the sample group undertook the different energy and water behaviours, before the visit, and again at a period of six months later. Coupled with the results of the Mann Whitney test it seems reasonable to conclude that the RE:NEW visits did not have a significant impact on participants' energy and water behaviours.

8.1.2 The Carbon Impact

Despite the results being statistically insignificant it is still possible to assess the impact of the behaviours of each household on an individual basis, alongside the assessment of the impact of the installation of measures. Analysis of the carbon impact estimated that the installation of easy measures gave an average carbon saving per household of 144 kg/CO_2 per year, for households within the sample. This figure was therefore 27 kgCO_2 lower than the RE:NEW estimate of 171 kgCO_2, which was calculated from all households across all boroughs. The average carbon saving per household as a result of reported behavioural changes was almost zero at 1.5 kg/CO_2 per year and therefore it would be reasonable to assume that as a sample group, overall there was no lasting change in behaviour, over the six month period, as a result of the visit.

Full details of how the estimations in carbon savings, as a result of the installation of small easy saving measures and behavioural changes, were calculated, see Appendix 9, but to illustrate, Table 8.4 to Table 8.6 detail a full worked example of how the carbon savings for a single household were calculated. This was repeated for all 118 households in turn.

Table 8.4 Worked example of carbon savings from easy measures for a single household

	Typical carbon and water saved per measure (see Table 5.7)		**Number of measures installed in individual household**	**Carbon and water saved as result of installation of measures in household**	
	Carbon saved (kgCO2 / measure / year)	Water saved (litres / measure / year)		Carbon saved (kgCO2 / household / year)	Water saved (litres / household / year)
No of CFLs/ lightbulbs	7	0	0	0	0
No of tap aerators	33	7000	0	0	0
No of radiator panels (type 1)	4	0	0	0	0
No of radiator panels (type 2)	2	0	0	0	0
No of standby switches	22	0	0	0	0
No of Real time monitors	64	0	1	64	0
No of Save a Flushes	3	4563	1	3	4563
No of Showertimers	7	913	1	7	913
No of Showerheads	83	10950	1	83	10950
No of Letterbox draught proofers	80	0	0	0	0
Garden Hose Guns	1	730	0	0	0
TOTAL				158	16425

Table 8.5 Worked example of carbon savings from behaviour change for a single household

	Reported frequency at phase 1	Reported frequency at phase 2	Change in reported frequency	Carbon saved (kgCO2 / household / year)
Behaviour 8	3	5	2	137
Behaviour 9	3	5	5	0
Behaviour 11	5	5	0	0
Behaviour 12	3	5	2	19
Behaviour 13	4	3	-1	-16
Total carbon saved from behaviour change				140

Survey Scale: 1 = Never, 2 = Rarely, 3 = Some of the time, 4 = Frequently, 5 = Always

Table 8.6 Total carbon savings from a RE:NEW visit for a single household

Aspect of home energy visit from which carbon is saved	Carbon saved (kgCO2/year)
Total carbon saved from easy measure	158
Total carbon from behaviour change	140
Total carbon saved	297

Differences in the behavioural score were observed amongst local authorities, this is detailed within Table 8.7. The largest difference in the estimated behavioural carbon saving was between local authorities B and C, and was approximately 43 $kgCO_2$ per household per year. No single local authority came close to the CERT carbon saving score of approximately 90 $kgCO_2$ per household per year (see section 5.1.1). Note that the negative score in behaviour change (-26 $kgCO_2$/householder/year) means that behaviour changed between the two stages of the survey to be less pro-environmental i.e. they generated more carbon. Despite this apparent difference, further analysis using the Kruskal-Wallis test, the non-parametric counterpart to the one-way ANOVA test (Field, 2009) found the difference between the mean carbon saving for each local authority to be insignificant, $H(2) = 1.48$, $p > 0.05$. The difference in the carbon abated as a result of the installation of easy measures was also insignificant, $H(2) = 3.66$, $p > 0.05$. As was the difference in the carbon abated as a result of behavioural change $H(2) = 5.12$, $p > 0.05$.

Table 8.7 Average carbon abated after RE:NEW visit

	Average water saved from easy measures (litres/year)	Average carbon saved from easy measures ($kgCO_2$/year)	Average carbon saved from behaviour change ($kgCO_2$/year)	Average total carbon saved ($kgCO_2$/year)
Local Authority A	12059	158.8	1.2	160.0
Local Authority B	9109	144.2	-25.7	118.5
Local Authority C	12081	130.9	17.1	148.0
All	11393	144.1	1.5	145.6

8.1.3 Cluster Analysis

Cluster analysis produced three clusters from the data. The full results can be seen Appendix 10. These results are presented graphically in Figure 8.2. The results demonstrate that the first cluster was characterised by respondents who identify themselves as being ‘green’. This cluster also felt that they have the ability to change their lifestyles to become more environmentally-friendly and strongly believed that it is important that the population all try and reduce their environmental impact. They were not merely interested in pro-environmental behaviour because it could save them money and they also had an optimistic outlook in that they felt that it is worthwhile to change ones behaviour to reduce ones environmental impact, even if others don't do the same.

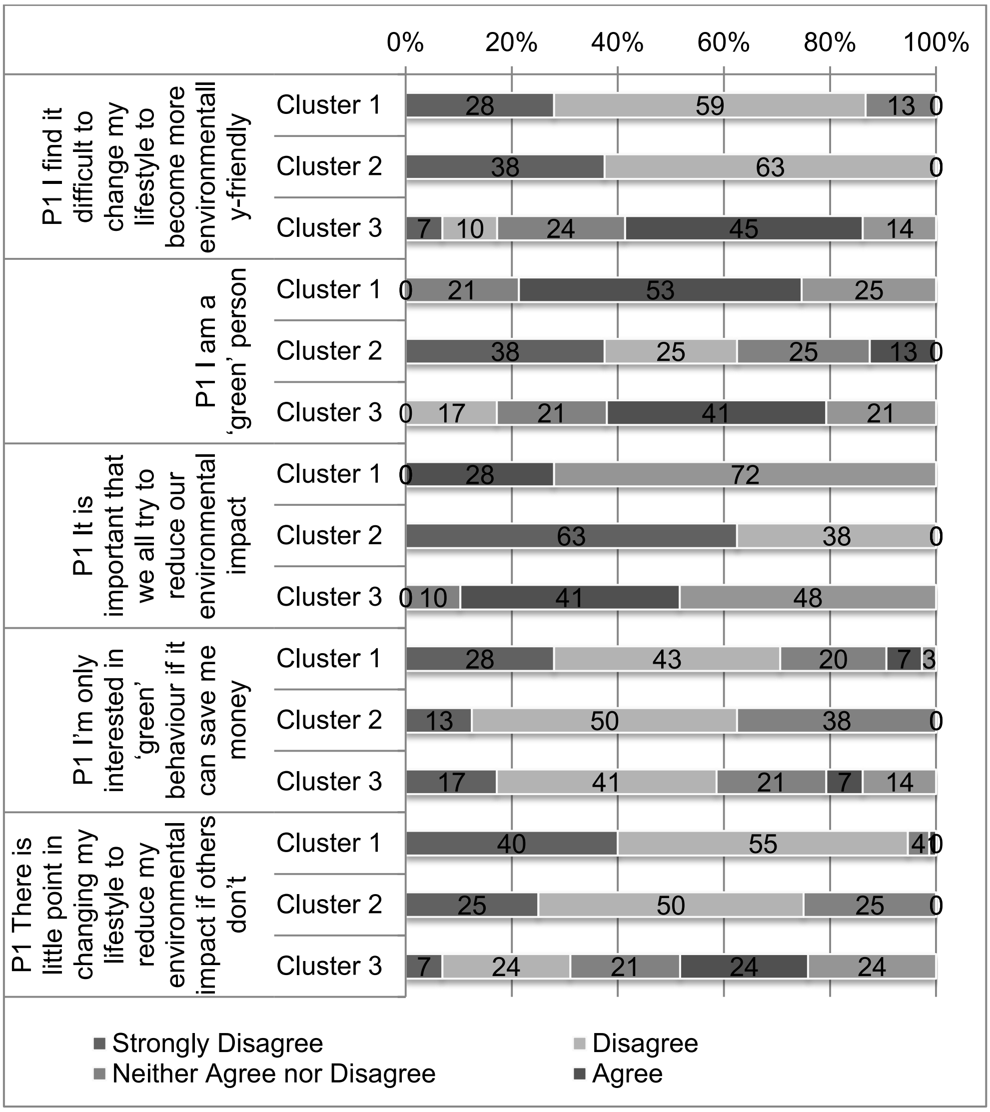

Figure 8.2 Results of responses to attitude statements by cluster

The results demonstrate that the second cluster was characterised by respondents who do not identify with being 'green' and over 60% described themselves this way. However, this cluster does feel that they have the ability to change their lifestyles to become more environmentally-friendly, though whether this ability is exercised is unknown. All respondents identified that they believe that it is not important that the population tries to reduce its environmental impact, with most identifying that they felt strongly about this. In addition, should they exercise pro-environmental behaviour, this would not be driven by the desire to save money. Interestingly, they do feel that is it not futile to change ones behaviour to reduce their environmental impact, even if others do not do the same.

The third and final cluster was characterised by respondents who generally identify themselves as being ‘green’, though this is to a lesser extent than cluster one. In addition, this group does not necessarily feel that they have the ability to change their lifestyle to become more environmentally-friendly, with more than half of respondents identifying that they find it difficult to change. This cluster does believe that it is important that the population all try and reduce their environmental impact but they are undecided as to whether the practice of undertaking pro-environmental behaviours is driven by the possibility of saving money, with more than 20% identifying that they are only interested in pro-environmental behaviours if they save them money. They are also undecided as to whether reducing ones environmental impact is worthwhile if others do not do the same.

Essentially, cluster one and cluster three respondents are similar. Both cluster one and cluster three identify themselves as being ‘green’ and think that is important that the population tries to reduce their environmental impact. However, cluster three is more likely to be driven to undertake pro-environmental behaviour if there is the possibility of also saving money and they feel that they have less ability to act and change their behaviour to be more pro-environmental, in comparison to cluster one.

Finally cluster two is quite different from the other two clusters. This group does not identify themselves as being ‘green’ and in fact they feel quite the opposite. They also believe that reducing the environmental impact of the population is an unimportant issue. However they support the belief that should individuals choose to change their behaviour to reduce their environmental impact, then this is not futile.

Comparison of the carbon impact of reported behavioural changes and the easy measures for each of these clusters was compared. Table 8.8 details this information for each cluster.

Table 8.8 Average carbon abated per household, by cluster

	Average water saved from easy measures (litres/year)	**Average carbon saved from easy measures ($kgCO_2$/year)**	**Average carbon saved from behaviour change ($kgCO_2$/year)**	**Average total carbon saved ($kgCO_2$/year)**
Cluster 1	12255	147.3	-6.6	140.7
Cluster 2	12200	145.7	106.6	252.3
Cluster 3	9519	139.6	-9.0	130.6
All Participants	11393	144.1	1.5	145.6

There was limited difference in the carbon and water saved as a result of the installation of easy measures installed between the clusters. However, of interest is the difference between clusters in the carbon saved as a result of behaviour change. As an average of the cluster agglomerations, the amount of carbon saved as a result of changes in behaviour, for cluster one and three, is slightly negative and given the small number this amount could reasonably be considered negligible. However, the average carbon saving as a result of behaviour change for cluster two is very large in comparison and represents over 40% of the total carbon saved in this cluster. These results are discussed in depth in discussion chapter (Chapter 9) in section 9.2.4.

Despite this apparent difference, further analysis between clusters, using the Kruskal-Wallis test, found the difference between groups, in the carbon abated as a result of behavioural change to be statistically insignificant, $H(2) = 3.24$, $p > 0.05$. This is most likely due to the small size of cluster two, which was comprised of 8 people. Unsurprisingly, the difference in the carbon abated as a result of the installation of easy measures was insignificant, $H(2) = .10$, $p > 0.05$. In addition the difference between the total mean carbon saving (easy measures plus behavioural change) for each cluster was also insignificant, $H(2) = 2.50$, $p > 0.05$.

8.1.4 Bias

As detailed within section 5.3.1.3 attrition bias between stage one and stage two of the survey did occur. There was significant bias between those that responded at the first stage only and those that responded in both stages, for four behaviours. Two of these behaviours were later removed from the analysis (B4 and B7), for reasons discussed in section 8.1.1, notably that causality between a home energy visit and a change in behaviour could not be determined and therefore it was deemed unreasonable to continue to include wider pro-environmental behaviours in the analysis of the impact of home energy visits.

Behaviours B9 and B11 were included within the carbon impact model. However because this analysis of RE:NEW focuses on individual households, and does not attempt to generalise these findings to a wider population, it is concluded that this bias does not affect the quality of these results, significantly.

8.2 Summary of Home Energy Visits Results

This section aimed to quantify the carbon impact of a RE:NEW home energy visit for a sample of households, across three inner London boroughs. The carbon impact was calculated from the change in carbon emissions as a result of a change in energy and water behaviours in the home and the installation of small easy measures that reduce energy and water consumption.

When this study was conceived it was hoped that it would be possible to produce results that could be generalised and that the outcomes could be reliably applied to the wider population, defined here as inner London. However, as the study started and the local authorities dictated the number of household that could be sample, it was found that this would not be the case. The comparison of the sample and control groups, using the Mann Whitney Test, demonstrated that there was no significant difference between the two groups after the RE:NEW visit. This led to the conclusion that causality between the RE:NEW visit and any associated behaviour change could not be found. In addition, tests using the Wilcoxon signed-rank test demonstrated no significant change in the frequency with which different behaviours were performed before and after the RE:NEW visit. As a result a more detailed analysis of the impact of the visits, at an individual household level was undertaken.

Further and more detailed analysis that aimed to estimate the carbon impact of changes in energy and water consumption within each household over the six month period following the energy visit, found that, on average the overall amount of carbon abated as a result of the installation of easy measures was 144 kg/CO_2 per household per year. This figure was therefore lower than the average saving per household calculated in the RE:NEW evaluation report (2014). This difference may be caused by the difference in typology and tenure of housing throughout London and the focus of this study on inner London.

The average amount of carbon abated as a result of behavioural change was 1.5 kg/CO_2 per household per year. Given that this figure is so small the average impact from behaviour is deemed negligible. However, it was found that one group of participants did change their behaviour positively and to a far greater degree than all other participants. The behaviour change carbon impact of this group was 107 kgCO_2/year. Interestingly this group identified themselves as not being 'green' and they supported the view that reducing the environmental impact of the population is an unimportant issue. Yet this group changed their behaviour by a far greater proportion than all other participants. Potential reasons to explain this difference will be discussed in greater depth in Chapter 9.

8.3 Results: Green Zones

This section introduces the results from the second inner London local authority sustainability programme that has been monitored and evaluated in this thesis. This sustainability project was led by the London Borough of Camden and specifically intended to encourage cycling. The project was delivered through a wider sustainability programme called 'Green Zones'. This specific Green Zone involved providing Camden residents with accessible and secure street level cycle parking.

This section draws together the results of the monitoring of resident cycle patterns in Lissenden Gardens and the resultant indicators of cycling prevalence; it also details the results of the statistical tests. As discussed in the methodology, the indicators of cycling prevalence, which describe cycle behaviour and patterns, have also been used to describe prevalence of other modes of transport, namely bus, car, train and tube, in order to estimate the total carbon impact of the intervention on each participants complete travel pattern. The indicators of the prevalence of these other modes of transport are also detailed within this section.

Table 8.9 details the outcomes of the analysis and the indicators of cycling prevalence for each participant in the sample and control groups, before and after the intervention. The difference in cycling prevalence, between the stages, is also detailed within this table. The carbon impact at each stage and the overall change in carbon impact for that mode and participant is also included. The same results but for the additional modes of transport are presented in Table 8.10 to Table 8.13.

It is worth noting that within the results in Table 8.9 to Table 8.13, where the change in any of the indicators of cycling prevalence (or other modes) is negative, this indicates that the rate of cycling has decreased between stages 1 and 2. Given that cycling and indeed all other modes of transport are attributed a carbon score, if there is a decrease in the prevalence of mode of transport i.e. the participant travelled less by that mode in the second stage of monitoring, in comparison to the first, then there will be a decrease in the carbon impact attributed to that mode of transport. This will present itself as a negative figure. The total change in carbon impact summed across all of the modes, for all participants, is detailed within Table 8.16.

Table 8.9 Indicators of cycle behaviour before and after the intervention, and carbon impact

Cycle		Pre intervention				Post intervention				Change between Stage 1 and 2			
Group	ID	Average cycle metres per travel day	Average cycle metres per cycle journey	Average number of cycle journeys per travel day	Carbon Impact	Average cycle metres per travel day	Average cycle metres per cycle journey	Average number of cycle journeys per travel day	Carbon Impact	Change in average cycle metres per travel day	Change in average cycle metres per cycle journey	Change in average number of cycle journeys per travel day	Change in Carbon Impact
Sample	P1	5381	7687	0.7	86	5812	4024	1.4	93	431	-3664	0.7	7
Sample	P2	0	0	0.0	0	191	2678	0.1	3	191	2678	0.1	3
Sample	P3	2471	4530	0.5	40	1732	4948	0.4	28	-739	418	-0.2	-12
Sample	P4	7800	4680	1.7	125	9067	4533	2.0	145	1267	-146	0.3	20
Sample	P5	3615	2892	1.3	58	791	2900	0.3	13	-2824	8	-1.0	-45
Control	P101	4003	2771	1.4	64	3004	2682	1.1	48	-999	-90	-0.3	-16
Control	P102	3315	3315	1.0	53	3422	3231	1.1	55	106	-84	0.1	2
Control	P103	7842	4278	1.8	125	5559	4276	1.3	89	-2283	-2	-0.5	-37
Control	P104	7678	6757	1.1	123	8659	6013	1.4	139	981	-744	0.3	16
Control	P105	2577	2108	1.2	41	6386	2919	2.2	102	3809	811	1.0	61

Table 8.10 Indicators of bus use behaviour and carbon impact

Bus		Pre intervention				Post intervention				Change between Stage 1 and 2			
Group	ID	Average bus metres per travel day	Average bus metres per bus journey	Average number of bus journeys per travel day	Carbon Impact	Average bus metres per travel day	Average bus metres per journey	Average number of bus journeys per travel day	Carbon Impact	Change in average cycle metres per travel day	Change in average cycle metres per cycle journey	Change in average number of cycle journeys per travel day	Change in Carbon Impact
Sample	P1	480	4800	0.1	36	897	2691	0.3	67	417	-2108	0.2	31
Sample	P2	3411	2818	1.2	256	2359	4129	0.6	177	-1051	1311	-0.6	-79
Sample	P3	2453	3373	0.7	184	2040	3708	0.6	153	-413	336	-0.2	-31
Sample	P4	279	1671	0.2	21	0	0	0.0	0	-279	-1671	-0.2	-21
Sample	P5	1607	3858	0.4	121	481	2643	0.2	36	-1127	-1215	-0.2	-85
Control	P101	2946	4079	0.7	221	1308	2179	0.6	98	-1638	-1900	-0.1	-123
Control	P102	311	1180	0.3	23	149	1265	0.1	11	-162	85	-0.1	-12
Control	P103	181	813	0.2	14	283	1885	0.2	21	102	1073	-0.1	8
Control	P104	1095	6021	0.2	82	490	4085	0.1	37	-605	-1936	-0.1	-45
Control	P105	1131	2544	0.4	85	400	2134	0.2	30	-731	-410	-0.3	-55

Table 8.11 Indicators of car use behaviour and carbon impact

Car		Pre intervention				Post intervention				Change between Stage 1 and 2			
Group	ID	Average car metres per travel day	Average car metres per car journey	Average number of car journeys per travel day	Carbon Impact	Average car metres per travel day	Average car metres per car journey	Average number of car journeys per travel day	Carbon Impact	Change in average cycle metres per travel day	Change in average cycle metres per cycle journey	Change in average number of cycle journeys per travel day	Change in Carbon Impact
Sample	P1	0	0	0.0	0	1471	6620	0.2	250	1471	6620	0	250
Sample	P2	3688	7786	0.5	627	911	6379	0.1	155	-2777	-1407	0	-472
Sample	P3	23170	28319	0.8	3939	10054	14363	0.7	1709	-13116	-13956	0	-2230
Sample	P4	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Sample	P5	0	0	0.0	0	7757	15514	0.5	1319	7757	15514	1	1319
Control	P101	10902	15096	0.7	1853	4744	6977	0.7	806	-6158	-8119	0	-1047
Control	P102	29608	56255	0.5	5033	504	4288	0.1	86	-29103	-51967	0	-4948
Control	P103	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Control	P104	1358	14941	0.1	231	5164	21516	0.2	878	3806	6575	0	647
Control	P105	8753	22508	0.4	1488	311	4968	0.1	53	-8442	-17540	0	-1435

Table 8.12 Indicators of tube use behaviour and carbon impact

Tube		**Pre intervention**				**Post intervention**				**Change between Stage 1 and 2**			
Group	ID	Average tube metres per travel day	Average tube metres per tube journey	Average number of tube journeys per travel day	Carbon Impact	Average tube metres per travel day	Average tube metres per tube journey	Average number of tube journeys per travel day	Carbon Impact	Change in average cycle metres per travel day	Change in average cycle metres per cycle journey	Change in average number of cycle journeys per travel day	Change in Carbon Impact
Sample	P1	1879	4697	0.4	128	1195	10751	0.1	81	-684	6054	0	-47
Sample	P2	372	3533	0.1	25	659	4612	0.1	45	287	1079	0	20
Sample	P3	0	0	0.0	0	582	5817	0.1	40	582	5817	0	40
Sample	P4	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Sample	P5	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Control	P101	1054	6322	0.2	72	1242	4435	0.3	84	188	-1887	0	13
Control	P102	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Control	P103	452	4069	0.1	31	210	4190	0.1	14	-243	121	0	-16
Control	P104	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Control	P105	771	4628	0.2	52	332	5315	0.1	23	-439	687	0	-30

Table 8.13 Indicators of train use behaviour and carbon impact

Train		Pre intervention				Post intervention				Change between Stage 1 and 2			
Group	ID	Average train metres per travel day	Average train metres per train journey	Average number of train journeys per travel day	Carbon Impact	Average train metres per travel day	Average train metres per train journey	Average number of train journeys per travel day	Carbon Impact	Change in average cycle metres per travel day	Change in average cycle metres per cycle journey	Change in average number of cycle journeys per travel day	Change in Carbon Impact
Sample	P1	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Sample	P2	4499	28494	0.2	238	2542	8897	0.3	135	-1957	-19597	0	-104
Sample	P3	0	0	0.0	0	208	2078	0.1	11	208	2078	0	11
Sample	P4	393	2360	0.2	21	0	0	0.0	0	-393	-2360	0	-21
Sample	P5	0	0	0.0	0	2420	17748	0.1	128	2420	17748	0	128
Control	P101	0	0	0.0	0	0	0	0.0	0	0	0	0	0
Control	P102	11454	9462	1.2	607	19298	29824	0.6	1023	7844	20362	-1	416
Control	P103	2315	10418	0.2	123	5014	16713	0.3	266	2699	6296	0	143
Control	P104	2180	6853	0.3	116	1405	3903	0.4	74	-776	-2950	0	-41
Control	P105	13144	78862	0.2	697	20581	65858	0.3	1091	7437	-13004	0	394

Table 8.9 details the analysis of the change in cycle patterns for both groups, before and after the intervention. These results show that for three of the sample group participants, their rate of cycling increased after the intervention, and this can be seen by an increase in carbon impact for the mode of transport, for cycling, as with the other modes of transport, is attributed a carbon impact. The greatest increase in cycle rates in the sample group can be seen by participant P4 who increased the average number of cycle journeys made per travel day from 1.7 in the pre-intervention period to 2.0 in the post-intervention period. However, the cycling prevalence of two of the sample group participants decreased after the intervention, with Participant P5 reducing their average number of cycle days per travel day from 1.3 in the pre-intervention period to 0.3 in the post-intervention period.

Analysis of the control group shows a similar picture as the sample group. For three of the control group participants, their rate of cycling increased. The prevalence of cycling for Participant P105 increased quite largely, with their average cycle journeys per travel day increasing from 1.2 to 2.2 in the post-intervention period. Again, as with the sample group, two of the control group participant's cycle prevalence reduced, with the largest reduction occurring for Participant P103, whose average cycle journeys per travel day decreased from 1.8 to 1.3 after the intervention period.

Therefore this analysis seems show a similar outcome in the change in cycle behaviours, before and after the intervention, for both the sample and control group. There does not seem to be a clear distinction between the two groups, despite one group being subject to the intervention, and one not.

Table 8.10 details the analysis of the change in bus use patterns for both groups, before and after the intervention. As discussed elsewhere, other modes of transport were analysed to ascertain whether the cycle parking caused a change in cycling prevalence, which led to a modal shift in transport use.

These results of the bus use analysis show that for four of the sample group participants, their rate of bus use decreased after the intervention and this can be seen by a reduction in carbon impact for the mode of transport. Only one sample group participant increased their bus use and this was minimal, Participant P1 increased the average number of bus journeys they make per travel day from 0.1 to 0.3. The same picture emerges for the control group with their rate of bus use also decreasing for four participants, after the intervention.

Overall, what is noticeable is that average bus use for both groups is relatively low with the average number of bus journeys per travel day being less than 1.0 for both groups, at both stages of the study, except for Participant P2 at stage 1. Reduction in bus use, after the intervention, seems to have occurred at a relatively similar rate for both groups.

Table 8.11 details the analysis of the change in car use patterns for both groups, before and after the intervention. These results of the car use analysis show that within each group there are single participants who do not use a car in either stage (Participants P4 and P103). In general, within the sample group, car use increases for two participants and decreases for two participants. For the control group, car use decreases for three participants and increases for one participant.

Therefore, no clear pattern emerges from the analysis of these results except that car use appears to reduce more significantly for the control group, rather than for the sample group, but car use is greater for the control group at the pre-intervention stage. In addition, what is noticeable from these results is that the resultant changes in carbon impact are much larger than for bus or cycle, due to the carbon impact of private car use.

Table 8.12 details the analysis of the change in tube use patterns for both groups, before and after the intervention. These results show that within each group there are two participants who do not use a car in either stage (Participants P4, P5, P102 and P104). Within the sample group, tube use increases for two participants and decreases for one participant. For the control group, tube use decreases for two participants and increases for one participant.

Therefore, no clear pattern emerges from the analysis of these results except that overall, it seems that tube use decreases by a greater amount for the control group than the sample group. As with bus use, the average number of tube journeys per travel day, for both groups is very low. In all cases it is at a rate of less than 0.5

Finally, analysis of train use in Table 8.13 shows that within each group there are single participants who do not use the train at either stage (Participants P1 and P101). Within the sample group, train use increases for two participants and decreases for two participants. For the control group, train use decreases for one participant but increases for three participants. Therefore, overall it seems that train use increases at a greater rate for the control group, after the intervention with average train journeys per travel day for control group participants increasing from about 0.2 to 0.3 to about 0.4.

To illustrate how these results in Table 8.9 to Table 8.13 were reached, a worked example for the pre-intervention data for participant P101 is given below. Table 8.14 details the raw data from the participant.

Table 8.14 Raw pre-intervention GPS travel data for participant P101

Day of study	Checked mode of travel	Distance (m)
Day 8	Cycle	1518
Day 8	Walks	415
Day 8	Cycle	2205
Day 8	Bus	438
Day 9	Tube	4640
Day 9	Tube	4926
Day 9	Car	1008
Day 9	Car	4644
Day 9	Walks	21
Day 9	Car	5103
Day 9	Car	1835
Day 10	Bus	932
Day 10	Tube	9398
Day 10	Bus	8634
Day 10	Bus	3644
Day 11	Cycle	3819
Day 11	Cycle	4341
Day 11	Walks	507
Day 12	Car	10214
Day 12	Car	9941
Day 12	Cycle	1396
Day 12	Cycle	1450
Day 13	Cycle	5766
Day 13	Cycle	4597
Day 14	Cycle	5216
Day 14	Walks	630
Day 14	Bus	10639
Day 14	Bus	8413
Day 15	Cycle	2050
Day 15	Cycle	2239
Day 15	Bus	1632
Day 15	Walks	1367

Day of study	Checked mode of travel	Distance (m)
Day 16	Cycle	4323
Day 16	Cycle	3115
Day 17	Bus	4613
Day 18	Cycle	1737
Day 18	Cycle	2077
Day 20	Cycle	1963
Day 20	Cycle	1983
Day 20	Cycle	4577
Day 20	Cycle	2670
Day 20	Walks	233
Day 21	Car	2928
Day 21	Car	61861
Day 23	Walks	808
Day 23	Car	69400
Day 23	Cycle	1733
Day 23	Cycle	718
Day 23	Bus	3494
Day 23	Bus	4568
Day 24	Cycle	1494
Day 24	Cycle	2087
Day 25	Cycle	5999
Day 25	Bus	1160
Day 25	Walks	123
Day 25	Bus	1049
Day 25	Walks	137
Day 25	Bus	3811
Day 25	Car	6124
Day 25	Car	3968
Day 27	Cycle	1697
Day 27	Cycle	1286
Day 28	Car	9817
Day 28	Car	9403

This information is represented geographically in Figure 8.3.

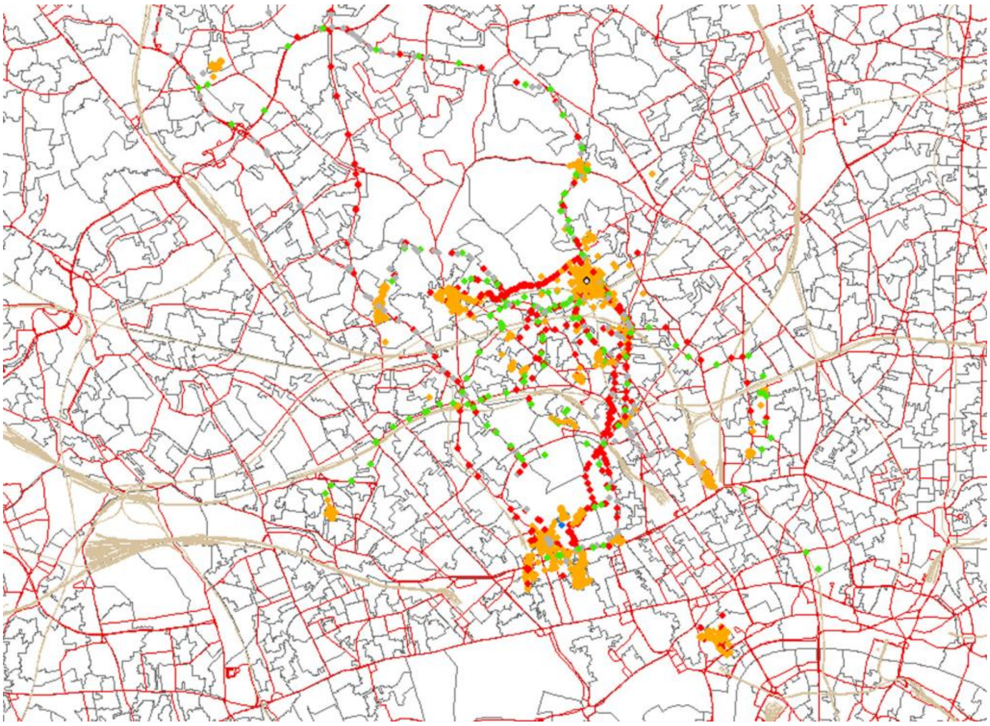

Figure 8.3 Output data for participant P101

Key: green = cycle, red = bus, orange = walk, grey = car, blue = train or tube

This data was then reduced to identify that the total number of 'cycle days' was 13, and the total number of 'travel days' was 18. In addition, 26 cycle trips, 13 bus trips, 13 car trips, 3 tube trips and 9 walking trips were made during the study period.

This raw data was then amalgamated to show complete travel patterns by all modes and provide the indicators of cycling prevalence (see Table 8.15), including, the ‘average number of cycle metres per cycle journey’, which in this case was 2771m, the ‘average cycle metres per travel day’, which in this case was 4003m and the ‘average number of cycle journeys per travel day, which was 26 cycle trips divided by 18 travel days, or 1.4.

Table 8.15 Complete processed travel data for participant P101

Day of study	Distance travelled by mode (m)					Total
	Bus	Car	Cycle	Tube	Walk	
Day 8	438		3724		415	4576
Day 9		12589		9567	21	22177
Day 10	13210			9398		22608
Day 11			8161		507	8668
Day 12		20155	2847			23001
Day 13			10363			10363
Day 14	19052		5216		630	24898
Day 15	1632		4288		1367	7288
Day 16			7438			7438
Day 17	4613					4613
Day 18			3814			3814
Day 20			11193		233	11426
Day 21		64789				64789
Day 23	8062	69400	2451		808	80721
Day 24			3581			3581
Day 25	6020	10092	5999		260	22371
Day 27			2983			2983
Day 28		19220				19220
Total Distance	53027	196245	72057	18965	4241	344534
Average distance travelled by mode, on an average 'travel day'	2946	10902	4003	1054	236	
Average trip length by mode	4079	15096	2771	6322	471	

8.3.1 Summary of Trip Analysis Results

Calculation of the indicators of cycling prevalence demonstrated that for the sample group, the average number of cycle journeys per travel day increased for three participants, and decreased for two participants, between stages ones and two. The same picture emerged for the control group.

Observation of the change in carbon impact, between the two stages showed that overall, for the sample group, the carbon impact attributable to cycling decreased by 27gCO_2, and for the control group, increased by 26gCO_2. This indicated that the impact of cycling, after the intervention, decreased for the sample group and increased for the control group.

Table 8.16 details the summary of the carbon impact of travel behaviours, by mode, using data found in Table 8.9 to Table 8.13. For all modes of transport, the total carbon impact reduced after the intervention for both groups. However the reduction in impact was far greater for the control group than the sample group.

Table 8.16 Summary of the carbon impact of travel behaviour, before and after the intervention, by mode

	Pre-intervention carbon impact (gCO_2)		Post-intervention carbon impact (gCO_2)	
	Sample	**Control**	**Sample**	**Control**
Bus	617.21	424.71	433.25	197.22
Car	4565.85	8605.68	3432.84	1823
Tube	153.05	154.84	165.58	121.27
Train	259.29	1541.93	274.01	2453.76
Cycle	308.27	406.66	281.49	432.47
Total	5904	11134	4587	5028

8.3.2 Results from Statistical Tests

To test for significant differences in cycling prevalence between the sample and control group and to ascertain whether the sample group cycled further and/or more frequently after the intervention, the ANCOVA test was used. The method is described in section 6.3.2.

When using ANCOVA, the first step is to test that the covariate is independent from the experimental effect. This can be checked using a t-test to ascertain that pre-intervention indicators are not different for both the sample and control groups. The second step in using ANCOVA is to test the assumption of homogeneity of regression and that the covariate has the same correlation with the dependent variable for both the sample and control groups. This is necessary because ANCOVA uses this information to estimate final adjusted means. If that correlation varies between the groups then the estimates will be inaccurate. The assumption of homogeneity can be tested by ascertaining the interaction effect between the grouping (sample and control) and the covariate. If this effect is not significant then the assumption of homogeneity of regression stands and ANCOVA is a suitable test.

The independence of the covariate and the treatment effect, for the three indicators, was first ascertained. The results found that on average:

i. The average cycle metres per travel day for the sample group (M = 3853, SE = 1318) was lower than for the control group (M = 5083, SE = 1116). This difference was not significant $t(8) = 0.712$, $p > .05$.
ii. The average number of cycle journeys per travel day for the sample group (M = 0.832, SE = 0.288) was lower than for the control group (M = 1.327, SE = 0.146). This difference was not significant $t(8) = 1.532$, $p > .05$.
iii. The average cycle metres per cycle journey for the sample group (M = 3958, SE = 1256) was higher than for the control group (M = 3846, SE = 810). This difference was not significant $t(8) = -.075$, $p > .05$.

Where M is the mean, SE is the standard error of the mean, t is the test statistic for Equality of Means, with the degrees of freedom indicated in brackets and p indicates the significance.

These findings therefore demonstrated that the covariate is independent of the grouping. In other words, none of the indicators were significantly different before the intervention, for the sample and control groups. Therefore the ANCOVA test was appropriate. The second test that needed to be conducted before the ANCOVA test could be undertaken was to test the assumption of homogeneity of regression. The results found that for each indicator of cycling prevalence the interaction effect between the grouping and the covariate was not significant and that the assumption of homogeneity of regression stood. ANCOVA was a suitable test for all indicators. SPSS outputs and detailed results of these tests can be viewed in Appendix 12.

The assumptions for ANCOVA were met. In particular, the homogeneity of the regression effect stood and the covariate was linearly related to the dependent measure. Therefore, a one-way analysis of covariance (ANCOVA) was conducted. The covariate was the pre-intervention indicator of cycling prevalence. The dependent variable was the post-intervention indicator of cycling prevalence. The results found that there was no significant effect of the intervention on any of the post-intervention indicators of cycling prevalence:

i. There was no significant effect of the intervention on the average cycle metres travelled per travel day, after controlling for the effect of the pre-intervention average cycle metres travelled per travel day, $F(1, 7) = .327$, $p = .585$.

The covariate, the pre-intervention average cycle metres travelled per travel day, was significantly related to the post-intervention average cycle metres travelled per travel day, $F(1, 7) = 11.196$, $p = .012$.

ii. There was no significant effect of the intervention on the average cycle metres per cycle journey, after controlling for the effect of the pre-intervention average cycle metres per cycle journey, $F(1, 7) = .009$, $p = .926$.
The covariate, the pre-intervention average cycle metres per cycle journey, was significantly related to the post-intervention average cycle metres per cycle journey, $F(1, 7) = 9.360$, $p = .018$.

iii. There was no significant effect of the intervention on the average number of cycle journeys per travel day, after controlling for the effect of the pre-intervention average number of cycle journeys per travel day, $F(1, 7) = .351$, $p = .572$.
The covariate, the pre-intervention average number of cycle journeys per travel day, was not significantly related to the post-intervention average number of cycle journeys per travel day, $F(1, 7) = 2.253$, $p = .177$.

Where F is the F-ratio and the degrees of freedom from which it was calculated and p indicates the significance. SPSS outputs results of these tests can be viewed in Appendix 13.

8.3.3 The Carbon Impact

Although these results appeared to clearly show that the intervention did not have an impact on the total carbon impact of the sample group, as discussed in earlier sections, when this research was originally conceived it was considered that if the provision of secure and accessible cycle parking encouraged participants who use the parking to cycle further or more frequently, then this could lead to a modal shift in transport and therefore a change in the overall carbon impact of an individual, as a result of their transport choices. Therefore, ANCOVA was used to ascertain this for certain and to control for variances in the pre-intervention carbon impact of participants. As already explained for the previous ANCOVA tests, first the independence of the covariate and the treatment effect had to be ascertained. The results found that on average:

i. The average total carbon impact for the sample group (M = 1181, SE = 768) was lower than for the control group (M = 2227, SE = 968). This difference was not significant $t(8) = 0.847$, $P > .05$.

These findings therefore demonstrated that the covariate is independent of the grouping; therefore the ANCOVA test was appropriate. The second test that needed to be conducted before the ANCOVA test could be undertaken was to test the assumption of homogeneity of regression. The results found that the interaction effect between the grouping and the covariate (the pre-intervention carbon impact) was not significant and that the assumption of homogeneity of regression stood. ANCOVA was a suitable test.

The assumptions for ANCOVA were met. In particular, the homogeneity of the regression effect stood and the covariate was linearly related to the dependent measure. Therefore, a one-way analysis of covariance (ANCOVA) was conducted. The covariate was the carbon impact of all modes, before the intervention. The dependent variable was the carbon impact of all modes, after the intervention. The results found that there was no significant effect of the intervention on the carbon impact of the sample group:

i. There was no significant effect of the intervention on the post-intervention carbon impact, after controlling for the effect of the pre-intervention carbon impact, $F(1, 7) = .072$, $p = .796$.
   The covariate, the pre-intervention carbon impact, was not significantly related to the post-intervention carbon impact, $F(1, 7) = 3.331$, $p = .111$.

SPSS outputs and detailed results of these tests can be viewed in Appendix 14.

8.3.4 Survey Results

After the study was complete, a short survey was undertaken to gather the views from participants as to whether they made use of the secure and accessible cycle parking, and more generally on their views of the barriers to cycling.

In total 10 participants completed the questionnaire, with 9 out of 10 respondents noting that they cycled in the first stage of monitoring, and all 10 participants noting that they cycled during the second stage of monitoring. In addition, at the time of the survey (after all monitoring was complete), 5 participants reported that they cycled between one and three times a week, and 3 noted that they cycled more than three times a week. The remaining two participants cycled less than once every fortnight.

Of the 6 respondents from the sample group (including corrupt data participants), all identified that they make use of the new cycle parking, with 5 identifying that they use it always and one identifying that they use it frequently. However, only two of the six respondents identified that the cycle parking has caused them to cycle more. Reasons as to why the cycle parking had helped participants to cycle more included that they ‘live of the third floor, so having the bike on street level makes it much easier to cycle’ (Participant 1, 2014) and that ‘it was also too hard to keep carrying the bike up stairs. It has made a big difference (Participant X2, 2014).

Reasons identified as to why the cycle parking had not caused participants to cycle more included that their ‘cycling habits depend mainly on the weather. I do not cycle much when it is cold and wet’ (Participant 3, 2014), another respondent echoed this saying that ‘the weather has been horrible, and that discouraged me from cycling’ (Participant 5, 2014). Another participant identified that they were ‘already cycling every day, but I do think the new cycle parking is convenient’ (Participant 4, 2014).

Although participants identified that they made use of the cycle parking, the survey identified how it could be potentially further improved; in response, three participants identified ‘if it was more spacious’ and three also identified ‘if it was more accessible’. Only one respondent said ‘if it was more secure’ and only one identified ‘if it had better lighting’.

Finally, all participants from all groups were asked to identify why they cycle at all, and what are the barriers that they feel prevent them from cycling more. Most participants had multiple reasons for choosing to cycle, these are shown in Figure 8.4. The main reason identified, by the cycle participants, as to why they choose to cycle, is that it gives them pleasure and enjoyment. Other popular reasons for choosing to be a cyclist is that it is convenient and quick, it keeps them fit and they do not have to rely on public transport.

Figure 8.4 Responses to survey: why do participants cycle?

The barriers that respondents identified prevented them from cycling more are shown in Figure 8.5. Interestingly, none of those in the study identified that the lack of segregated cycle parking facilities or the lack of on-street or at home cycle parking, so generally cycling infrastructure, prevented them from cycling more. Instead, the main barrier identified was unpleasant weather. The second most selected barrier was generally dangerous traffic conditions. Other barriers selected included if the destination is too far away, not wanting to get sweaty, if it is dark outside and if the weather conditions are dangerous. The notable commonality of these barriers is that apart from the barrier of generally dangerous traffic conditions, all of the others are beyond the control of the local authority.

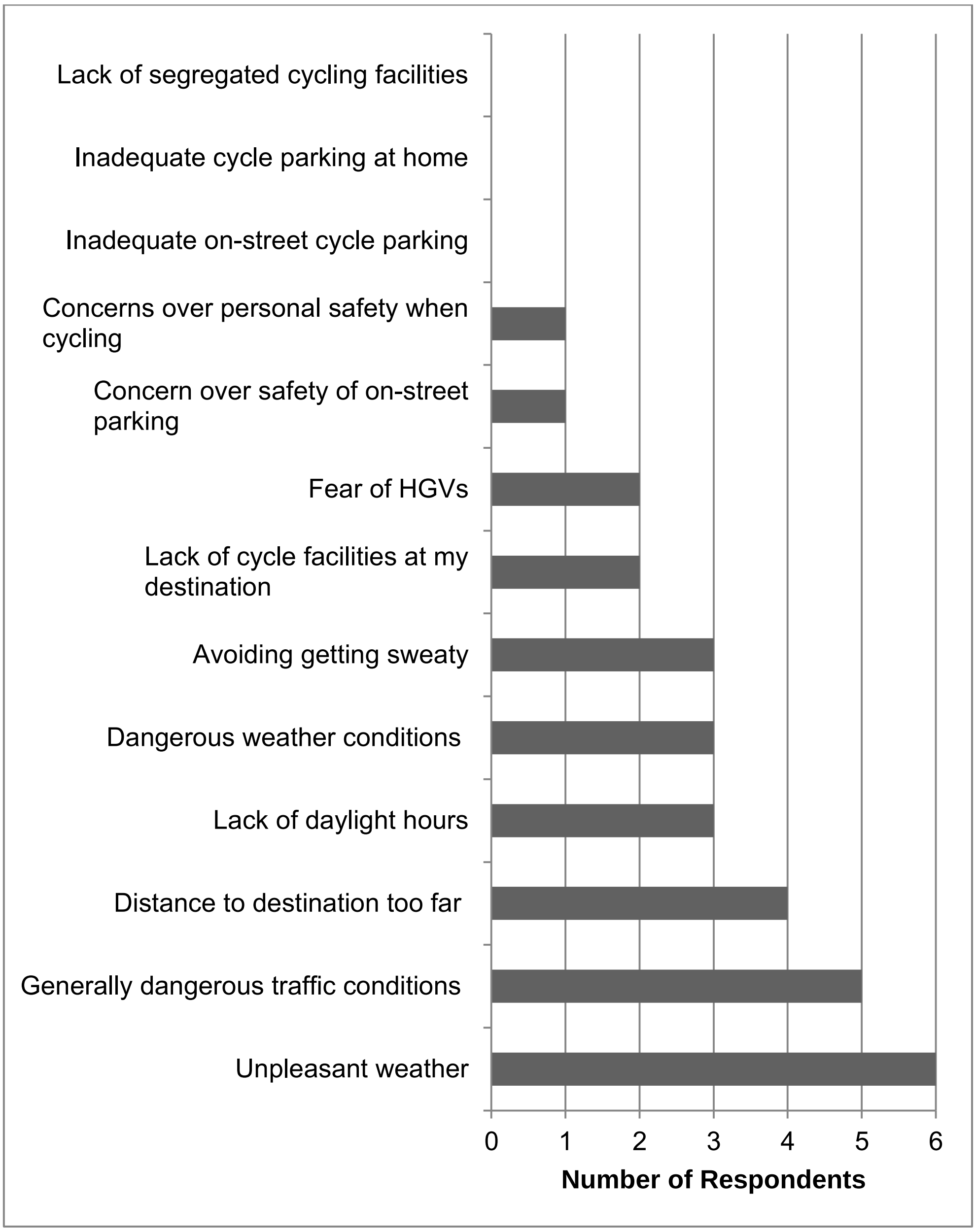

Figure 8.5 Responses to survey: what are the barriers to cycling more?

8.3.5 Bias and Problems

Clearly, the significant delay experienced in the implementation of this project was not ideal for the purposes of evaluation. Baseline monitoring was undertaken in June 2013, with the intention that post-intervention monitoring would take place in July 2013. However, the delay to the opening of the cycle parking caused post-intervention monitoring to be delayed by 6 months until January 2014. Despite this delay, given that a control group was in place and that ANCOVA only compares differences between groups of post-intervention cycling behaviours (when both groups would have been subject to the same weather conditions this delay), the results remain insightful, however, the impact of such a small sample group on the results, must be taken into consideration.

However, there are some points to consider. The less pleasant weather conditions in January may have still influenced the results. For, as shown in Figure 8.5, when participants were asked about the barriers to cycling more, the most cited reason was unpleasant weather. It could be hypothesised that this may have disproportionately affected the sample group, for, as identified in Table 6.1, the sample group were less committed cyclists than the control group. In the control group, each participant cycled at least once a week. In the sample group, only three participants cycled at least one a week, with the remaining two cycling less frequently. However, closer analysis of the survey results in Figure 8.5 identified that six participants responded with this answer, three from the sample group and three from the control. Therefore it is not possible to know if the weather had a disproportionate effect on either group.

Finally, if the cycle parking had opened in July, as planned, and when the project had a great deal of support from participants and momentum, participants may have used the cycle parking to a disproportionately greater extent, which could have caused a false positive in the results. This could have been overcome by monitoring cycle behaviours a few months after the opening of the cycle parking. By January, the enthusiasm of participants for the project had sufficiently waned and therefore this was unlikely to have been a problem for the January monitoring.

8.4 Summary of Green Zones Results

This section aimed to ascertain whether the intervention, which was the provision of accessible and secure cycle parking, would cause the sample (treatment) group to cycle more frequently and further. To ascertain this, a set of indicators of cycling prevalence were developed. These indicators were used in ANCOVA analysis to establish that the intervention did not cause the sample group to cycle more frequently and further.

This section also intended to ascertain the carbon impact of observed changes in travel habits. However, given the insignificant change in cycle patterns, it was expected that there would be no significant change in the carbon impact, as a result of modal shift. The carbon impact of all modes of travel for all participants was estimated. ANCOVA analysis was again used to ascertain that the intervention did not cause a significant change in carbon impact, as a result of modal shift, for those that received the intervention.

Reasons to explain why this intervention was ineffective at changing cycle behaviours will be discussed in greater depth in Chapter 9.

Chapter 9 Discussion

This thesis has worked to understand how local authorities have been encouraging pro-environmental behaviour in their citizens through local authority sustainability interventions, and the environmental impact of these interventions. This research question was born out of gaps identified in the literature, as to the effectiveness of environmental behaviour change interventions and the different policy levers that can be used to encourage behaviour change (section 2.3.4). These gaps in the literature led to the conclusion that the evaluation of local authority sustainability programmes may provide an opportunity to develop the evidence base on pro-environmental behaviour change (section 2.4).

As a result, Chapter 4 detailed the methods and Chapter 7 detailed the results, from a series of interviews with local authority sustainability officers. These interviews uncovered how local authorities have been working to encourage citizens to transition towards more sustainable lifestyles. Chapter 5 and Chapter 6 which detailed the methods, and Chapter 8, which detailed the results, developed upon this work to estimate the environmental impact of two different local authority sustainability programmes. These projects focused on two specific pro-environmental behaviours. The first intended to reduce energy consumption in the home and the second intended to encourage cycling.

The significance of the results from these two results chapters will be discussed in this chapter. This chapter will therefore build a picture of the contribution that this thesis has made to knowledge and understanding of the prevalence and environmental impact of local authority sustainability programmes, within the context of London, in the United Kingdom.

9.1 Local Authorities and Sustainability

The first phase of the research undertaken in this thesis is presented in Chapter 4 and Chapter 7. This chapter provided detailed and structured evidence about the nature and extent of sustainability work being undertaken by local authorities in London. The key findings from this series of interviews with sustainability officers within London and the contribution to knowledge that this chapter makes can be identified as:

Finding 1: Despite a lack of regulation, and therefore as a result of local political commitments, local authorities are currently working voluntarily and in a number of ways to deliver sustainability programmes and encourage pro-environmental behaviour amongst citizens.

Finding 2: Monitoring, evaluation and assessment of the effectiveness of local authority sustainability programmes is limited.

Finding 3: The environmental impact of different sustainability programmes delivered is ambiguous.

These findings supported the evidence base which directed the subsequent research undertaken in this thesis and therefore the crux of the discussion pertaining to these findings is within Chapter 7. To summarise, this phase of the research concluded that there was an evident need to build monitoring and evaluation into the design of local authority sustainability projects, to undertake evaluation.

9.1.1 Policy Recommendations

Despite finding a lack of available data with which to robustly evaluate the sustainability projects discussed in Chapter 7, the evidence collected through the interviews did offer a number of lessons and policy recommendations that may improve the effectiveness of local authority sustainability projects.

9.1.1.1 Working with localism

The recent shift towards localism (section 2.1.4) has led to a shift in how funding is allocated for local level sustainability work, with funding being allocated more freely to communities and community groups (section 7.1.4.3). However, volunteer community groups can lack capacity to deliver projects as effectively as local authority staff. Therefore, it would be beneficial to ensure that communities are supported in their endeavours by trained officers who are familiar with applying for funding and developing, delivering and procuring such programmes. This has already started to happen in some local authorities who observe that it has had a positive impact on project outcomes (Local Authority G). This could be facilitated through the funding mechanism, potentially from central government, for example, by requiring that sustainability projects be collaborative ventures between communities and local authorities.

9.1.1.2 Commitment and support

Analysis of the interviews in Chapter 7 demonstrated that both political support and support from the upper echelons of the local authority are essential for effective sustainability projects (section 7.1.4.2). However, commitment to addressing unsustainability and climate change varies between local authorities, and even between different teams. This variance could be amplified by a lack of a statutory framework to incentivise action on unsustainability and climate change. As a result, commitment and action is voluntary. Action from central government could counter this, to incentivise better performance, for example, through the reintroduction of mandatory reporting on borough level carbon emissions.

9.1.1.3 Monitoring and quantifying the environmental impact

This phase of research found that there was a lack of monitoring and evaluation of the different sustainability programmes. To remedy this, some local authorities were relying on participating citizens to collect data on the performance of the sustainability projects, with which they could undertake simple evaluation. Based on the qualitative evidence from the interviews detailed within Chapter 7, this research has concluded that this is not preferable, for such projects that ask residents to undertake extensive self-monitoring can be deemed intrusive (see section 7.1.4.1) and could cause residents to disengage from the project altogether. As a result, it is recommended that residents should only at most, be asked to collect limited amounts of data. In addition, evaluation should be built into the project design so that it can support pre- and post-intervention monitoring, and where possible, it should make use of objective measures and controls.

9.2 The Impact of RE:NEW

The results of the second phase of the research, undertaken in this thesis, have been presented in Chapter 8. In Chapter 8, the carbon impact of a RE:NEW home energy visit for a sample of households across three inner London boroughs, was estimated. The impact of a RE:NEW home energy visit has been calculated as the sum of the estimated carbon saving from the installation of easy measures plus the estimated carbon saving as a result of reported behavioural changes. Carbon savings from the installation of significant measures were omitted due to the very low number of referrals.

The key findings from the monitoring and estimation of the RE:NEW home energy visit programme, for this small sample of 118 households, and the contribution to knowledge can be identified as:

Finding 4: The RE:NEW home energy visit did not cause the frequency with which participants undertook different energy and water related pro-environmental behaviours to change to any significant extent. Therefore, these visits did not overcome the barriers to behaviour change for these particular households.

Finding 5: RE:NEW visits did not overcome the barriers to the installation of more significant measures, such as loft and wall insulation, for these particular 118 households.

Finding 6: For the 118 households in the sample, the average carbon impact of a home energy visit was estimated to be 145.6 $kgCO_2$ per household per year. This represents an average reduction in annual household emissions of 3%. Of this total 144.1 kg/CO_2 was attributable to easy measures and 1.5 kg/CO_2 to behavioural change, which was far less than the 90$kgCO_2$ per year awarded under CERT for behaviour change advice.

Finding 7: Cluster analysis demonstrated that for the 118 households in the sample, one type of programme participant changed their behaviour by a far greater degree than other participants, though this change was not statistically significant. The average estimated carbon impact of this group, as a result of behavioural change, was 107 kgCO_2/year.

These findings and recommendations to improve visits are discussed here in much greater depth; areas for future work to further advance the field are also mentioned.

9.2.1 Changing Behaviour

As discussed within Chapter 5, each visit intended to encourage both curtailment and efficiency energy conservation behaviours. During a RE:NEW visit, it was intended that advisors would 'explain how the customer can make changes to their behaviour to stop wasting energy and water' (Mayor of London, 2011d), to encourage curtailment behaviours. In addition, to encourage efficiency behaviours, visits would include the provision of a 'tailored advice pack reminding [householders] of actions they can take to make their home more energy efficient' (Mayor of London, 2011d).

These visits therefore intended to enable behaviour change by removing barriers through the provision of energy saving measures and by giving behaviour change advice and information, to engage by using the council brand to encourage trust and by targeting specific wards, to exemplify the local authority and GLA and lead by example through the pro-active delivery of the home energy visits and to encourage through the provision of free energy saving measures.

However, despite this intention to provide behaviour change advice and tailored information, RE:NEW home energy visits, on average, for these 118 households within the sample, did not have an impact on the frequency with which programme participants undertook a number of curtailment energy saving behaviours. For the estimated average carbon saved as result of behavioural change for a number of headline curtailment behaviours gave a negligible saving of 1.5 kgCO_2/year (see section 8.1.2). Potential reasons to explain this observed lack of behaviour change, despite the emphasis of the programme on behaviour change, are many.

Firstly, the information to encourage curtailment behaviours may have been too generic due to a lack of training and expertise of the advisors (discussed in more detail in section 9.2.5.2). Secondly, the provision of information may have been limited. It was recorded that on average less than half of householders (46%) were given advice on using their heating controls and less than a quarter (19%) was given advice on understanding their bills. Thirdly, there is evidence that the provision of information to increase knowledge and awareness does not necessarily lead to pro-environmental behaviour (Burgess et al., 1998, Kollmuss and Agyeman, 2002, Peattie, 2010).

9.2.2 Easy Measures

Analysis demonstrated that on average, the estimated carbon saving as result of the provision of easy measures during a visit was 144 kgCO_2/year. This equates to an annual average reduction in household carbon emissions of approximately 3%. This is based on the assumption that the average London household emits 4970 kgCO_2 per year (GLA, 2011). It is worth noting that a 3% reduction is meaningful and this can be illustrated by comparing the reduction to the predicted reductions in energy consumption as a result of the national roll-out of smart meters. The impact assessment predicts that the roll-out of smart meters will lead to reductions of 2.8% in electricity consumption and 2% in gas consumption, as a result of the installation of the meter and in-home display (DECC, 2012).

There was no statistical difference observed in the performance of the three local authorities, for these 118 households in the sample, and the average amount of emissions abated as a result of easy measures provided. However, this is not surprising as all local authorities would have received the same measures and guidance from the GLA.

In terms of the method of estimation, there were limitations on the method. One of the key limitations was that the estimation of carbon abated, as a result of the installation of easy measures, was based on pre-existing published figures (see in Table 5.7). As a result, the extent to which these figures incorporate and model realistic installation rates is uncertain. However, from the information that is available it seems sensible to conclude that the figures used are based on the assumption that all measures are installed and put to use, except in the case of shower timers which had an estimated installation rate of 50%.

However, in practice, it is unlikely that all measures provided were installed. This will be as a result of the limited length of each visit, which was on average between 40 minutes and one hour, making it unlikely that advisors would have the time available to install all measures during the visit. For example, during a visit, tap aerators and shower heads may be installed, along with an energy use monitor and a demonstration of the installation of a radiator panel but it is unlikely that an advisor would have time to install each measure during the visit.

There would also be a lack of time to explain how the home energy use monitor worked, or to speak in more detail about the specific benefits of each easy measure provided. Not being able to install all measures provided at the point of the visit is a limitation on the effectiveness of the visit. This ambiguity as to the actual extent of installation of easy measures is also a limitation on the study, for it means that only indicative estimates of the impact of the easy measures provided can be calculated, based on the assumption that all measures provided were installed. This is likely to lead to an overestimation of the impact of the installation of the easy measures.

9.2.3 Referrals for Significant Measures

Despite tailored information being provided to householders, referrals for significant measures such as loft and wall insulation, to further reduce energy consumption and associated carbon emission, were limited. Overall, one referral was made for cavity wall insulation and five future referrals were recorded for cavity wall and loft insulation. Potential reasons for the limited number of referrals are many and are discussed in the below paragraphs. As a result, estimations of the carbon savings from the installation of significant measures was not undertaken because the rate of installation of significant measures was assumed to be negligible.

As discussed in section 8.1, advisors also offered advice to encourage householders to adopt efficiency behaviours and make structural changes to their homes. The provision of this advice was recorded and 10% of households were given advice on DIY insulation with 17% of households being given advice on solid wall insulation. 17% of households were given advice on secondary glazing and only 9% of households were given advice on renewables.

Therefore, the extent of advice given on more structural measures was rather limited. One reason for this may be that the advisor had asked the householder about the tenure of their property, and if they ascertained that it was rented they may have assumed that the householder had limited control over structural changes and therefore felt it was not worthwhile to discuss such significant measures. On average, 61% of the residents in the sample lived in rented accommodation (privately, council or Registered Social Landlord), which is higher than the London average of 49% but slightly less than the proportion living in rented accommodation across all three boroughs, which stood at of 65%.

As a result, many of these tenants would have limited control over the fabric of their homes and may not have the ability to make significant structural changes to the property, such as installing insulation. In addition, they may be disincentivised from investing financially in such measures as they do not own their homes. Secondly, the majority of participants in the study lived in flats or maisonettes, 66% and 13% respectively. As a result, many of these homes would not have lofts, as they could be located between other flats and insulation of walls may require negotiation between neighbours. In addition, high rise flats with 6 stories or more are seen as particularly difficult to insulate, and are deemed as hard-to-treat (Dowson et al., 2012).

A further barrier to installation is that London has the highest proportion of hard-to-treat properties in England, with 58% of properties being solid-walled (Centre for Sustainable Energy, 2011). Within this study, 64% of homes were solid-walled and 32% had cavity walls. This means that the cost of insulating these buildings will be significant. In addition, given that 48% of the buildings in the sample date from pre-1900, a number of these homes are likely to be situated within conservation areas, which means that solid wall insulation will only be possible on the interior of the building, rather than the exterior.

Finally, it was observed by officers that much work has already been done in these boroughs to insulate cavity walls and lofts, where possible. Therefore prior to the project, it was mentioned by officers that they thought it was unlikely that many visits would lead to the installation of these measures. When coupled together these factors may have led to a low conversion rate from home energy visit to referral and to the installation of significant measures.

9.2.4 Results of Cluster Analysis

Results from the cluster analysis (section 8.1.3) generated some interesting findings and demonstrated that there may be a link between people's attitudes towards the environment before a visit and the efficacy of a home energy visit, in relation to encouraging behaviour change. In general the average behaviour change observed in all participants was negligible at 1.5 $kgCO_2$, except for those in the second cluster, who had a reported behavioural impact of 106.6 $kgCO_2$. This was clearly much higher than the average but the most interesting finding was that participants in this cluster identified at phase one that they did not perceive themselves to be environmentally inclined. They also did not believe that it is important that people reduce their environmental impact. However, at phase two, attitudes of participants in this cluster had somewhat changed (see Figure 9.1, which is a more detailed view of cluster two, repeated from Figure 5.3.) and their behaviour had also changed by a greater amount than in the other two clusters.

Therefore, one potential reason for this uptake in pro-environmental behaviour may be that the participants changed their attitude, which in turn led to the adoption of a number of pro-environmental behaviours. Another potential reason for the greater level of behaviour change may be that this group was less likely to practice pro-environmental behaviour before the visit (stage 1) and therefore they would have had the potential to reduce their environmental impact, through behaviour change, to a greater extent than other participants. For example, if a participant is already frequently undertaking a number of pro-environmental behaviours before the visit, it would be more difficult to improve and further reduce their environmental impact after the visit. However, for a participant that rarely undertakes pro-environmental behaviour, this group will have the potential to improve by changing their behaviour by starting to undertake the pro-environmental behaviour some of the time, or more frequently.

These results are therefore interesting but they are inconclusive and there is a need to be cautious about these results, given the small size of this cluster (8 in 112). However these findings indicate that this could be a potential area for future research and if proven to be accurate then this finding could be used to improve project performance and impact by targeting less environmentally-inclined citizens during pro-environmental behaviour change programmes.

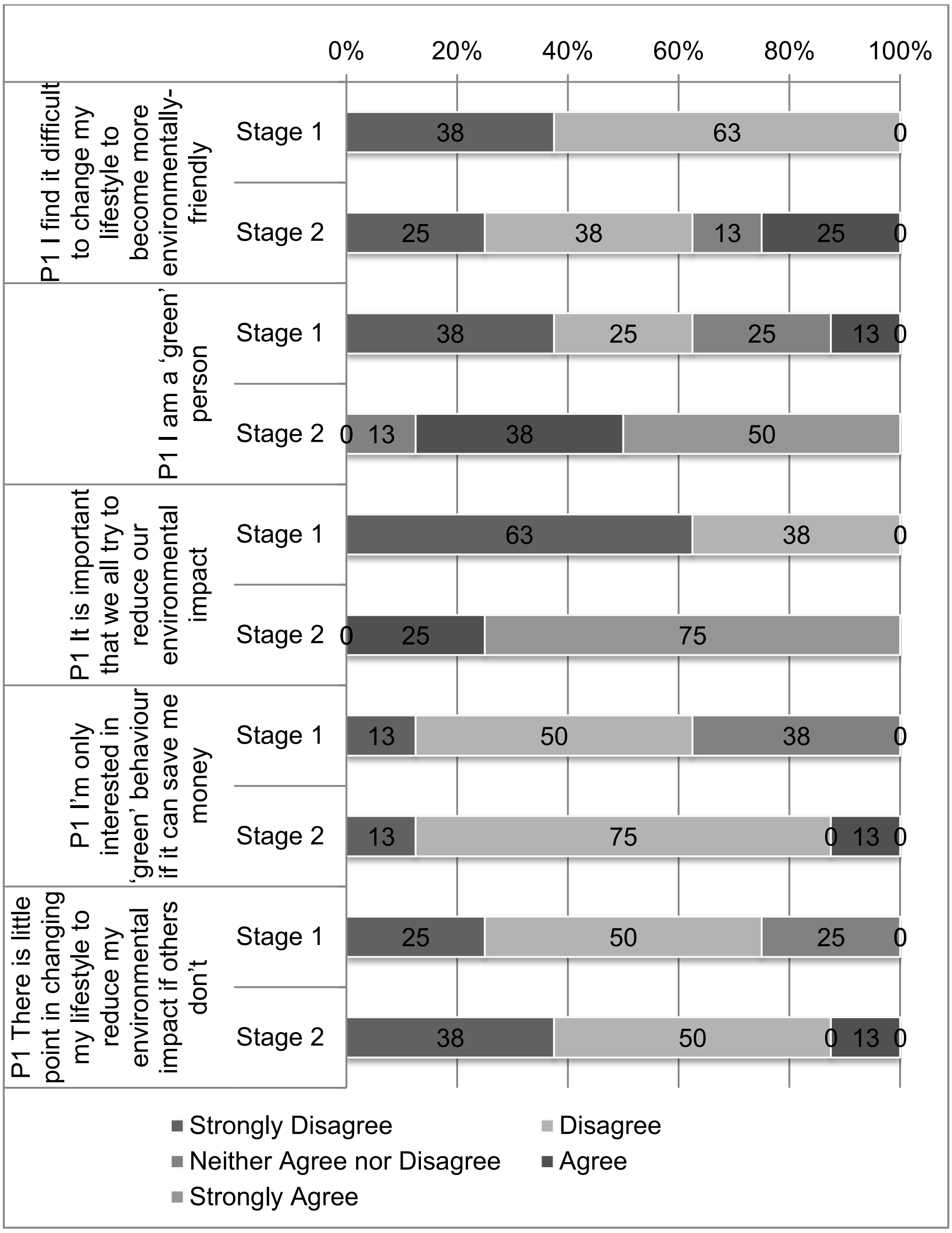

Figure 9.1 Attitudes of participants in cluster two

9.2.5 Recommendations to Improve Visits

The RE:NEW programme and the specification of the visit were conceived at City Hall and were based on a policy intent of reducing carbon emissions, rather than as the result of demands or expressed desire from residents. As a result, the appetite for the programme, from householders, was questionable. A number of local authorities found it difficult to obtain the desired penetration rates..

To overcome this potential lack of appetite, incentives were used. The visit was free and householders were given free energy saving measures that were likely to generate modest savings for residents on their fuel bills. However, despite these efforts, the findings of this research demonstrate that the effectiveness of visits could be improved. As a result, this thesis recommends a number of improvements that may increase the effectiveness of the home energy visit. The summary evaluation report of the RE:NEW programme and the final evaluation report published in February 2014, also identify a number of recommendations and these are discussed here (GLA, 2013b, 2014).

9.2.5.1 Time constraints on visits

Firstly, one of the limitations of the study was the time constraint on visits. Visits generally lasted no longer than an hour and this was due to a number of reasons. Most of the advisors were employed as contract workers and were paid a fixed price for each visit delivered. The intention of this was to incentivise advisors to complete more visits. This was confirmed in the RE:NEW post-evaluation report which notes the ‘delivery of RE:NEW emphasised achieving the homes visit target and achieving a high penetration rate of home visits’ (GLA, 2014). However, in reality this meant that there was a focus on the number of visits delivered, rather than the length or quality of the visit. As a result, visits were short in length and this was compounded by the fact that advisors had to pay for local car parking, which was necessary due to the easy measures advisors had to carry with them. This therefore constrained the visit and meant that advisors could not run over the allocated time, or they would receive a parking fine.

In addition, the short visit time meant that advisors did not have adequate time to install all of the easy measures provided, during the visit. Therefore, to improve the likelihood that measures provided remain installed after the visit, and will continue to deliver their assumed carbon savings, it is recommended that all measures be installed at the point of the visit by the advisor. In addition, it is recommended that the advisor be specific about the benefits of each measure, to encourage householders to keep using them. These recommendations are confirmed by the recommendations of the GLA, who advise that future visits should set targets based on carbon targets, rather than the number of visits delivered (GLA, 2014).

This is likely to lead to visits lasting longer and therefore it is also recommended that visits be allocated more time or be delivered by more than one advisor. In addition, to improve the estimation of the carbon impact of the easy measures provided, it is suggested that follow up monitoring be undertaken at reasonable intervals after the visit, to observe and record the extent to which measures remain in place. This information could then be used to improve the evaluation and give a more accurate estimation of the carbon impact of the easy measures. Additionally, monitoring of electricity and gas consumption prior to the visit and after the visit would allow further investigation into energy use consumption patterns. However, it would still be challenging to link any changes in consumption patterns to specific behavioural changes or to the installation of specific easy energy saving measures without enhanced monitoring (beyond household metering).

9.2.5.2 Expertise and training of energy advisors

The effectiveness of visits, specifically in relation to encouraging the adoption of curtailment behaviours was limited by the expertise of the ‘energy advisors’, who had generally limited and arguably inadequate training prior to delivering the visits. As mentioned, energy advisors tended to be temporary contract workers and as a result, the investment in their training was limited (see 9.2.5.1). This finding that training was not sufficient was confirmed in the RE:NEW post-evaluation report which identified that future programmes should ‘consider a more effective, focused programme of training for Home Energy Advisors to ensure accuracy of in home assessments and opportunities for installations’ (GLA, 2014). The present research concludes that it may be more beneficial for the council to employ advisors directly, to ensure that the quality of training is adequate. Local authorities could provide training that is sensitive to local residents needs and directed at the prevalent housing types within the borough. This would lead to more informed recommendations of appropriate measures that could reduce emissions and reduce fuel bills.

In addition, as long-term staff develop their skills and knowledge they will be able to provide better, more area specific, tailored information. Also, if advisors are long-term employees of the local authority then they may have a greater vested interest in learning and developing their skills to be effective advisors, if they have the possibility of developing their careers further within the local authority. However, although these findings are confirmed in the GLA’s evaluation report in which they observe that a ‘higher level of staff training would be beneficial’ they do not go as far as the recommendations in this thesis, instead they identify that it would be helpful to ‘link the day-to-day delivery of RE:NEW with other council activity’ (GLA, 2014).

Finally, training in the giving of behaviour change advice i.e. how to tailor information, induce commitment and frame the recommendations, would improve the likelihood that householders will act on advisors advice and install more significant measures (Gonzales et al., 1988). For it is clear from these results, that presently, the provision of information under the current programme has no effect on behaviour, therefore if adequate training is not provided, it is relatively unlikely that behavioural change will be observed in home visits that operate similarly.

9.2.5.3 Targeting of visits

In relation to penetrating different sectors of society, the RE:NEW participants were not necessarily representative of the ward. Study participants were more likely to be females and in households of multiple occupancy and with children. Council and RSL owned properties were also overrepresented. This is most likely as a result of the times of the visit. Visits were generally undertaken during regular working hours and given the focus on achieving the home visits target, and that the most prevalent method of recruitment was door-knocking, the advisors tended to target areas where they thought people would be at home. This is likely to have led to an overrepresentation of these groups. To counter this out of hours door knocking could reach more groups.

This finding was confirmed in the RE:NEW post-evaluation report, which noticed that 'in some cases delivery agents focused delivery of visits to social housing properties because this met the council's fuel poverty objectives and they were more likely to respond during daylight hours' (GLA, 2014). However these visits were not necessarily co-ordinated with the landlords and this meant that in over 70% of the visits to the sample groups in local authorities B and

C, the householder receiving the visit did not have control over the potential to install further measures.

9.2.5.4 Agreement and alignment of aims

Finally, there is an issue in that the GLA and the local authorities were focused on achieving different outcomes from the RE:NEW visits. For the GLA the focus of the visits was on reducing carbon emissions, whereas for the local authorities the focus was on reducing fuel poverty and ensuring that residents home are heated and their needs are met, but these differing aims are not necessarily complementary (GLA, 2014). The evaluation report of RE:NEW observed that a balance needs to be struck ‘between achieving carbon saving and alleviating fuel poverty’ (GLA, 2014), however these aims are arguably contradictory. Both reducing carbon emissions and reducing fuel poverty are important political aims but this thesis suggests that they should not be sought in the same project, for what is most effective at delivering reductions in environmental impact and carbon emissions, is unlikely to be most effective at reducing fuel poverty.

If an impact-oriented approach is taken to reducing carbon emissions then the focus of home energy visits should be on high energy consumers, who are likely to be from more wealthy areas of the city (Druckman and Jackson, 2008), and home-owners who will have the control over their properties to make structural changes. Though using tax-payers money to fund such work is unlikely to be politically acceptable, therefore an alternative would be to work with social landlords directly to deliver structural changes and reduce energy consumption. This is an improvement that has been taken forward by the GLA, who now assert that they intend to ‘move away slightly from the individual property door-knocking exercises’ and towards ‘much more strategic engagement with the major landlords' in on-going RE:NEW work (GLA, 2013a). They have also identified that they need to bring both the priorities of the GLA and the local authorities into greater alignment (GLA, 2014), which was another potential improvement that was identified in this research.

9.2.5.5 Type of intervention

With reference to the Ladder of Interventions (Table 2.2), this intervention intended to reduce carbon emissions and encourage behaviour change through non-fiscal, non-regulatory incentives, which were the easy energy saving measures and the provision of information. However, in relation to the provision of information to specifically encourage behaviour change, this was ineffective (section 8.1.1). This is despite efforts to ensure that the information was personalised and tailored (section 5.1). This research therefore recommends that alternative interventions, beyond the provision of information, as identified on the ladder of interventions, need to be utilised if effective behaviour change is to take place.

9.2.6 Limitations and Potential Improvements

If this study was to be undertaken again then a number of changes would improve it. These improvements were not possible in this study due to limitations. Notably, that it was not possible to build evaluation into the design of the RE:NEW programme, instead evaluation had to be built around the already existing design. As a result, the majority of these recommendations revolve around being able to work with programme developers to build evaluation into the programme design, from the start.

To develop a more robust experimental design it would have been essential to work with city hall and other stakeholders (the city council, local council, landlords, delivery agent, and residents), from the point at which they conceived the home energy visit programme, to influence the programme design. To do this, it would have been necessary to be working with the GLA from the conception of the programme, likely a year or two before. This was not possible in this study because when the local authorities agreed to this research being undertaken the programme was already at the point of delivery. In addition, a relationship with the GLA had not been developed and they were unwilling to engage with the research.

Despite this limitation, the opportunity to monitor such a large home energy visit programme, simultaneously in different boroughs, does not present itself frequently and as a result, it was deemed that the results that would come from the study would be worthwhile, even when considering the limitations. However, this did mean that it was not possible to build the experimental design into the study. Instead monitoring and evaluation had to be built around the already existing design and facilitated by the council. As a result, if the research was to be undertaken again, a number of improvements could be made.

In an ideal world, household energy consumption data would improve the study, as would pre-visit surveying of participants' pro-environmental behaviour. Practically, to do this, a call for participants in the ward area where the visits are to be delivered, could be undertaken. Households that respond to the call could then be provided with a smart meter minus the in-home display for this could have an effect on behaviour. This smart meter would support detailed monitoring of energy consumption for data collection purposes. At the same time, the frequency with which the participants undertake a number of pro-environmental behaviours could be recorded. Of course, the provision of a smart meter could still influence behaviour as a result of the Hawthorne effect, which is where individuals change their behaviour because they know they are being watched (Wood and Newborough, 2003). It is known that this can influence energy consumption behaviours and in fact research into the energy saving behaviour interventions can be heavily affected by the Hawthorne effect (Stern, 1992). Therefore it is very important to minimise this effect as much as possible by keeping interactions with participants and the visibility of the study to a minimum.

After this call, these participants could be randomly split into two groups (sample and control) and the sample group could be given a home energy visit. At a later point in the study, the frequency of pro-environmental behaviours could be recorded once again. This data, when coupled with energy consumption data, for both the sample and control groups could give a more complete picture of the impact of the home energy visit. Once the study is complete, households in the control group could receive a home energy visit, should they wish.

It was not possible to recruit participants before the programme started because when monitoring of the programme begun in partnership with the local authorities, contracts with the delivery agents had already been negotiated and agreed. Therefore it was not possible to stipulate that the delivery agent undertaken pre-monitoring of pro-environmental behaviours, for this was not part of the contract and would have eaten into the short amount of time that advisors had to deliver visits. Instead, addresses of participating households were shared post-visit and postal surveys were sent out.

The proposed improved experimental design would reduce bias in the study. Bias would have been introduced in the existing study sample through participants' decision to firstly participate in the RE:NEW home energy visit and then participate in the questionnaire, twice. In this improved experimental design, although the study may have bias through the initial recruitment process, when participants choose to take part in the home energy visit programme and associated monitoring, there would not be bias between the two groups (sample and control) because of random assignment. However, the most significant hurdle in such a study would be recruitment of large numbers of participants, especially given that local authorities and delivery agents found it very difficult to just deliver the visits, even when not requiring energy monitoring.

Another opportunity to improve the study would be in monitoring the extent to which the easy measures remain in place in people's homes. Finally, such an experimental design, if the sample was representative, could potentially support the generalisation of results to the wider population.

9.3 The Impact of Green Zones

The third phase of the research undertaken in this thesis has been presented in Chapter 8. In Chapter 8 the impact of a 'Green Zones' programme, which intended to encourage cycling through the provision of accessible and secure street level cycle parking, was estimated. This was achieved by monitoring travel behaviour (or travel patterns) in comparison to a control group. The carbon impact of any modal shift as a result of this intervention was also estimated.

The key findings from the monitoring of the Green Zones cycle parking project, and the contribution to knowledge can be identified as:

Finding 8: The evaluation of the Green Zones cycle parking project, although limited by small sample sizes and the potential impact of weather, identified that the provision of enabling infrastructure did not cause the frequency or the distance with which participants cycled to change to any significant extent. Therefore, this project did not overcome the barriers to behaviour change.

Finding 9: For the 5 participants in the sample group, the average daily carbon impact of travel for all modes reduced by 1317gCO_2 after the intervention (263gCO_2 per participant). This reduction was not significant against the control group.

These findings and some recommendations as to how to better encourage cycling through local authority sustainability programmes are discussed here in more depth; areas for future work to further advance the field are also mentioned.

9.3.1 Changing Behaviour

The Green Zones programme was a sustainability programme designed by Camden Council which intended to support residents to take pro-environmental action and green their local area (Camden Council, 2013). It worked to encourage a number of different types of pro-environmental behaviour with Lissenden Gardens Green Zones working to encourage cycling.

Specifically relating Lissenden Gardens Green Zones back to DEFRA's 4 E's, the project intended to enable behaviour change by removing barriers to cycling through the provision of facilities, in this case the cycle parking. To engage by using the Green Zones programmes and the council brand to reach out to networks and co-produce the outputs of the project with the tenants association, to exemplify the local authority through the pro-active delivery of the cycle parking and by working with the residents association who gave their time for free and to encourage through the provision of the cycle parking.

Monitoring of this particular individual Green Zone at Lissenden Gardens, established that the programme did not cause recipients of the intervention to cycle more frequently or further (section 8.3.2). In addition, further analysis demonstrated that when complete travel patterns by all modes were considered, although the carbon impact for the sample group was lower than for the control group, it was not significantly different (section 8.3.3). Potential reasons for this are discussed in more detail here.

9.3.1.1 Barriers to cycling

Firstly, one of the potential reasons as to why the study may not have had an effect on how frequently or how far participants cycled is that the participants of this study had already overcome the barriers to cycling, and therefore, may have been cycling as frequently as they wanted to already. This was found through the end of study survey where 9 out of 10 respondents noted that they cycled in the first stage of monitoring, before the cycle parking had opened, specifically for those in the sample group, 5 out of 6 were already cycling before the cycle parking opened (see section 8.3.4). For although they found the lack of cycle parking annoying, if it have been an insurmountable barrier then they would not have been cyclists in the first place.

However, although the intervention had no impact on those who already cycled it could be hypothesised that the provision of secure and accessible cycle parking may increase the likelihood that other residents at Lissenden Gardens, who are non-cyclists because they do find the lack of accessible parking an insurmountable barrier, to take up cycling; although, this has not been tested in this study and is not demonstrated by these results. Therefore assessment of the impact of the provision of cycle infrastructure on non-cyclists could be an area for future work.

9.3.1.2 Weather

Another potential reason as to why the study may not have had an effect on how frequently or how far participants cycled was the weather. As discussed in depth, although this delay did not invalidate results (however the impact of such a small sample on the robustness of the result cannot be ignored) the less pleasant weather conditions of January may have still influenced the results and caused the less committed sample group to cycle disproportionately less. The original design of the experiment, which involved monitoring at similar times of year (May/June and July/August) would have meant that the weather did not need to be considered in the analysis but the delay to the experiment, due to the delays in Camden Council opening the cycle parking, meant that this had to be a consideration.

9.3.1.3 Beyond an environmental programme

Another potential reason as to why the study may not have had an impact on cycling behaviours is that although Green Zones is labelled as a sustainability programme by the council, and for them it is intended to support residents to 'green their local areas' (Camden

Council, 2013), residents may not have interacted with the programme for this reason.

To illustrate, with the specific case of Lissenden Gardens, this Green Zone was promoted and led by a member of the LGTA who although they did perceive cycling to be a pro-environmental behaviour they primarily saw Green Zones as an opportunity to get support from the local authority to deliver a project that had been 7 years in the making. The LGTA had wanted cycle parking on the estate for many years to prevent the stairwells from being damaged as result of bicycles being carried up and down them and to make cyclists lives easier. This was not known until well into the delivery of the Green Zone and as friendships were developed with members of the LGTA.

Until the Green Zone was created, the residents had not been able to get the support they needed to deliver the cycle parking project. Green Zones made their project possible and although many cyclists benefited from this project the project was not necessarily seen as an opportunity to improve pro-environmental behaviour but instead it was seen as a way to obtain something residents had wanted to many years.

9.3.1.4 Perception of cycling as a pro-environmental behaviour

Finally, another reason as to why the cycle parking may not have had an environmental impact is because residents do not necessarily perceive cycling as a pro-environmental behaviour, instead cycling is chosen as a mode of travel for its speed, convenience and health and financial benefits, rather than its environmental credentials. This was evident from the survey results, conducted once the Green Zone was completed (section 8.3.4).

This survey found that the most popular reason people gave for cycling, which eight respondents gave, was that they cycled for pleasure or enjoyment, 7 also reported that they cycled for convenience or speed, for fitness or health and to avoid relying on public transport. Only four respondents noted that they cycled for environmental concern, one of their least favoured reasons given (see Figure 8.4). Therefore the cycle parking project may have been conceived not as a way to reduce carbon impact by cycling further and/or more frequently, but instead so that cyclists may have an easier life. For the residents, there may have been no aim to reduce environmental impact.

This was also evident in the reasons given as to why residents wanted a cycle parking space at Lissenden Gardens. Reasons given included having a bad back and being unable to carry a bike up the stairs easily, to getting older and again being unable to carry a bike up the stairs easily. Two participants had experienced bike theft due to a lack of secure parking and one participant found cycling difficult because they had small children, who they had to carry up the stairs alongside the bike. Barriers like these, as a result of changing circumstances may cause a cyclist's commitment to this mode of travel to wane. Especially as it seems that these cyclists are driven more by extrinsic motivations (saving money and time, convenience) than intrinsic motivations (environmental concern, ideology). Therefore, it could be hypothesised that the cycle parking may have created resilience and this may help to ensure longevity of a participants' choice to be a cyclist; although this has not been tested in this study.

9.3.2 Recommendations to Improve Green Zones

As was the case with the RE:NEW home energy visits, the Green Zones project did not cause a significant change in behaviour. Despite this, evaluation has identified some recommendations that could improve future pro-cycling interventions and the Green Zones project overall, and these are discussed here.

9.3.2.1 Targeting the correct groups

The first recommendation from this research is that programmes to encourage cycling should focus on removing the barriers to cycling, as identified by non-cyclists. This intervention did not have an effect on participants' cycle behaviours and it is likely that this could be because these cyclists had already overcome the barriers to cycling. To increase uptake of cycling, focus needs to be placed on non-cyclists who still find the barriers insurmountable.

9.3.2.2 Cycling projects are transport projects

Second, this research has found that for the people in this study, cycling is not necessarily chosen as a mode of transport for its environmental credentials, instead it is chosen for its speed, convenience and health and financial benefits. In addition, although this intervention did not cause residents to cycle further or more frequently, or generate a reduction in environmental impact, it should not be ignored that this project has been appreciated and valued by residents, and fundamentally, it is used by residents. Therefore, although it may not necessarily generate additional environmental benefit, cycling does offer other societal benefits and this project has value for the community which should not be overlooked.

When the multiple benefits of cycling are considered in parallel with the finding that these participant cyclists do not choose to cycle out of environmental concern, and therefore for them the aim of this project is not to achieve a reduction in environmental impact, this leads to the recommendation that cycling projects are fundamentally transport projects and although they may bring environmental benefits; they are not primarily sustainability projects. Therefore, cycling projects should be delivered by local authority transport teams who have the knowledge and resourcing to be able to deliver these programmes properly.

Such an approach would mean that when evaluated as transport projects, the wider tangential benefits of the intervention could also be considered alongside the environmental benefits. This is likely to give a more holistic view of the success and effectiveness of the intervention, for the carbon impact of the programme would be just one aspect of the evaluation and wider economic and health benefits could also be evaluated. Indeed, the same approach could be taken to the evaluation of all local authority sustainability projects.

9.3.2.3 Agreement of clear aims

The final recommendation relates to the Green Zones programme as a whole. As identified in section 9.3.1.3, the aims of the local authority for the Green Zones that they support and the aims of the residents may differ. Given this, it is recommended that the local authority works with residents to ensure that the final aims and objectives for both parties are aligned, or are at least complimentary. This would ensure that environmental impact remains a key objective of the programme.

9.3.2.4 *Type of intervention*

With reference to the Ladder of Interventions (Table 2.2), this intervention intended to encourage cyclists to cycle more frequently or further, to reduce carbon emissions. This behaviour was encourage through the removal of barriers through the provision of accessible cycle parking, which is a non-fiscal, non-regulatory incentive.

However, the provision of this infrastructure did not cause cyclists to cycle more frequently or further. This may be because for those who opted to use a cycle parking space, they were already cyclists and therefore the provision of cycle parking was not the removal of a barrier, for potentially, there was no barrier in the first place. Conversely, one of the participants (and an additional two for who data was corrupted) did say that they could not cycle because of the lack of cycle parking. Despite this, this research recommends that the barriers to the uptake of behaviours which are the target of behaviour change programmes must be first clearly identified, to ensure that the intervention is specifically removing the primary barriers to behaviour change.

9.3.3 Limitations and Potential Improvements

Although this study did have the advantage of being conceived alongside the development of the Green Zone and therefore it was possible to build evaluation into the design of the programme (unlike with the RE:NEW home energy visits programme), if this study was to be undertaken again then there are some changes that would improve it.

Firstly, the study involved a very small sample and control group, which was made smaller through corruption of data and the loss of a tracker. If this study was to be undertaken again then a larger sample and control group would be preferable. This was not possible in the study for the reasons explained within the methodology of Chapter 6.

Secondly, the nature of the natural experiment and the reliance on the council for the delivery of the programme led to a significant delay, which meant that the weather conditions in the two monitoring stages were different. Although this did not affect the robustness of the study, one participant group could have been disproportionately affected by unpleasant weather conditions which could have affected the results. Therefore, if this experiment was to be undertaken again, monitoring should be undertaken a points in the year when weather conditions are similar i.e. March and September. This was not possible in this study because the experiment was constrained by the council's delivery dates.

Additionally, as hypothesised in the section 9.3.1, the intervention may have had an impact on the resilience and longevity of a participants' choice to be cyclist. It may also have an ongoing impact on whether other Lissenden Gardens' residents choose to become cyclists in the future. However, the design of this study has not been able to ascertain this. Therefore, the study could be improved by monitoring cycling rates at Lissenden Gardens over a much longer time period, for example, intermittently over 2 to 3 years. Monitoring of cycle rates of all residents at Lissenden Gardens, would make it possible to observe whether longevity of a participants' choice to be cyclist does occur and whether Lissenden Gardens' residents are more likely to choose to become cyclists in the future (note that an additional control group would be require to demonstrate any effect).

Finally, one of the challenges with this research was that the analysis of the data was very time intensive. The final raw data took a long time to process and also required extensive manual checking. If this research was to be undertaken again, a better approach may be to make use of new apps such as 'moves' (Moves, 2014). However, at the time of the study it was not possible to download the data from the app and therefore it was not suitable for this study. Since April 2014, it has been possible to download moves data in a format that is suitable for such analysis as what has been undertaken in this research.

The moves app has the advantage of being able to record trip data, infer mode, but also allow manual checking of trips by participants. Another advantage of such an app is that for participants that already own smartphones, the cost of obtaining the data is low because the cost of the app is low. Additionally, it is more likely that participants would have their phone with them at all times and because the app runs in the background, it is unlikely that there would be days where data is not recorded. The main disadvantage of such an approach is that if participation was limited to only those that own smartphones then this would introduce bias into the experiment. This could be resolved by providing those without a smartphone a device for the duration of the study, however this could be costly. Finally, some participants may have concerns about sharing data from an app such as moves. They may have concerns of confidentiality, and believe that they app interacts with other personal data and apps on their device. This may discourage them from taking part in the study.

9.4 Evaluating Sustainability Programmes

This thesis has evaluated the environmental impact of two local authority sustainability projects: the RE:NEW home energy visit programme and the Green Zones programme. Both of these programmes intended to encourage behaviour change through the use of ‘nudges’ and non-regulatory, non-fiscal incentives. For RE:NEW the incentive was the provision of easy energy saving measures, for Green Zones, the incentive was the provision of enabling infrastructure which was accessible cycle parking.

Evaluation of both of these programmes has thrown up multiple challenges and during evaluation numerous barriers to undertaking robust evaluation were faced. In both cases only estimates of the impact of the programmes have been possible and even then, these have been based on a number of assumptions. This research has shown clearly why there was a lack of evaluation of local authority sustainability programmes and the reasons are straightforward. Evaluation is time consuming, it requires analytical expertise and fundamentally, due to the complexity and interactions with citizens, it is simply difficult.

Despite this, there remains value to evaluation, at least certainly for researchers and academics. This study has identified that neither of the sustainability programmes led to significant behaviour change. Before this research was undertaken, this was not known. It also identified ways in which both of these programmes could potentially be improved and this is useful because it can be used to create better programmes, which may lead to significant reductions in environmental impact. This research also provides researchers and policy makers alike a clearer picture of how environmental interventions, which require individual behaviour change, can be monitored and evaluated. s

However, evaluation is time consuming and complex and for the local authorities themselves, the value of evaluation of this type depends on the priorities of that council and whether a reduction in environmental impact is the main aim of their sustainability programmes. If it is a main aim, then evaluating impact remains important, for it could help improve programmes so that they have greater impact and it ensures that limited funding can be directed at the programmes that deliver the best value for money.

To summarise, this evaluation means that it is possible to identity whether the intervention is worthwhile. For Camden, with the Green Zones programme, this evaluation would now enable Camden to be able to decide whether providing cycle parking is worthwhile and something that they should continue to do. As a researcher, if I was asked whether, as a result of this evaluation, I would recommend wider roll-out of cycle parking, I would conclude that it depends on the objectives of the council. This research has found that cycle parking makes cycling easier for residents, it prevents damage to stairwells, it promotes a healthy lifestyle to residents and it helps project a positive image of the council. These are all worthwhile endeavours and if these are objectives of Green Zones then yes, this evaluation has shown that more cycle parking should be rolled out. However, if the objective of Green Zones is to reduce environmental impact and there are only limited funds with which to deliver this objective then this evaluation shows that cycle parking would not be the most appropriate programme to deliver this objective.

Overall, the contribution to knowledge from this chapter and key findings from the monitoring of both the RE:NEW home energy visits programme and Green Zones cycle parking project are that:

Finding 10: There is a lack of evaluation of local authority sustainability programmes because it is time consuming, requires analytical expertise and is overly complex and difficult.

Finding 11: Estimation of the environmental impact of two local authority led pro-environmental behaviour programmes demonstrated that neither led to a significant change in behaviour or reduction in environmental impact.

Finding 12: There are wider benefits to sustainability programmes, beyond environmental impact and therefore the merit of the programme depends on the objectives that the different local authorities have for their sustainability programmes.

Finding 13: In these two projects, the use of non-regulatory, non-fiscal 'nudges', that guide choice through non-fiscal incentives or enable choice by changing the physical infrastructure, have been ineffective at changing behaviour.

9.4.1 Recommendations to Improve Evaluation

During the evaluation of these sustainability programmes a number of challenges were faced, many of which had to be overcome to complete the evaluation. Given this, lessons were learnt as to how to best undertake evaluation in practice, which may be of value to anyone undertaking evaluation of local authority sustainability programmes. These lessons learnt are discussed here.

9.4.1.1 The aims of the programme need to be clear

Prior to inception and evaluation of any programme, the aims, objectives and indicators of performance for the intervention, need to be agreed. This study has used carbon as an indicator of environmental impact, which is appropriate for the UK given the commitment in the UK carbon budgets, but other indicators could be equally valid. In addition, where a programme has other objectives, for example generating community cohesion, or improving health, as long as these are intended aims of the programme then appropriate indicators should also be used to evaluate performance against these objectives. This approach would ensure that all those involved in delivering the intervention are on the same page and that evaluation truly reflects the effectiveness of the programme against the objectives.

9.4.1.2 Evaluation must be built into the design of the programme

To undertake robust evaluation, it is more straightforward when it is designed in parallel with the intervention and built into the programme of delivery. By building it into the programme from the start, data on measures of performance can be more easily collected, with fewer burdens on participants and robust sample and control groups can be fully utilised.

Clearly, it is not possible to build the design into programmes that are already existing but given the generally relatively short lifetime (no more than a few years) of local authority sustainability programmes, due to changes in the political landscape, this research recommends that efforts be placed on evaluating new programmes rather than existing schemes.

9.4.1.3 Partnering with research institutions

Evaluation of sustainability projects is time-consuming. It requires the development of working relationships with local residents, vast data collection and often complex analysis. Therefore, the resource to undertake this work may not necessarily be available within the local authority. This lack of resource could be overcome if local authorities worked in partnership with research institutions to evaluate programmes. Alternatively, if evaluation if required then appropriate funding must be provided.

9.4.1.4 Reducing burden on citizens

In Chapter 7 it was identified that relying on residents for data collection can cause them to disengage from the programme and therefore this is not a preferred method of data collection. Although this is still true, often there is no alternative but to collect data from residents. This was true for the evaluation of both RE:NEW and Green Zones. Therefore it is recommended that where is cannot be avoided this burden on residents is kept to a minimum. For example, with the RE:NEW study, steps were taken to ensure that the surveys were quick and easy for participants to complete and return. For the Green Zones study, trackers were used so as to ensure that participants did not need to complete travel diaries.

9.4.1.5 Collaborative working and trusted messengers

One of the aspects that worked well in the evaluation of this Green Zones was that both the delivery and the evaluation of the project was a collaborative effort and this helped break down some barriers related to trust. The research team (myself), the residents association and the council all worked together with residents to evaluate the programme. The advantage of this approach was that the trust for different groups could be utilised. For example, the Camden Council trusted UCL, the residents association trusted Camden Council and residents trusted the residents association. This meant that barriers that UCL would face in normally recruiting study participants were broken down by the residents association and the barrier that the residents association would face in accessing researchers were broken down through Camden Council.

9.5 Summary

This chapter has discussed the results of Chapter 7 to Chapter 8. This chapter commenced by outlining the key findings from the series of interviews with sustainability officers and the contribution to knowledge that Chapter 7 makes to the thesis. Notably, that many local authorities are currently working in a number of ways to deliver sustainability programmes and encourage pro-environmental behaviour amongst citizens, yet monitoring and evaluation of these programmes is limited (section 9.1).

In section 9.2, the impact of RE:NEW is discussed in more detail. The main findings of the results are discussed. Notably that the RE:NEW home energy visits did not cause the frequency of different pro-environmental behaviours to increase to any significant extent. Therefore, these visits did not overcome the barriers to behaviour change. Recommendations as to how to improve home energy visits were also presented.

Section 9.3 discussed the impact of the Green Zones cycling parking project and identified the contribution to knowledge that Chapter 8 makes to the thesis. Notably, it identified that the Green Zones project did not cause the frequency or the distance with which participants cycled to change to any significant extent and therefore did not overcome the barriers to behaviour change. Recommendations as to how to improve pro-cycling projects were also presented.

Finally, section 9.4 brought the findings of the thesis together. It identified that there is a lack of evaluation of local authority sustainability programmes because it is time consuming, requires analytical expertise and is overly complex and difficult. Despite this, there remains value in undertaking evaluation of environmental impact, especially if the primary aim of the projects being evaluated is to reduce environmental impact.

This thesis demonstrated that neither project led to a significant change in behaviour or reduction in environmental impact. Therefore if this was the primary aim of both of these projects then this evaluation has identified that it may represent better value for money if limited funding be directed elsewhere. Alternatively, evaluation identified numerous recommendations that may lead to improvements in the programmes, which if adopted could also lead to a more beneficial environmental impact and therefore also offer better value for money.

Chapter 10 Conclusion

10.1 Summary of Findings

This thesis has worked to understand how local authorities have been encouraging pro-environmental behaviour in their citizens through local authority sustainability interventions, and the environmental impact of these interventions. The contribution to knowledge that this thesis provides is a clear picture of how these two specific local authority environmental interventions, which require individual behaviour change, can be monitored and evaluated. In addition, it has identified that the programmes evaluated in this research have had no impact on pro-environmental behaviour change, in terms of CO_2 emission reduction. This finding is significant given that central government places such great onus on local authorities to contribute to CO_2 emission reduction.

This contribution has been achieved by answering the following questions:

1. How are local authorities currently working to encourage pro-environmental behaviour amongst their residents and assist residents in a transition to a more sustainable lifestyle through local authority sustainability interventions?
2. What is the environmental impact of local authority sustainability interventions and any associated pro-environmental behavioural changes?

This thesis has answered these questions through a series of interviews with local authority sustainability officers (Chapter 4 and Chapter 7), and the evaluation and assessment of the environmental impact of two local authority sustainability programmes: the RE:NEW home energy visit programme (Chapter 5 and Chapter 8) and the Green Zones programme (Chapter 6 and Chapter 8).

Research question one was answered through interviews with local authority sustainability officers (Chapter 7) which found that across the eight local authorities interviewed, 31 projects were being delivered to encourage local residents to adopt pro-environmental behaviour. These 31 projects were assessed against their perceived performance and effectiveness, as identified by the local authority officers delivering them, and this data was correlated with information on the mechanisms of the 4 E's that each project used to encourage behaviour change. The results found that only a weak correlation existed between the use of the mechanisms in the 4 E's model and the perceived effectiveness of the project at changing behaviour. Hence, for these 31 projects, the 4 E's framework was not a good predictor of the perceived effectiveness or performance of a project.

The analysis of the interviews concluded that local authorities were working in a number of ways to deliver sustainability programmes and encourage pro-environmental behaviour amongst citizens but monitoring, evaluation and assessment of the effectiveness of these programmes was limited. Therefore understanding of their effectiveness at reducing environmental impact was ambiguous.

As a result of this finding, two local authority sustainability programmes were monitored and evaluated. This chapter advanced understanding of the breadth of local authority sustainability interventions.

The first programme evaluated was the RE:NEW home energy visit programme (Chapter 5 and Chapter 8). These home energy visits intended to encourage reductions in household carbon emissions and water consumption through the installation of small energy saving measures, further significant energy saving measures and behaviour change advice.

Through monitoring and evaluation, this research found that the environmental impact of the RE:NEW programme, estimated in terms of carbon emissions abated, was on average for each household in the study, 146 $kgCO_2$. This research concluded that these visits did not overcome the barriers required to generate behaviour change or the barriers to the installation of more significant energy saving measures, for these specific households. Given this, a number of recommendations were proposed as to how to improve these visits.

The second programme evaluated was the Camden Green Zones cycle parking project (Chapter 6 and Chapter 8), which sought to ascertain whether new accessible cycle parking would cause participants to cycle more frequently and / or further. Through monitoring and evaluation, this research found that the environmental impact of the Lissenden Gardens Green Zones programme was insignificant for these specific individuals and that there was no significant reduction in carbon impact for those that received the intervention. Given this, a number of recommendations were proposed as to how to improve pro-cycling and Green Zones projects.

To summarise, for both of these programmes evaluated, no significant impact, on pro-environmental behaviour, was identified.

10.2 Policy Recommendations

This thesis evaluated the environmental impact of two local authority sustainability projects and although the evaluation enabled the estimation of the environmental impact of both of the programmes and identification of ways to improve them, the evaluation was neither easy nor straightforward. Undertaking robust evaluation of local authority sustainability projects was very challenging. It was time consuming, analytically complex and as discussed in section 0, required careful project management due to the numerous stakeholders including local authorities, residents groups and individual residents.

However, this evaluation demonstrated a significant result in identifying that for these two local authority sustainability programmes evaluated, the use of non-regulatory, non-fiscal ‘nudges’, that guide choice through non-fiscal incentives and information or enable choice by changing the physical infrastructure, have not been effective at changing behaviour. This is a significant result given that the British Government is relying on both local authorities and behaviour change to deliver carbon abatement.

Given this continued focus by central government on the role of local authorities, there are some important lessons arising from this research for central government policy-makers. These are given here:

- It is likely that robust evaluation of local authority sustainability programmes would be too onerous for local authorities to undertake without additional resourcing. Therefore, if evaluation is required, then appropriate funding must also be provided.

- Encourage local authorities to partner with academic institutions to undertake evaluation.
- Do not shy away from recommending a mix of behaviour change mechanisms, including regulation and fiscal measures. Effective behaviour change cannot be delivered only through ‘nudges’.
- To deliver effective behaviour change it is not essential to utilise all of DEFRA’s 4 E’s (Figure 2.3). This research showed that different mixes of E’s did not make a predictable difference to the overall perceived effectiveness of the project (section 7.1.3).

10.3 Recommendations for Future Research

The RE:NEW study was limited in that the evaluation could not be built into the design of the programme and there was no access to energy consumption data. Therefore, as identified in Chapter 9, home energy visits could be better understood if smart meter data was leveraged. In addition, the use of a robust sample and control group would help to demonstrate that any changes in consumption are as a result of the visit. Finally, monitoring of the longevity of easy measures in people’s homes would help to ascertain whether changes are as a result of behaviour change or as a result of the installation of measures.

The Green Zones study was limited by participants forgetting their trackers and the time it took to process the data (see section 6.3.1). Therefore, as identified in Chapter 9, understanding the influence of cycle infrastructure on travel behaviours could be better achieved by using location data collected through mobile phone apps, over longer periods of time. Use of such apps would permit much larger sample sizes. Finally, such studies could incorporate participants that are both cyclists and non-cyclists, to observe whether infrastructure changes result in non-cyclists opting to become cyclists.

Finally, given that this research has focused on two specific local authority projects, a more generic tool, to support local authorities in the evaluation of their sustainability projects may be helpful. For example, a toolkit, templates or guidance on evaluation methods may prove useful. Though whether local authorities would have the time and resources to fully utilise these tools is not clear.

10.4 Summary

Local authorities, as the governance level closest to the people, play a vital role in promoting sustainable development (UNCED, 1992). Local authorities also have the ability to influence many key emitting sectors (CCC, 2012), therefore it is sensible that central government reaches out to local government to deliver its sustainability objectives and pro-environmental behaviour change. However, central government needs to appreciate that both the design and delivery of behaviour change programmes and their evaluation is time consuming, complex and requires expertise. Many local authorities lack the time, funding and expertise to undertake effective behaviour change programmes and evaluation. Given this, this thesis concludes that capacity needs to be built in local governments through appropriate training, but most importantly, adequate funding needs to be provided. Finally, where appropriate, more restrictive behaviour change interventions must be considered, for nudges cannot be solely relied upon. Without these considerations, it is unlikely that neither effective behaviour change nor effective evaluation is within the grasp of local authorities.

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Appendices

Appendix 1: Interviews Information Sheet, Interview Questions, Interviews Informed Consent Form

Appendix 2: Sample Group Survey at Stage 1 and Stage 2

Appendix 3: Control Group Survey at Stage 1 and Stage 2

Appendix 4: Sample Size Calculations

Appendix 5: SPSS Output: Little's MCAR Test

Appendix 6: SPSS Output: Survey Attrition

Appendix 7: SPSS Output: Mann Whitney Test

Appendix 8: SPSS Output: Wilcoxon Signed-Rank Test

Appendix 9: Model of Carbon Impact of Visit

Appendix 10: SPSS Output: Cluster Analysis

Appendix 11 GTrek User Guide, Lissenden Gardens GPS Study Information Sheet, Lissenden Gardens GPS Study Consent Form

Appendix 12 SPSS Output: T-test and Homogeneity of Regression of analysis of cycling prevalence

Appendix 13 SPSS Output: ANCOVA Results of analysis of cycling prevalence

Appendix 14 SPSS Output: T-test and Homogeneity of Regression and ANCOVA Results of analysis of total carbon impact

Appendix 1: Interviews Information Sheet, Interview Questions and Informed Consent Form

Prior to the interviews with local authority sustainability officers, interviewees were briefed on the nature of the study and provided with an information sheet that gave an overview of the research. This information sheet was emailed ahead of the interview, with the questions that would be asked. At the start of the interview, this information sheet, questions and a consent form were supplied in printed form.

CENTRE FOR URBAN SUSTAINABILITY AND RESILIENCE
CIVIL, ENVIRONMENTAL & GEOMATIC ENGINEERING

Research Interviews Information Sheet

Achieving sustainable living

Kristy Revell, PhD student,

Department of Civil, Environmental and Geomatic Engineering,

University College London.

I thank you for your time and agreeing to participate in this interview. This information sheet explains the purpose of the research and how participants have been chosen.

Purpose of the research

This research is being undertaken as part of a PhD at University College London. The research aims to understand what factors influence the effectiveness of local authority sustainability projects and to what extent public acceptance of sustainability projects affects success.

These exploratory interviews are an initial step in answering this question. The interviews aim to understand how a transition to a more sustainable lifestyle is currently being facilitated by local authorities and how the borough population are responding to these interventions. Interviews are being conducted with different local authorities in London.

Factors that influence the effectiveness of a local authority sustainability project could range from the borough population demographics to the types of building, density and land use in the borough. The social and behavioural norms of the borough population will also impact upon the overall sustainability of the borough, as will of course, policies, targets, funding, budgeting and political alliance at the local authority. It is hoped that these interviews will help pinpoint which factors are most significant.

These interviews will collect data on the sustainability projects undertaken by the local authority within each borough. Successful sustainability projects will be identified in the interviews and the factors that have influenced their success, in the view of the participant, will be discussed. Unsuccessful projects will also be identified and discussed. The interaction between the projects and the borough population will be discussed in depth.

Participation in the research

You have been chosen to take part in this interview because you have knowledge of the sustainability projects being undertaken within a local authority in London.

The interview should last approximately 1 hour. Participation is voluntary and you may discontinue participation and withdraw from this research at any time. This interview is confidential and data will be stored in accordance with the Data Protection Act 1998 and disposed of in a secure manner in due course. You will not be named in transcriptions of the interview.

At the end of my research I can provide you with a copy of any reports or other publications arising from your participation in this research. I can also provide you with transcripts of the interview. Please let me know if you would like these.

Should you have any follow up questions regarding this research please do contact me; my details are at the foot of this information sheet, as is my department. This project is supervised by Prof. Nick Tyler, Head of Department, Department of Civil, Environmental and Geomatic Engineering at UCL.

Once again, I thank you for your time and agreeing to take part in this research. It is greatly appreciated.

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CIVIL, ENVIRONMENTAL & GEOMATIC ENGINEERING

Interview Questions

Achieving sustainable living

Kristy Revell, PhD student,
Department of Civil, Environmental and Geomatic Engineering,
University College London.

Introductory question

1. Could you tell me a little bit about yourself, such as your educational background and your career path, how long you have been with [insert name] Council and in this current post?

Central research questions

2. Could you tell me about the sustainability projects that [insert name] Council is currently delivering and the sustainability projects that [insert name] Council has delivered in the past. Please focus on the projects that aim to reduce the environmental impact of the borough population.

3. Could you identify which of these projects you have been involved with and in what capacity?

4. Which of the sustainability projects have been the most successful? In your opinion, why?

5. Which of the sustainability projects have been unsuccessful? In your opinion, why?

6. In relation to the successful projects, do you think the borough population contributed to their success?

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Consent Form

Achieving sustainable living

Kristy Revell, PhD student,
Department of Civil, Environmental and Geomatic Engineering,
University College London.

1. I confirm that I have read and understand the information sheet for the above study and that I have had the opportunity to ask questions.

2. I agree to take part in the above study.

3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.

4. I agree to the interview being audio recorded.

5. I agree to the use of unnamed quotes in publications.

6. I agree that my data gathered in this study may be stored (after anonymisation) and used in future research, public lectures or talks and publications.

Identifying the council

	Yes	No
I agree that the name of the council can be identified	☐	☐
I agree that the council can be identified as a borough located within London	☐	☐
I agree that the council can be identified as ____________________ ____	☐	☐

1

Confirmation of Consent

Name of Participant	Date	Signature
Name of Researcher	Date	Signature

Appendix 2: Sample Group Survey at Stage 1 and Stage 2

Both stages of the RE:NEW panel survey sought to obtain a record of respondent's responses to a number of environmentally themed statements and the frequency with which they undertook a number of pro-environmental behaviours, such as 'I turn off unused appliances such as televisions and computers and do not leave them on standby' and 'I only fill the kettle with the water I need'.

Copies of the panel survey, sent out to the sample group at stage 1 and stage 2 of the survey are detailed here.

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SUSTAINABILITY AND RESILIENCE

UCL

I am carrying out a survey about people's environmental behaviour and the effect that council sustainability projects have on [borough name]'s environmental impact. I would really appreciate it if you took a few minutes to complete the following questionnaire.

I am a PhD student at University College London and [borough name] Council has agreed to let me carry out this research in relation to your recent home energy visit. Enclosed is an envelope to return this survey for free to UCL. Respondents will be entered into a prize draw to win a £20 voucher for Marks and Spencer.

If you take part, any information you give will be treated in strict confidence. No information that can identify you or your household will be passed to any other organisation. Please direct any enquiries related to this survey to kristy.revell.09@ucl.ac.uk or UCL Department of Civil, Environmental and Geomatic Engineering, Gower Street, London. WC1E 6BT.

The following questions ask about your recent home energy visit:

	Yes	No
1. Has your home recently undergone a home energy visit?	○	○
2. Would you recommend the home energy visit?	○	○

The following questions ask about your **attitudes towards the environment**, please could you indicate how much you **agree or disagree** with the following statements:

	Strongly Disagree 1	Disagree 2	Neither Agree nor Disagree 3	Agree 4	Strongly Agree 5	Not Applicable
3. I find it difficult to change my lifestyle to become more environmentally-friendly	○	○	○	○	○	○
4. I am a 'green' person	○	○	○	○	○	○
5. I think that it is important that we all try to reduce our environmental impact and protect the environment	○	○	○	○	○	○
6. I'm only interested in 'green' behaviour if it can save me money	○	○	○	○	○	○
7. I think that there is little point in changing my lifestyle to reduce my environmental impact if others don't do the same	○	○	○	○	○	○

Please turn over

The following questions ask how you feel about your heating controls and energy bills. Please indicate whether you **agree or disagree** with the following statements:

	Agree	Disagree	Not Applicable
8. As a result of the visit, I am more confident in using my heating system	○	○	○
9. As a result of the visit, I have since made changes to my heating controls to better suit my lifestyle	○	○	○
10. As a result of the visit, I now ensure my bills are accurate by reading my meter and submitting the readings to my energy company	○	○	○
11. I would like support to help me understand my heating controls better	○	○	○

Below is a list of different environmental actions. Please indicate **how often you did these actions**, prior to the home energy visit:

	Never 1	Rarely 2	Some of the time 3	Frequently 4	Always 5	Not Applicable
12. I use public transport, walk or cycle for everyday journeys	○	○	○	○	○	○
13. I use my car for short journeys	○	○	○	○	○	○
14. I take overseas holidays that involve flying	○	○	○	○	○	○
15. I separate and recycle my rubbish	○	○	○	○	○	○
16. I grow my own food	○	○	○	○	○	○
17. I buy food that is local and in-season	○	○	○	○	○	○
18. I actively try to reduce my waste	○	○	○	○	○	○
19. If I am cold I'll put a jumper on or use a blanket instead of turning up the heating	○	○	○	○	○	○
20. I try to cut down on the amount of water I use at home	○	○	○	○	○	○
21. I use my own reusable shopping bags for my grocery shopping	○	○	○	○	○	○
22. I turn off unused appliances such as televisions and computers and do not leave them on standby	○	○	○	○	○	○
23. I set my washing machine to economy or low temperature cycles	○	○	○	○	○	○
24. I only fill the kettle with the water that I need	○	○	○	○	○	○

Thank you for taking the time to fill out this survey. It is very much appreciated. Please post this survey back to UCL using the freepost envelope. I will send you a very similar looking survey again in 6-9 months, please do fill it in. If you would be willing to assist this research further and possibly be interviewed, please indicate below:

	Yes	No
25. I am happy to be interviewed in relation to this piece of research	○	○

If you are happy to be interviewed please provide your name and a contact telephone number or email address:

....

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SUSTAINABILITY AND RESILIENCE

UCL

You are receiving this survey because in March 2012, you or a member of your household previously completed and returned a similar looking survey. I would really appreciate it if the member of your household who previously completed the questionnaire, took a few minutes to complete this follow up questionnaire. Respondents can choose to be entered into a **prize draw to win a £20 voucher** for Marks and Spencer. The winner will be notified by 15th December 2012. You may notice that some of the questions are the same as in the last questionnaire. Please still fill them in. Enclosed is an envelope to return this survey for free to UCL.

This survey is about people's environmental behaviour and the effect that council sustainability projects have on [borough name]'s environmental impact. I am a PhD student at University College London and [borough name] council has agreed to let me carry out this research.

If you take part, any information you give will be treated in strict confidence. No information that can identify you or your household will be passed to any other organisation. Please direct any enquiries related to this survey to kristy.revell.09@ucl.ac.uk or UCL Department of Civil, Environmental and Geomatic Engineering, Gower Street, London. WC1E 6BT.

Around the start of 2012 you took part in a home energy visit and an energy expert visited your home and gave you advice on how to reduce your energy consumption. After this visit, you received a similar looking questionnaire from UCL, completed and returned it.

	Yes	No
1. Do you remember completing and returning the similar looking survey earlier this year?	○	○
2. Since this visit have you made any changes to you home, to improve it's energy efficiency?	○	○

If you answered yes to question 2, please could you give more details about these changes:

....

....

The following questions ask about your **attitudes towards the environment**, please could you indicate how much you **agree or disagree** with the following statements:

	Strongly Disagree 1	Disagree 2	Neither Agree nor Disagree 3	Agree 4	Strongly Agree 5	Not Applicable
3. I find it difficult to change my lifestyle to become more environmentally friendly	○	○	○	○	○	○
4. I am a 'green' person	○	○	○	○	○	○
5. I think that it is important that we all try to reduce our environmental impact and protect the environment	○	○	○	○	○	○
6. I'm only interested in 'green' behaviour if it can save me money	○	○	○	○	○	○
7. I think that there is little point in changing my lifestyle to reduce my environmental impact if others don't do the same	○	○	○	○	○	○

The following questions ask how you feel about your heating controls and energy bills. Please indicate whether you **agree or disagree** with the following statements:

	Agree	Disagree	Not Applicable
8. As a result of the visit, I became and remained confident in using my heating system	○	○	○
9. As a result of the visit, I have since made changes to my heating controls to better suit my lifestyle	○	○	○
10. As a result of the visit, I continue to ensure my bills are accurate by reading my meter and submitting the readings to my energy company	○	○	○
11. I would like support to help me understand my heating controls better	○	○	○

Below is a list of different environmental actions. Please indicate **how often you do these actions**:

	Never 1	Rarely 2	Some of the time 3	Frequently 4	Always 5	Not Applicable
12. I use public transport, walk or cycle for everyday journeys	○	○	○	○	○	○
13. I use a car for short journeys	○	○	○	○	○	○
14. I take overseas holidays that involve flying	○	○	○	○	○	○
15. I separate and recycle my rubbish	○	○	○	○	○	○
16. I grow my own food	○	○	○	○	○	○
17. I buy food that is local and in-season	○	○	○	○	○	○
18. I actively try to reduce my waste	○	○	○	○	○	○
19. If I am cold I'll put a jumper on or use a blanket instead of turning up the heating	○	○	○	○	○	○
20. I try to cut down on the amount of water I use at home	○	○	○	○	○	○
21. I use my own reusable shopping bags for my grocery shopping	○	○	○	○	○	○
22. I turn off unused appliances such as televisions and computers and do not leave them on standby	○	○	○	○	○	○
23. I set my washing machine to economy or low temperature cycles	○	○	○	○	○	○
24. I only fill the kettle with the water that I need	○	○	○	○	○	○

Thank you for taking the time to fill out this survey. It is very much appreciated. Please post this survey back to UCL using the freepost envelope. In your original response, you indicated that you would be willing to assist this research further, possibly by taking part in an interview or focus group. If you are still willing, please indicate below.

	Yes	No
25. I am still willing to assist this research though a focus group or interview	○	○

If you would like to be entered into the prize draw to win a £20 Marks and Spencer voucher, please provide your initials and family name below:

Title.................................... Initials .... Family name ....

Appendix 3: Control Group Survey at Stage 1 and Stage 2

Both stages of the RE:NEW panel survey sought to obtain a record of respondent's responses to a number of environmentally themed statements and the frequency with which they undertook a number of pro-environmental behaviours, such as 'I turn off unused appliances such as televisions and computers and do not leave them on standby' and 'I only fill the kettle with the water I need'.

Copies of the panel survey, sent out to the control group at stage 1 and stage 2 of the survey are detailed here.

UCL CENTRE FOR URBAN
SUSTAINABILITY AND RESILIENCE

UCL

I am carrying out a survey about people's environmental behaviour and the effect that council sustainability projects have on [borough name]'s environmental impact. I would really appreciate it if you took a few minutes to complete the following questionnaire.

I am a PhD student at University College London. Enclosed is an envelope to return this survey for free to UCL Respondents will be entered into a prize draw to win a £20 voucher for Marks and Spencer.

If you take part, any information you give will be treated in strict confidence. No information that can identify you or your household will be passed to any other organisation. Please direct any enquiries related to this survey to kristy.revell.09@ucl.ac.uk or UCL Department of Civil, Environmental and Geomatic Engineering, Gower Street, London. WC1E 6BT.

[Borough name] Council has recently been offering home energy visit to their residents:

	Yes	No
1. Has your home recently undergone a home energy visit?	○	○

The following questions ask about your **attitudes towards the environment**, please could you indicate how much you **agree or disagree** with the following statements:

	Strongly Disagree 1	Disagree 2	Neither Agree nor Disagree 3	Agree 4	Strongly Agree 5	Not Applicable
3. I find it difficult to change my lifestyle to become more environmentally-friendly	○	○	○	○	○	○
4. I am a 'green' person	○	○	○	○	○	○
5. I think that it is important that we all try to reduce our environmental impact and protect the environment	○	○	○	○	○	○
6. I'm only interested in 'green' behaviour if it can save me money	○	○	○	○	○	○
7. I think that there is little point in changing my lifestyle to reduce my environmental impact if others don't do the same	○	○	○	○	○	○

Please turn over

The following questions ask how you feel about your heating controls and energy bills. Please indicate whether you **agree or disagree** with the following statements:

	Agree	Disagree	Not Applicable
8. I am confident in using my heating system	O	O	O
9. I have recently made changes to my heating controls to better suit my lifestyle	O	O	O
10. I ensure that fuel my bills are accurate by reading my meter and submitting the readings to my energy company	O	O	O
11. I would like support to help me understand my heating controls better	O	O	O

Below is a list of different environmental actions. Please indicate **how often you do these actions:**

	Never 1	Rarely 2	Some of the time 3	Frequently 4	Always 5	Not Applicable
12. I use public transport, walk or cycle for everyday journeys	O	O	O	O	O	O
13. I use my car for short journeys	O	O	O	O	O	O
14. I take overseas holidays that involve flying	O	O	O	O	O	O
15. I separate and recycle my rubbish	O	O	O	O	O	O
16. I grow my own food	O	O	O	O	O	O
17. I buy food that is local and in-season	O	O	O	O	O	O
18. I actively try to reduce my waste	O	O	O	O	O	O
19. If I am cold I'll put a jumper on or use a blanket instead of turning up the heating	O	O	O	O	O	O
20. I try to cut down on the amount of water I use at home	O	O	O	O	O	O
21. I use my own reusable shopping bags for my grocery shopping	O	O	O	O	O	O
22. I turn off unused appliances such as televisions and computers and do not leave them on standby	O	O	O	O	O	O
23. I set my washing machine to economy or low temperature cycles	O	O	O	O	O	O
24. I only fill the kettle with the water that I need	O	O	O	O	O	O

Thank you for taking the time to fill out this survey. It is very much appreciated. Please post this survey back to UCL using the freepost envelope. I will send you a very similar looking survey again in 6-9 months, please do fill it in. If you would be willing to assist this research further and possibly be interviewed, please indicate below:

	Yes	No
24. I am happy to be interviewed in relation to this piece of research	O	O

If you are happy to be interviewed please provide your name and a contact telephone number or email address:

....

....

UCL CENTRE FOR URBAN
SUSTAINABILITY AND RESILIENCE

UCL

This survey is about people's environmental behaviour and the effect that council sustainability projects have on [borough name]'s environmental impact. You are receiving this survey because around April 2012, you or a member of your household previously completed and returned a similar looking survey. I would really appreciate it if the member of your household who previously completed the questionnaire, took a few minutes to complete this follow up questionnaire.

Enclosed is an envelope to return this survey for free to UCL. Respondents will be entered into a prize draw to win a £20 voucher for Marks and Spencer. The winner will be notified by 15th December 2012. You may notice that some of the questions are the same as in the last questionnaire. Please still fill them in.

If you take part, any information you give will be treated in strict confidence. No information that can identify you or your household will be passed to any other organisation. Please direct any enquiries related to this survey to kristy.revell.09@ucl.ac.uk or UCL Department of Civil, Environmental and Geomatic Engineering, Gower Street, London. WC1E 6BT.

	Yes	No
1. Do you remember completing and returning a similar looking survey earlier this year?	○	○
2. In the last six months, have you made any changes to you home to improve it's energy efficiency?	○	○

If you answered yes to question 2, please could you give more details about these changes:

....

....

....

The following questions ask about your **attitudes towards the environment**, please could you indicate how much you **agree or disagree** with the following statements:

	Strongly Disagree 1	Disagree 2	Neither Agree nor Disagree 3	Agree 4	Strongly Agree 5	Not Applicable
3. I find it difficult to change my lifestyle to become more environmentally friendly	○	○	○	○	○	○
4. I am a 'green' person	○	○	○	○	○	○
5. I think that it is important that we all try to reduce our environmental impact and protect the environment	○	○	○	○	○	○
6. I'm only interested in 'green' behaviour if it can save me money	○	○	○	○	○	○
7. I think that there is little point in changing my lifestyle to reduce my environmental impact if others don't do the same	○	○	○	○	○	○

Below is a list of different environmental actions. Please indicate **how often you do these actions**:

	Never 1	Rarely 2	Some of the time 3	Frequently 4	Always 5	Not Applicable
8. I use public transport, walk or cycle for everyday journeys	○	○	○	○	○	○
9. I use my car for short journeys	○	○	○	○	○	○
10. I take overseas holidays that involve flying	○	○	○	○	○	○
11. I separate and recycle my rubbish	○	○	○	○	○	○
12. I grow my own food	○	○	○	○	○	○
13. I buy food that is local and in-season	○	○	○	○	○	○
14. I actively try to reduce my waste	○	○	○	○	○	○
15. If I am cold I'll put a jumper on or use a blanket instead of turning up the heating	○	○	○	○	○	○
16. I try to cut down on the amount of water I use at home	○	○	○	○	○	○
17. I use my own reusable shopping bags for my grocery shopping	○	○	○	○	○	○
18. I turn off unused appliances such as televisions and computers and do not leave them on standby	○	○	○	○	○	○
19. I set my washing machine to economy or low temperature cycles	○	○	○	○	○	○
20. I only fill the kettle with the water that I need	○	○	○	○	○	○

Thank you for taking the time to fill out this survey. It is **really appreciated**. Please post this survey back to UCL using the freepost envelope. There is no need to attach a stamp.

Appendix 4: Sample Size Calculations

The sample size for the RE:NEW panel surveys was decided in collaboration with the participating local authorities. It was agreed that 500 households per local authority would be a sensible number of households to survey (1500 in total)

The sample size calculations used a sampling error of 10% and response rate of 10%, to account for both stages of the panel survey (first stage at 25% and second stage at 40%), which gave a sample size, at stage one, of 960, which was larger than the agreed sample size of 1500 participants. These sample size calculations were based on James E. Bartlett et al. (2001).

Sample Size Calculations

Sample size calculated using a sampling error of 5%

n0		required return sample size according to Cochran's formula
(p)(q)	0.25	estimate of variance = (maximum possible proportion (.5) * 1- maximum possible proportion (.5) produces maximum possible sample size).
d	0.05	acceptable margin of error for mean being estimated (5%)
t	1.96	value for selected alpha level of 0.05 (or 0.025 in each tail) = 1.96 (95%)
pop	4400	population
n1		required return sample size because sample > 5% of population

Sample size according to Cochran's formula

n0	=	(t^2)*(p)(q) / (d^2)
n0	=	384

Sample exceeds 5% of the population

n1	=	n0 / (1 + (n0/pop))
n1	=	353

Assumed response rates

25%	using response rate at stage 1
10%	using response rate at stage 1 and 2

Sample size to survey

1413	using response rate at stage 1
3533	using response rate at stage 1 and 2

Sample size calculated using a sampling error of 10%

n0		required return sample size according to Cochran's formula
(p)(q)	0.25	estimate of variance = (maximum possible proportion (.5) * 1- maximum possible proportion (.5) produces maximum possible sample size).
d	0.1	acceptable margin of error for mean being estimated (5%)
t	1.96	value for selected alpha level of 0.05 (or 0.025 in each tail) = 1.96 (95%)
pop	4400	population
n1		required return sample size because sample > 5% of population

Sample size according to Cochran's formula

n0	=	(t^2)*(p)(q) / (d^2)
n0	=	96

Sample does not exceed 5% of the population

Assumed response rates

25%	using response rate at stage 1
10%	using response rate at stage 1 and 2

Sample size to survey

384	using response rate at stage 1
960	using response rate at stage 1 and 2

Reference:

James E. Bartlett, Joe W. Kotrlik & Chadwick C. Higgins 2001. Organizational research: Determining appropriate sample size in survey research appropriate sample size in survey research. Information Technology, Learning, and Performance Journal, 19, 43-50.

Appendix 5: SPSS Output: Little's MCAR Test

To assess the nature of missing variables in the data collected through the RE:NEW panel surveys, Little's MCAR test (Little and Rubin, 2002) which is a chi-squared test for missing completely at random, was undertaken using SPSS version 21. Analysis was undertaken on a complete data set that included all variables for both the treatment and control groups at both stages. Data on household attributes were not included in the analysis because this was a complete data set without missing values.

The data was assessed using the 'missing value analysis' function within SPSS. This data identifies the proportion of missing values and what percentage of the sample they represent. The data output also provides the Little's MCAR chi-squared test statistic, the degrees of freedom and the significance of the result. A non-statistically significant result means that the null hypothesis is not rejected and that the data is missing completely at random.

It was found that the test was not statistically significant, therefore the null hypothesis that the missing values occur completely at random, is not rejected (Little's MCAR test: $\chi 2 = 1075.557$, df = 1020, p = 0.111).

EM Means[a]

B1P1	B2P1	B3P1	B4P1	B5P1	B6P1	B7P1	B8P1	B9P1
4.49	4.29	3.23	4.60	1.84	3.42	4.27	3.92	4.25

EM Means[a]

B10P1	B11P1	B12P1	B13P1	B1P2	B2P2	B3P2	B4P2	B5P2
4.19	4.44	4.22	4.48	4.46	4.33	3.42	4.61	1.77

EM Means[a]

B6P2	B7P2	B8P2	B9P2	B10P2	B11P2	B12P2	B13P2
3.48	4.25	3.97	4.19	4.20	4.40	4.26	4.53

a. Little's MCAR test: Chi-Square = 1075.557, DF = 1020, Sig. = .111

EM Covariances[a]

	B1P1	B2P1	B3P1	B4P1	B5P1	B6P1	B7P1	B8P1
B1P1	.800							
B2P1	.575	1.101						
B3P1	-.208	-.025	1.256					
B4P1	.136	.128	.144	.842				
B5P1	.187	-.007	-.095	.085	1.294			
B6P1	.006	.040	.178	.163	.068	1.011		
B7P1	-.032	.092	.053	.362	.106	.369	.738	
B8P1	.004	.056	.040	.216	.105	.075	.205	.880
B9P1	-.052	.008	.100	.219	.022	.195	.349	.286
B10P1	-.005	.076	.089	.280	.065	.048	.302	.264
B11P1	.043	.223	.137	.163	.003	.169	.175	.143
B12P1	.183	.133	-.182	.155	.086	.264	.329	.281
B13P1	.015	.071	.031	.105	.035	.171	.302	.162
B1P2	.602	.514	-.121	.220	.105	.117	.072	.111
B2P2	.385	.776	-.237	.152	.138	-.022	.113	.124
B3P2	-.136	.016	.846	-.124	-.114	.083	-.032	-.067
B4P2	.253	.161	.077	.645	.128	.199	.343	.135
B5P2	.187	.034	-.145	.042	1.046	-.011	.093	-.014
B6P2	.218	.180	.013	.152	.137	.441	.198	-.006
B7P2	.042	-.042	.121	.252	-.026	.431	.442	.103

Appendix 6: SPSS Output: Survey Attrition

When collecting data through the RE:NEW panel survey during the first stage, 305 survey were returned. The second stage elicited a response of 118 follow-up surveys.

In order to ascertain if there were any attrition biases, the stage one survey responses of those respondents who completed both stages of the survey were compared with those respondents who had only completed the first stage survey. This comparison of the two groups was undertaken using the Mann Whitney U-test.

It was found that there was attrition bias with those that dropped out after the first stage performing the different energy water and wider pro-environmental behaviours with less frequency than those that completed both stages of the survey. This difference was significant for four behaviours.

Ranks

	PHASE	N	Mean Rank	Sum of Ranks
Use public Transport, walk, or cycle	1	178	142.51	25367.50
	2	117	156.35	18292.50
	Total	295		
Use my car for short journeys	1	183	145.78	26677.50
	2	118	159.10	18773.50
	Total	301		
Take overseas flying holidays	1	183	152.54	27915.00
	2	118	148.61	17536.00
	Total	301		
Seperate and recycle rubbish	1	181	141.10	25539.50
	2	117	162.49	19011.50
	Total	298		
Grow my own food	1	183	148.77	27224.00
	2	118	154.47	18227.00
	Total	301		
Buy local and in-season food	1	177	137.95	24418.00
	2	112	156.13	17487.00
	Total	289		
Actively try to reduce waste	1	178	137.79	24527.00
	2	117	163.53	19133.00
	Total	295		
If cold, put a jumper on instead of increasing heating	1	177	142.02	25138.00
	2	116	154.59	17933.00
	Total	293		
Cut down on water use	1	182	141.67	25783.50
	2	117	162.96	19066.50
	Total	299		
Use reuseable shopping bags	1	182	147.48	26841.50
	2	117	153.92	18008.50
	Total	299		
Turn off unused appliances, do not leave on standby	1	183	140.92	25788.50
	2	117	165.48	19361.50
	Total	300		
Set my washing machine to economy	1	171	139.50	23855.00
	2	109	142.06	15485.00
	Total	280		
Only fill kettle with the water I need	1	181	147.96	26780.00
	2	118	153.14	18070.00
	Total	299		

Test Statistics[a]

	Use public Transport, walk, or cycle	Use my car for short journeys	Take overseas flying holidays	Seperate and recycle rubbish
Mann-Whitney U	9436.500	9841.500	10515.000	9068.500
Wilcoxon W	25367.500	26677.500	17536.000	25539.500
Z	-1.573	-1.349	-.395	-2.612
Asymp. Sig. (2-tailed)	.116	.177	.693	.009
Exact Sig. (2-tailed)	.116	.178	.694	.009
Exact Sig. (1-tailed)	.058	.089	.347	.004
Point Probability	.000	.000	.000	.000

Test Statistics[a]

	Grow my own food	Buy local and in-season food	Actively try to reduce waste	If cold, put a jumper on instead of increasing heating
Mann-Whitney U	10388.000	8665.000	8596.000	9385.000
Wilcoxon W	27224.000	24418.000	24527.000	25138.000
Z	-.592	-1.905	-2.696	-1.299
Asymp. Sig. (2-tailed)	.554	.057	.007	.194
Exact Sig. (2-tailed)	.555	.057	.007	.195
Exact Sig. (1-tailed)	.277	.028	.003	.097
Point Probability	.000	.000	.000	.000

Test Statistics[a]

	Cut down on water use	Use reuseable shopping bags	Turn off unused appliances, do not leave on standby	Set my washing machine to economy
Mann-Whitney U	9130.500	10188.500	8952.500	9149.000
Wilcoxon W	25783.500	26841.500	25788.500	23855.000
Z	-2.221	-.679	-2.763	-.286
Asymp. Sig. (2-tailed)	.026	.497	.006	.775
Exact Sig. (2-tailed)	.026	.498	.006	.775
Exact Sig. (1-tailed)	.013	.249	.003	.389
Point Probability	.000	.000	.000	.000

Test Statistics[a]

	Only fill kettle with the water I need
Mann-Whitney U	10309.000
Wilcoxon W	26780.000
Z	-.602
Asymp. Sig. (2-tailed)	.547
Exact Sig. (2-tailed)	.548
Exact Sig. (1-tailed)	.275
Point Probability	.001

a. Grouping Variable: PHASE

```
DESCRIPTIVES VARIABLES=B4P1 B7P1 B9P1 B11P1
  /STATISTICS=MEAN STDDEV.
```

Notes

Output Created		05-JUN-2013 10:44:20
Comments		
Input	Data	C: \Users\uceskrl\Dropbox\PhD\Surveys\HEA\Attrition\2013.05.31 Attition Data (Both Phases).sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	301
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	All non-missing data are used.
Syntax		DESCRIPTIVES VARIABLES=B4P1 B7P1 B9P1 B11P1 /STATISTICS=MEAN STDDEV.
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.01

Mann Whitney Test
Calculating the effect size

$$r = Z / (\sqrt{N})$$

r = effect size estimate
Z = z score produced in SPSS
N = size of the study

Survey Stage 1

I actively try to reduce my waste (B7)

z =	-2.696
N =	295
r =	-0.15697

I separate and recycle my rubbish (B4)

z =	-2.612
N =	298
r =	-0.15131

I try to cut down on the amount of water I use at home (B9)

z =	-2.763
N =	300
r =	-0.15952

I turn off unused appliances such as televisions
and computers and do not leave them on standby (B11)

z =	-2.221
N =	299
r =	-0.12844

Appendix 7: SPSS Output: Mann Whitney Test

One of the aims of this study was to ascertain if the RE:NEW home energy visits had an impact on participants' energy and wider pro-environmental behaviours. To do this, the Mann Whitney U-Test, which is a non-parametric equivalent of the independent t-test, was used to calculate if there were significant differences in the amount that RE:NEW participants, known herein as the sample group (n_s = 118), changed the frequency with which they undertake a range of pro-environmental behaviours, compared to residents that had not taken part in the programme, herein referred to as the control group (n_c = 10). Both tests were undertaken in SPSS version 21. All tests had the significance level set at 0.05, at which the null hypothesis would be rejected (Field, 2009: 51).

The Mann Whitney test was run twice. These tests intended to ascertain if there was any statistical difference between the sample group and the control group. Firstly at stage one and secondly at stage two. This was in an effort to ascertain if, at stage one the groups were comparable, and at stage two, to demonstrate whether the groups were different in terms of reported changes in behaviour. To do this, the Mann Whitney test was used to compare the frequency with which the sample group undertook the different pro-environmental behaviours in comparison to the control group.

It was found that the frequency with which the sample group undertook the selected pro-environmental behaviours at stage one, did not differ significantly from the control group for twelve of the thirteen behaviours, rendering the groups comparable on all but this one behaviour. The one behaviour where a significant difference was observed between the two groups was for the behaviour 'I turn off unused appliances such as televisions and computers and do not leave them on standby' (B11).

Comparing the two groups at stage two, (behaviour 11 was excluded from this analysis as the groups were not comparable at stage one), a similar result was found, except there was no significant difference between the two groups for any of the behaviours.

Ranks

	Control or Sample Group	N	Mean Rank	Sum of Ranks
P1 Use public Transport, walk, or cycle	Control	10	72.70	727.00
	Sample	117	63.26	7401.00
	Total	127		
P1 Use a car for short journeys	Control	5	36.50	182.50
	Sample	68	37.04	2518.50
	Total	73		
P1 Take overseas holidays that involve flying	Control	10	54.75	547.50
	Sample	113	62.64	7078.50
	Total	123		
P1 Seperate and recycle rubbish	Control	10	63.30	633.00
	Sample	117	64.06	7495.00
	Total	127		
P1 Grown own food	Control	8	46.75	374.00
	Sample	93	51.37	4777.00
	Total	101		
P1 Buy local and in-season food	Control	10	48.05	480.50
	Sample	112	62.70	7022.50
	Total	122		
P1 Actively try to reduce waste	Control	10	59.55	595.50
	Sample	117	64.38	7532.50
	Total	127		
P1 If cold, put a jumper on instead of increasing heating	Control	10	60.15	601.50
	Sample	116	63.79	7399.50
	Total	126		
P1 Cut down on water use	Control	10	47.55	475.50
	Sample	117	65.41	7652.50
	Total	127		
P1 Use reuseable shopping bags	Control	10	45.80	458.00
	Sample	117	65.56	7670.00
	Total	127		
P1 Turn off unused appliances, do not leave on standby	Control	10	25.05	250.50
	Sample	117	67.33	7877.50
	Total	127		
P1 Set washing machine to economy or low cycle	Control	9	51.94	467.50
	Sample	109	60.12	6553.50
	Total	118		
P1 Only fill kettle with the water I need	Control	10	53.65	536.50
	Sample	118	65.42	7719.50
	Total	128		

Test Statistics[a]

	P1 Use public Transport, walk, or cycle	P1 Use a car for short journeys	P1 Take overseas holidays that involve flying	P1 Seperate and recycle rubbish
Mann-Whitney U	498.000	167.500	492.500	578.000
Wilcoxon W	7401.000	182.500	547.500	633.000
Z	-.952	-.059	-.700	-.089
Asymp. Sig. (2-tailed)	.341	.953	.484	.929
Exact Sig. [2*(1-tailed Sig.)]		.958[b]		
Exact Sig. (2-tailed)	.378	.971	.501	.899
Exact Sig. (1-tailed)	.208	.499	.255	.409
Point Probability	.091	.065	.003	.031

Test Statistics[a]

	P1 Grown own food	P1 Buy local and in-season food	P1 Actively try to reduce waste	P1 If cold, put a jumper on instead of increasing heating
Mann-Whitney U	338.000	425.500	540.500	546.500
Wilcoxon W	374.000	480.500	595.500	601.500
Z	-.472	-1.319	-.435	-.318
Asymp. Sig. (2-tailed)	.637	.187	.664	.750
Exact Sig. [2*(1-tailed Sig.)]				
Exact Sig. (2-tailed)	.671	.204	.677	.773
Exact Sig. (1-tailed)	.356	.104	.341	.382
Point Probability	.004	.009	.009	.025

Test Statistics[a]

	P1 Cut down on water use	P1 Use reuseable shopping bags	P1 Turn off unused appliances, do not leave on standby	P1 Set washing machine to economy or low cycle
Mann-Whitney U	420.500	403.000	195.500	422.500
Wilcoxon W	475.500	458.000	250.500	467.500
Z	-1.599	-1.761	-4.184	-.769
Asymp. Sig. (2-tailed)	.110	.078	.000	.442
Exact Sig. [2*(1-tailed Sig.)]				
Exact Sig. (2-tailed)	.123	.092	.000	.470
Exact Sig. (1-tailed)	.064	.043	.000	.219
Point Probability	.010	.001	.000	.005

Test Statistics[a]

	P1 Only fill kettle with the water I need
Mann-Whitney U	481.500
Wilcoxon W	536.500
Z	-1.154
Asymp. Sig. (2-tailed)	.249
Exact Sig. [2*(1-tailed Sig.)]	
Exact Sig. (2-tailed)	.235
Exact Sig. (1-tailed)	.143
Point Probability	.023

a. Grouping Variable: Control or Sample Group

b. Not corrected for ties.

```
 SORT CASES  BY GROUP.
SPLIT FILE SEPARATE BY GROUP.
FREQUENCIES VARIABLES=B11P1
  /STATISTICS=STDDEV VARIANCE MEAN MEDIAN
  /ORDER=ANALYSIS.
```

Frequencies

Ranks

	Control or Sample Group	N	Mean Rank	Sum of Ranks
P2 Use public Transport, walk, or cycle	Control	10	79.05	790.50
	Sample	115	61.60	7084.50
	Total	125		
P2 Use a car for short journeys	Control	4	42.50	170.00
	Sample	84	44.60	3746.00
	Total	88		
P2 Take overseas holidays that involve flying	Control	10	48.55	485.50
	Sample	112	62.66	7017.50
	Total	122		
P2 Seperate and recycle rubbish	Control	10	68.15	681.50
	Sample	116	63.10	7319.50
	Total	126		
P2 Grown own food	Control	10	61.65	616.50
	Sample	97	53.21	5161.50
	Total	107		
P2 Buy local and in-season food	Control	10	75.20	752.00
	Sample	116	62.49	7249.00
	Total	126		
P2 Actively try to reduce waste	Control	10	72.80	728.00
	Sample	113	61.04	6898.00
	Total	123		
P2 If cold, put a jumper on instead of increasing heating	Control	10	67.75	677.50
	Sample	117	63.68	7450.50
	Total	127		
P2 Cut down on water use	Control	10	62.15	621.50
	Sample	116	63.62	7379.50
	Total	126		
P2 Use reuseable shopping bags	Control	10	59.40	594.00
	Sample	117	64.39	7534.00
	Total	127		
P2 Turn off unused appliances, do not leave on standby	Control	10	45.85	458.50
	Sample	118	66.08	7797.50
	Total	128		
P2 Set washing machine to economy or low cycle	Control	9	49.78	448.00
	Sample	109	60.30	6573.00
	Total	118		
P2 Only fill kettle with the water I need	Control	10	65.40	654.00
	Sample	116	63.34	7347.00
	Total	126		

Test Statistics[a]

	P2 Use public Transport, walk, or cycle	P2 Use a car for short journeys	P2 Take overseas holidays that involve flying	P2 Seperate and recycle rubbish
Mann-Whitney U	414.500	160.000	430.500	533.500
Wilcoxon W	7084.500	170.000	485.500	7319.500
Z	-1.737	-.179	-1.268	-.623
Asymp. Sig. (2-tailed)	.082	.858	.205	.533
Exact Sig. [2*(1-tailed Sig.)]		.885[b]		
Exact Sig. (2-tailed)	.102	1.000	.211	.649
Exact Sig. (1-tailed)	.057	.501	.110	.383
Point Probability	.045	.132	.009	.078

Test Statistics[a]

	P2 Grown own food	P2 Buy local and in-season food	P2 Actively try to reduce waste	P2 If cold, put a jumper on instead of increasing heating
Mann-Whitney U	408.500	463.000	457.000	547.500
Wilcoxon W	5161.500	7249.000	6898.000	7450.500
Z	-.915	-1.125	-1.091	-.354
Asymp. Sig. (2-tailed)	.360	.261	.275	.723
Exact Sig. [2*(1-tailed Sig.)]				
Exact Sig. (2-tailed)	.351	.272	.285	.726
Exact Sig. (1-tailed)	.187	.142	.147	.366
Point Probability	.006	.023	.019	.003

Test Statistics[a]

	P2 Cut down on water use	P2 Use reuseable shopping bags	P2 Turn off unused appliances, do not leave on standby	P2 Set washing machine to economy or low cycle
Mann-Whitney U	566.500	539.000	403.500	403.000
Wilcoxon W	621.500	594.000	458.500	448.000
Z	-.131	-.450	-1.910	-1.033
Asymp. Sig. (2-tailed)	.896	.653	.056	.302
Exact Sig. [2*(1-tailed Sig.)]				
Exact Sig. (2-tailed)	.920	.668	.064	.295
Exact Sig. (1-tailed)	.468	.337	.031	.161
Point Probability	.020	.022	.000	.009

Test Statistics[a]

	P2 Only fill kettle with the water I need
Mann-Whitney U	561.000
Wilcoxon W	7347.000
Z	-.218
Asymp. Sig. (2-tailed)	.828
Exact Sig. [2*(1-tailed Sig.)]	
Exact Sig. (2-tailed)	.814
Exact Sig. (1-tailed)	.438
Point Probability	.004

a. Grouping Variable: Control or Sample Group

b. Not corrected for ties.

```
SORT CASES  BY GROUP.
SPLIT FILE SEPARATE BY GROUP.
SPLIT FILE OFF.
```

Mann Whitney Test
Calculating the effect size

$$r = Z / (\surd N)$$

r = effect size estimate
Z = z score produced in SPSS
N = size of the study

Survey Stage 1

'I turn off unused appliances such as televisions
and computers and do not leave them on standby' (B11).

z =	-4.184
N =	127
r =	-0.37127

Appendix 8: SPSS Output: Wilcoxon Signed-Rank Test

One of the aims of this study was to ascertain if the RE:NEW home energy visits had an impact on participants' energy and wider pro-environmental behaviours. To do this, the Wilcoxon signed-rank test, which is a non-parametric equivalent of the dependent t-test was used to calculate if there were significant differences in the amount that the sample group of RE:NEW participants changed the frequency with which they undertake a range of pro-environmental behaviours, between stages 1 and 2.

It was found that the change in the frequency with which the sample group undertook the five energy and water behaviours was not significant. It stands that there was no significant change in the frequency with which the sample group undertook the different energy and water behaviours, before the visit, and again at a period of six months later.

Descriptive Statistics[a]

	N	Mean	Std. Deviation	Minimum	Maximum
P1 If cold, put a jumper on instead of increasing heating	116	3.93	.958	1	5
P1 Cut down on water use	117	4.29	.841	2	5
P1 Turn off unused appliances, do not leave on standby	117	4.54	.836	2	5
P1 Set washing machine to economy or low cycle	109	4.23	1.127	1	5
P1 Only fill kettle with the water I need	118	4.50	.865	1	5
P2 If cold, put a jumper on instead of increasing heating	117	3.96	1.029	1	5
P2 Cut down on water use	116	4.20	.897	1	5
P2 Turn off unused appliances, do not leave on standby	118	4.44	.901	1	5
P2 Set washing machine to economy or low cycle	109	4.30	1.143	1	5
P2 Only fill kettle with the water I need	116	4.54	.838	1	5

a. Control or Sample Group = Sample

Wilcoxon Signed Ranks Test

Ranks[a]

		N	Mean Rank	Sum of Ranks
P2 If cold, put a jumper on instead of increasing heating - P1 If cold, put a jumper on instead of increasing heating	Negative Ranks	26[b]	26.00	676.00
	Positive Ranks	28[c]	28.89	809.00
	Ties	61[d]		
	Total	115		
P2 Cut down on water use - P1 Cut down on water use	Negative Ranks	26[e]	23.69	616.00
	Positive Ranks	19[f]	22.05	419.00
	Ties	71[g]		
	Total	116		
P2 Turn off unused appliances, do not leave on standby - P1 Turn off unused appliances, do not leave on standby	Negative Ranks	18[h]	15.11	272.00
	Positive Ranks	11[i]	14.82	163.00
	Ties	88[j]		
	Total	117		
P2 Set washing machine to economy or low cycle - P1 Set washing machine to economy or low cycle	Negative Ranks	16[k]	17.81	285.00
	Positive Ranks	19[l]	18.16	345.00
	Ties	73[m]		
	Total	108		
P2 Only fill kettle with the water I need - P1 Only fill kettle with the water I need	Negative Ranks	15[n]	14.90	223.50
	Positive Ranks	16[o]	17.03	272.50
	Ties	85[p]		
	Total	116		

a. Control or Sample Group = Sample

b. P2 If cold, put a jumper on instead of increasing heating < P1 If cold, put a jumper on instead of increasing heating

c. P2 If cold, put a jumper on instead of increasing heating > P1 If cold, put a jumper on instead of increasing heating

d. P2 If cold, put a jumper on instead of increasing heating = P1 If cold, put a jumper on instead of increasing heating

e. P2 Cut down on water use < P1 Cut down on water use

f. P2 Cut down on water use > P1 Cut down on water use

g. P2 Cut down on water use = P1 Cut down on water use

h. P2 Turn off unused appliances, do not leave on standby < P1 Turn off unused appliances, do not leave on standby

i. P2 Turn off unused appliances, do not leave on standby > P1 Turn off unused appliances, do not leave on standby

j. P2 Turn off unused appliances, do not leave on standby = P1 Turn off unused appliances, do not leave on standby

k. P2 Set washing machine to economy or low cycle < P1 Set washing machine to economy or low cycle

l. P2 Set washing machine to economy or low cycle > P1 Set washing machine to economy or low cycle

m. P2 Set washing machine to economy or low cycle = P1 Set washing machine to economy or low cycle

n. P2 Only fill kettle with the water I need < P1 Only fill kettle with the water I need

o. P2 Only fill kettle with the water I need > P1 Only fill kettle with the water I need

Test Statistics[a,b]

	P2 If cold, put a jumper on instead of increasing heating - P1 If cold, put a jumper on instead of increasing heating	P2 Cut down on water use - P1 Cut down on water use	P2 Turn off unused appliances, do not leave on standby - P1 Turn off unused appliances, do not leave on standby	P2 Set washing machine to economy or low cycle - P1 Set washing machine to economy or low cycle
Z	-.618[c]	-1.189[d]	-1.238[d]	-.513[c]
Asymp. Sig. (2-tailed)	.537	.234	.216	.608
Exact Sig. (2-tailed)	.532	.253	.234	.627
Exact Sig. (1-tailed)	.266	.126	.117	.313
Point Probability	.008	.017	.013	.018

Test Statistics[a,b]

	P2 Only fill kettle with the water I need - P1 Only fill kettle with the water I need
Z	-.506[c]
Asymp. Sig. (2-tailed)	.613
Exact Sig. (2-tailed)	.626
Exact Sig. (1-tailed)	.313
Point Probability	.013

a. Control or Sample Group = Sample

b. Wilcoxon Signed Ranks Test

c. Based on negative ranks.

d. Based on positive ranks.

```
FREQUENCIES VARIABLES=B8P1 B9P1 B11P1 B12P1 B13P1
  /STATISTICS=STDDEV VARIANCE MEAN MEDIAN
  /ORDER=ANALYSIS.
```

Frequencies

Wilcoxon Signed-Rank Test
Calculating the effect size

r = Z / (√ N)

r = effect size estimate
Z = z score produced in SPSS
N = size of the study

Behaviour Number	Behaviour Description	Z	N*	r
B8	If cold, put a jumper on instead of increasing heating	-0.618	230	-0.041
B9	Cut down on water use	-1.189	232	-0.078
B11	Turn off unused appliances, do not leave on standby	-1.238	234	-0.081
B12	Set washing machine to economy or low cycle	-0.513	216	-0.035
B13	Only fill kettle with the water I need	-0.506	232	-0.033

* This figure is the sample size doubled - because it is a repeated measure, with two measures taken, one at survey stage one and a second at survey stage two.

Appendix 9: Model of Carbon Impact of Visit

This appendix reports the results of the analysis intended to estimate the carbon impact of the reported behavioural changes and the easy measures installed during each RE:NEW visit, for each household in the sample. This piece of the analysis intends to give a picture of the changes in energy and water consumption within the household over a six month period, following the energy visit, as a result of both the installation of easy measures during the visit and any behavioural change.

Carbon factors were attributed to each easy measure and energy or water saving behaviour and the total saving for each household is detailed within this appendix.

Measures delivered	Figures calculated	
	kgCO2 / yr	litres H2O/ property/ yr
CFLs/ lightbulbs	6.74	0
Tap aerators	33.00	7000
Radiator panels (Solid and uninsulated cavity walls - type 1)	4.13	0
Radiator panels (All wall types, including insulated - type 2)	2.48	0
TV and PC standby switches	22.18	0
Real time monitors	64.40	0
Save a Flushes	3.41	4563
Showertimers	6.91	913
Showerheads	82.93	10950
No of Letterbox draught proofers	79.86	0
Garden Hose Guns	0.55	730

Behaviour change

Description		Never to Rarely	Rarely to Some of the time	Some of the time to Frequently	Frequently to Always	Always to Frequently	Frequently to Some of the time	Some of the time to Rarely	Rarely to Never
Change in Interval		1 to 2	2 to 3	3 to 4	4 to 5	5 to 4	4 to 3	3 to 2	1 to 2
If I am cold I'll put a jumper on or use a blanket instead of turning up the heating	Savings in kgCO2 / year per household	45.1	91.6	91.6	45.1	-45.1	-91.6	-91.6	-45.1
I try to cut down on the amount of water I use at home		29.7	60.3	60.3	29.7	-29.7	-60.3	-60.3	-29.7
I turn off unused appliances such as televisions and computers and do not leave them on standby		48.5	98.5	98.5	48.5	-48.5	-98.5	-98.5	-48.5
I set my washing machine to economy or low temperature cycles		6.2	12.6	12.6	6.2	-6.2	-12.6	-12.6	-6.2
I only fill the kettle with the water that I need		7.8	15.9	15.9	7.8	-7.8	-15.9	-15.9	-7.8

Phases	Local Authority	Hhold ID	Clusters	Total Water from Easy Measures (litres/year)	Total Carbon from Easy Measure (kgCO2/year)	Total Carbon from B8 Change (kgCO2/year)	Total Carbon from B9 Change (kgCO2/year)	Total Carbon from B11 Change (kgCO2/year)	Total Carbon from B12 Change (kgCO2/year)	Total Carbon from B13 Change (kgCO2/year)	Total Carbon from Behaviour Change (kgCO2/year)	Total Carbon Saved (kgCO2/year)	GI1	GI2	GI3	GI4	GI5
2	1		0	11680	183.5	91.6	0.0	0.0	0.0	7.8	99.4	282.9	5	1	1	9	3
2	1		0	17155	193.9	0.0	0.0	48.5	0.0	0.0	48.5	242.4	2	9	5	5	5
2	1		0	16425	201.6	-136.7	0.0	0.0	-6.2	0.0	-142.9	58.7	2	9	4	2	1
2	3		0	4563	16.9	0.0	120.6	0.0	6.2	-15.9	110.9	127.8	10	10	10	5	10
2	3		0	913	29.1	0.0	-29.7	0.0	-6.2	0.0	-35.9	-6.8	5	4	5	1	10
2	3		0	913	115.3	0.0	0.0	0.0	0.0	0.0	0.0	115.3	3	10	5	10	4
2	1		1	12593	96.6	0.0	-60.3	0.0	12.6	7.8	-39.9	56.7	4	5	5	5	5
2	1		1	7000	63.0	0.0	0.0	0.0	0.0	0.0	0.0	63.0	4	3	5	4	4
2	1		1	12593	184.8	0.0	60.3	48.5	0.0	0.0	108.8	293.6	4	4	5	4	4
2	1		1	5475	96.9	-91.6	0.0	98.5	0.0	0.0	7.0	103.9	5	4	5	1	4
2	1		1	17155	180.4	0.0	60.3	0.0	-31.3	-23.7	5.3	185.6	4	4	4	3	4
2	1		1	11680	97.0	-45.1	0.0	0.0	-12.6	0.0	-57.7	39.3	4	3	5	3	3
2	1		1	10950	100.6	45.1	0.0	48.5	0.0	0.0	93.6	194.2	5	4	5	4	4
2	1		1	17155	107.3	0.0	29.7	0.0	0.0	7.8	37.5	144.8	5	4	5	5	5
2	1		1	1643	94.0	0.0	0.0	0.0	0.0	0.0	0.0	94.0	3	3	4	4	4
2	1		1	13205	210.3	0.0	0.0	0.0	0.0	-23.7	-23.7	186.6	5	5	5	5	5
2	1		1	16425	157.7	136.7	0.0	0.0	18.8	-15.9	139.5	297.2	5	5	5	5	5
2	1		1	4563	90.0	-183.1	-90.0	0.0	-6.2	0.0	-279.3	-189.3	5	5	5	5	5
2	1		1	24155	204.7	-91.6	0.0	48.5	0.0	0.0	-43.0	161.6	4	5	5	5	4
2	1		1	17155	298.5	0.0	0.0	0.0	0.0	0.0	0.0	298.5	4	4	5	4	4
2	1		1	12593	190.5	0.0	0.0	0.0	0.0	0.0	0.0	190.5	4	5	5	4	5
2	1		1	16425	196.4	0.0	0.0	0.0	-12.6	0.0	-12.6	183.8	4	4	5	2	4
2	1		1	17155	193.9	0.0	0.0	0.0	-12.6	0.0	-12.6	181.3	4	4	5	4	5
2	1		1	17155	193.9	0.0	0.0	0.0	0.0	0.0	0.0	193.9	5	5	5	5	5
2	1		1	16425	193.3	91.6	-29.7	0.0	0.0	0.0	61.9	255.2	4	4	4	2	4
2	1		1	10950	121.7	-91.6	0.0	0.0	6.2	0.0	-85.4	36.3	4	3	4	4	4
2	1		1	1643	85.3	0.0	0.0	-48.5	-12.6	0.0	-61.1	24.3	5	5	5	5	5
2	1		1	18863	145.0	0.0	0.0	0.0	0.0	0.0	0.0	145.0	4	5	5	4	4
2	1		1	17155	116.0	91.6	-60.3	0.0	0.0	-15.9	15.4	131.4	5	4	5	4	5
2	1		1	17155	180.4	0.0	0.0	0.0	0.0	0.0	0.0	180.4	4	4	5	3	4
2	1		1	913	186.8	0.0	29.7	0.0	0.0	0.0	29.7	216.5	3	3	4	4	4
2	1		1	11863	294.6	91.6	0.0	-48.5	-12.6	0.0	30.5	325.1	4	4	5	4	5
2	1		1	0	30.0	0.0	0.0	0.0	25.1	0.0	25.1	55.2	5	5	5	4	4
2	2		1	0	0.0	0.0	0.0	147.1	0.0	0.0	147.1	147.1	4	4	5	3	4
2	2		1	1643	98.8	0.0	-29.7	-48.5	-6.2	0.0	-84.4	14.4	3	3	5	5	4
2	2		1	19593	240.0	45.1	60.3	0.0	0.0	0.0	105.4	345.4	4	5	5	4	5
2	2		1	0	100.1	136.7	0.0	98.5	0.0	0.0	235.2	335.3	3	4	5	4	4
2	2		1	730	180.5	45.1	0.0	0.0	0.0	0.0	45.1	225.6	5	4	4	5	5
2	2		1	7000	68.7	-91.6	0.0	0.0	0.0	-7.8	-99.4	-30.7	5	5	5	5	5
2	2		1	913	151.2	-45.1	0.0	0.0	0.0	0.0	-45.1	106.1	4	4	4	4	4
2	2		1	913	93.5	0.0	-90.0	0.0	6.2	0.0	-83.8	9.7	4	5	5	4	4
2	2		1	913	45.6	0.0	0.0	0.0	-6.2	0.0	-6.2	39.4	3	3	4	3	4
2	2		1	0	11.7	-45.1	-120.6	-48.5	0.0	7.8	-206.4	-194.7	5	4	5	5	5
2	2		1	913	151.2	0.0	0.0	0.0	0.0	0.0	0.0	151.2	4	4	4	4	4
2	2		1	30543	292.9	0.0	60.3	-147.1	0.0	0.0	-86.8	206.1	4	3	5	3	3
2	2		1	24155	213.4	0.0	0.0	0.0	0.0	0.0	0.0	213.4	5	4	4	2	2
2	2		1	1643	78.6	91.6	29.7	0.0	0.0	0.0	121.3	199.9	4	4	4	4	4
2	2		1	23425	226.3	91.6	60.3	0.0	-12.6	-23.7	115.6	341.9	4	3	4	4	4
2	2		1	12475	145.9	45.1	-60.3	0.0	-12.6	0.0	-27.8	118.1	5	3	4	4	4
2	2		1	7913	108.4	0.0	0.0	0.0	0.0	0.0	0.0	108.4	4	4	5	5	5
2	2		1	11863	161.0	-91.6	0.0	0.0	0.0	0.0	-91.6	69.4	5	4	4	4	4
2	2		1	0	86.2	0.0	-29.7	-48.5	-6.2	-7.8	-92.2	-6.1	5	5	5	5	5
2	2		1	0	75.3	-91.6	0.0	-48.5	0.0	-7.8	-147.9	-72.6	4	5	5	3	4
2	2		1	67550	478.0	-45.1	60.3	0.0	6.2	7.8	29.2	507.2	5	4	5	4	3
2	2		1	18863	222.9	0.0	0.0	0.0	0.0	0.0	0.0	222.9	4	4	4	3	4
2	3		1	19593	152.3	0.0	-60.3	-48.5	0.0	7.8	-101.0	51.3	4	5	5	4	4
2	3		1	0	77.9	0.0	0.0	0.0	6.2	0.0	6.2	84.1	4	4	5	5	5

2	3		1	15513	164.2	0.0	0.0	48.5	6.2	7.8	62.5	226.8	4	4	4	4	4
2	3		1	11863	161.0	-45.1	0.0	0.0	0.0	0.0	-45.1	115.9	4	4	5	3	5
2	3		1	22513	145.2	0.0	60.3	0.0	0.0	0.0	60.3	205.5	4	5	5	2	5
2	3		1	11863	176.4	-91.6	0.0	0.0	6.2	0.0	-85.4	91.0	3	4	5	3	4
2	3		1	12593	234.6	0.0	-90.0	0.0	0.0	-7.8	-97.8	136.8	4	4	4	4	4
2	3		1	17950	151.6	91.6	0.0	0.0	6.2	-7.8	89.9	241.5	4	4	5	3	4
2	3		1	0	42.9	45.1	0.0	0.0	-18.8	7.8	34.2	77.0	4	4	5	5	5
2	3		1	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4	3	4	4	4
2	3		1	0	20.2	0.0	-29.7	0.0	0.0	-7.8	-37.5	-17.3	4	4	5	4	4
2	3		1	11863	115.7	0.0	-60.3	197.1	0.0	0.0	136.8	252.5	4	3	5	3	5
2	3		1	4563	39.1	0.0	0.0	0.0	0.0	0.0	0.0	39.1	3	3	4	4	4
2	3		1	913	29.1	0.0	0.0	0.0	0.0	0.0	0.0	29.1	4	3	4	4	4
2	3		1	0	0.0	0.0	0.0	0.0	37.5	0.0	37.5	37.5	3	3	5	4	4
2	3		1	0	160.8	91.6	-29.7	0.0	0.0	0.0	61.9	222.7	3	3	5	5	5
2	3		1	10950	184.5	-91.6	0.0	-48.5	0.0	-15.9	-156.0	28.6	4	4	5	5	4
2	3		1	30425	188.2	91.6	-29.7	0.0	0.0	7.8	69.7	257.9	4	4	5	4	4
2	3		1	15513	186.4	45.1	0.0	0.0	0.0	7.8	52.9	239.3	5	5	5	1	5
2	3		1	25863	231.3	228.2	-29.7	0.0	0.0	0.0	198.5	429.9	4	4	5	5	5
2	3		1	23425	226.3	0.0	0.0	0.0	-18.8	0.0	-18.8	207.6	3	4	4	3	4
2	3		1	22513	148.3	-45.1	-60.3	-147.1	0.0	0.0	-252.5	-104.2	5	5	5	5	5
2	3		1	29513	269.0	-45.1	0.0	0.0	0.0	0.0	-45.1	223.9	4	4	5	3	5
2	3		1	29513	269.0	0.0	90.0	-98.5	18.8	23.7	33.9	302.9	5	4	5	2	5
2	3		1	29513	262.2	0.0	0.0	-294.1	0.0	0.0	-294.1	-31.9	4	4	5	3	5
2	3	[illegible]	1	11563	72.1	0.0	29.7	0.0	0.0	0.0	29.7	101.8	4	4	5	5	5
													4	4	5	4	4
2	1		2	17155	193.9	136.7	29.7	245.6	6.2	0.0	418.1	612.0	5	1	1	5	5
2	1		2	0	107.3	0.0	0.0	0.0	0.0	0.0	0.0	107.3	5	1	1	3	5
2	2		2	7000	133.1	0.0	0.0	0.0	0.0	0.0	0.0	133.1	4	3	1	4	4
2	3		2	11863	112.0	136.7	29.7	0.0	0.0	0.0	166.4	278.4	5	1	1	4	4
2	3		2	7730	133.6	0.0	-120.6	0.0	0.0	0.0	-120.6	13.0	4	2	1	4	4
2	3		2	0	100.1	0.0	0.0	0.0	0.0	0.0	0.0	100.1	4	4	2	3	4
2	3		2	23425	190.7	91.6	29.7	0.0	0.0	39.6	160.9	351.5	4	3	2	3	3
2	3	[illegible]	2	30425	194.9	228.2	0.0	0.0	0.0	0.0	228.2	423.2	4	2	2	4	3
													4	2	1	4	4
2	1		3	11863	213.6	-91.6	-29.7	0.0	-18.8	-7.8	-147.8	65.8	1	5	5	5	1
2	1		3	13205	143.9	-45.1	0.0	0.0	0.0	0.0	-45.1	98.8	2	4	5	5	5
2	1		3	12475	95.5	0.0	0.0	0.0	6.2	0.0	6.2	101.7	3	3	4	2	3
2	1		3	0	64.4	0.0	0.0	0.0	0.0	0.0	0.0	64.4	3	2	4	4	1
2	1		3	11863	189.9	0.0	-29.7	-48.5	0.0	0.0	-78.2	111.7	3	3	5	1	3
2	1		3	4563	102.4	-45.1	-29.7	0.0	0.0	0.0	-74.8	27.6	2	3	4	4	4
2	1		3	18863	235.3	0.0	0.0	-147.1	25.1	0.0	-121.9	113.4	2	3	5	4	4
2	1		3	15513	198.8	91.6	0.0	98.5	6.2	7.8	204.1	402.9	2	4	4	4	4
2	1		3	18863	243.6	-91.6	0.0	-48.5	-25.1	-7.8	-173.0	70.5	2	4	5	4	4
2	1		3	11863	214.7	91.6	0.0	0.0	0.0	0.0	91.6	306.3	4	4	5	3	1
2	1		3	7000	134.6	0.0	29.7	0.0	0.0	0.0	29.7	164.3	2	4	5	5	4
2	2		3	0	179.9	-91.6	29.7	0.0	0.0	0.0	-61.9	118.1	2	4	4	4	3
2	2		3	913	151.2	-136.7	0.0	0.0	0.0	0.0	-136.7	14.5	4	2	4	4	2
2	2		3	0	64.4	-91.6	0.0	0.0	0.0	0.0	-91.6	-27.2	3	3	4	3	1
2	2		3	7000	133.8	-91.6	-90.0	-48.5	0.0	0.0	-230.1	-96.3	2	2	4	4	4
2	3		3	10950	173.7	0.0	0.0	0.0	0.0	47.5	47.5	221.1	2	2	4	1	2
2	3		3	0	86.6	-91.6	-60.3	0.0	0.0	0.0	-151.9	-65.3	5	5	5	5	1
2	3		3	11863	89.8	0.0	90.0	0.0	0.0	0.0	90.0	179.8	2	4	5	3	2
2	3		3	16425	179.8	91.6	60.3	0.0	0.0	0.0	151.9	331.7	3	4	3	3	3
2	3		3	0	22.2	-45.1	0.0	0.0	0.0	0.0	-45.1	-22.9	1	5	5	1	3
2	3		3	0	13.5	0.0	0.0	0.0	0.0	0.0	0.0	13.5	2	4	4	4	4
2	3		3	15513	186.4	91.6	0.0	-48.5	0.0	7.8	50.9	237.3	1	5	5	1	1
2	3		3	0	20.7	136.7	0.0	48.5	-12.6	23.7	196.4	217.0	1	5	5	5	5
2	3		3	10950	131.0	0.0	0.0	0.0	0.0	0.0	0.0	131.0	4	4	5	4	2
2	3		3	0	123.8	0.0	0.0	0.0	0.0	0.0	0.0	123.8	3	3	3	3	2
2	3		3	16425	136.1	0.0	0.0	0.0	0.0	7.8	7.8	143.9	5	5	5	3	1
2	3		3	29513	245.7	45.1	29.7	48.5	0.0	0.0	123.3	369.0	3	4	4	2	2
2	3		3	0	0.0	0.0	0.0	98.5	0.0	0.0	98.5	98.5	2	2	3	4	3
2	3	[illegible]	3	30425	271.7	0.0	0.0	0.0	0.0	0.0	0.0	271.7	2	4	4	4	2
				11393.0	144.1						1.5	145.6	3	4	4	3	3

Appendix 10: SPSS Output: Cluster Analysis

All RE:NEW participants were clustered according to the answers they gave at stage one in relation to the environmentally themed statements on attitudes. The analysis did not take into account any other variables beyond these five attitude statements and the analysis was run in SPSS Version 21. A hierarchical cluster analysis was undertaken, using Ward's method (Squared Euclidean Distance).

The analysis produced three clusters which were later examined in subsequent analysis.

Ward Linkage

Agglomeration Schedule

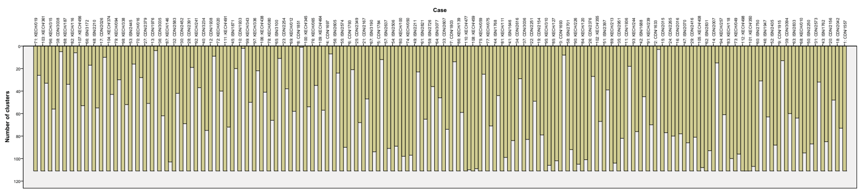
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	101	112	.000	0	0	5
2	108	110	.000	0	0	3
3	75	108	.000	0	2	53
4	62	105	.000	0	0	19
5	60	101	.000	0	1	16
6	85	95	.000	0	0	10
7	84	90	.000	0	0	11
8	35	89	.000	0	0	30
9	32	87	.000	0	0	50
10	3	85	.000	0	6	33
11	26	84	.000	0	7	20
12	73	83	.000	0	0	16
13	41	81	.000	0	0	28
14	74	80	.000	0	0	15
15	49	74	.000	0	14	23
16	60	73	.000	5	12	51
17	50	68	.000	0	0	25
18	5	67	.000	0	0	65
19	14	62	.000	0	4	31
20	26	58	.000	11	0	85
21	54	57	.000	0	0	23
22	6	55	.000	0	0	88
23	49	54	.000	15	21	89
24	9	52	.000	0	0	49
25	31	50	.000	0	17	48
26	29	47	.000	0	0	31
27	20	43	.000	0	0	64
28	34	41	.000	0	13	68
29	22	37	.000	0	0	63
30	11	35	.000	0	8	73
31	14	29	.000	19	26	34
32	16	24	.000	0	0	34
33	3	19	.000	10	0	63
34	14	16	.000	31	32	35
35	14	15	.000	34	0	97
36	42	93	.401	0	0	67
37	12	40	.803	0	0	75
38	7	33	1.204	0	0	66

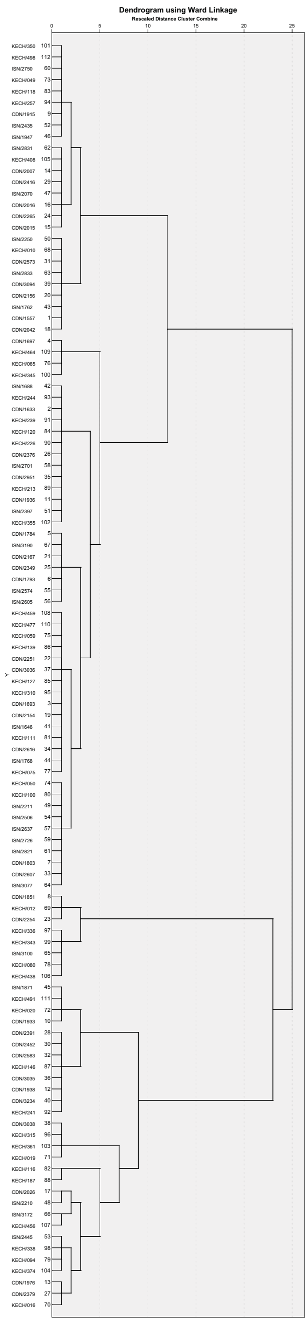
Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
39	1	18	1.606	0	0	64
40	45	111	2.007	0	0	72
41	44	77	2.449	0	0	68
42	2	91	2.899	0	0	67
43	28	30	3.400	0	0	70
44	21	25	3.902	0	0	65
45	51	102	4.458	0	0	73
46	65	78	5.015	0	0	71
47	59	61	5.572	0	0	76
48	31	63	6.235	25	0	52
49	9	46	6.904	24	0	81
50	32	36	7.572	9	0	70
51	60	94	8.241	16	0	81
52	31	39	9.004	48	0	80
53	75	86	9.840	3	0	87
54	8	69	10.683	0	0	74
55	4	109	11.527	0	0	77
56	38	96	12.371	0	0	79
57	17	48	13.222	0	0	95
58	76	100	14.113	0	0	77
59	66	107	15.016	0	0	95
60	53	98	15.919	0	0	82
61	13	27	16.862	0	0	84
62	97	99	17.821	0	0	90
63	3	22	18.891	33	29	83
64	1	20	19.976	39	27	80
65	5	21	21.112	18	44	91
66	7	64	22.316	38	0	76
67	2	42	23.626	42	36	94
68	34	44	24.970	28	41	83
69	79	104	26.315	0	0	82
70	28	32	27.684	43	50	93
71	65	106	29.074	46	0	90
72	45	72	30.466	40	0	92
73	11	51	31.861	30	45	85
74	8	23	33.322	54	0	101
75	12	92	34.797	37	0	93
76	7	59	36.334	66	47	89
77	4	76	37.873	55	58	105
78	82	88	39.479	0	0	106
79	38	103	41.102	56	0	86

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
80	1	31	43.149	64	52	99
81	9	60	45.214	49	51	97
82	53	79	47.351	60	69	96
83	3	34	49.531	63	68	87
84	13	70	51.722	61	0	96
85	11	26	54.133	73	20	94
86	38	71	56.714	79	0	107
87	3	75	59.632	83	53	98
88	6	56	62.767	22	0	91
89	7	49	66.028	76	23	98
90	65	97	69.470	71	62	101
91	5	6	73.277	65	88	100
92	10	45	77.370	0	72	103
93	12	28	81.685	75	70	103
94	2	11	86.010	67	85	104
95	17	66	91.494	57	59	102
96	13	53	97.840	84	82	102
97	9	14	104.342	81	35	99
98	3	7	111.741	87	89	100
99	1	9	120.976	80	97	109
100	3	5	130.537	98	91	104
101	8	65	141.643	74	90	110
102	13	17	153.260	96	95	106
103	10	12	164.927	92	93	108
104	2	3	179.754	94	100	105
105	2	4	201.506	104	77	109
106	13	82	223.766	102	78	107
107	13	38	251.029	106	86	108
108	10	13	287.592	103	107	110
109	1	2	339.207	99	105	111
110	8	10	441.480	101	108	111
111	1	8	555.000	109	110	0




Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine
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Agglomeration Schedule

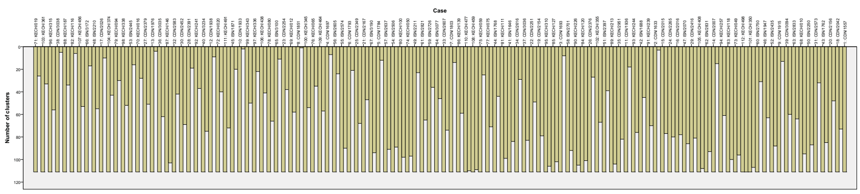
Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	101	112	.000	0	0	5
2	108	110	.000	0	0	3
3	75	108	.000	0	2	53
4	62	105	.000	0	0	19
5	60	101	.000	0	1	16
6	85	95	.000	0	0	10
7	84	90	.000	0	0	11
8	35	89	.000	0	0	30
9	32	87	.000	0	0	50
10	3	85	.000	0	6	33
11	26	84	.000	0	7	20
12	73	83	.000	0	0	16
13	41	81	.000	0	0	28
14	74	80	.000	0	0	15
15	49	74	.000	0	14	23
16	60	73	.000	5	12	51
17	50	68	.000	0	0	25
18	5	67	.000	0	0	65
19	14	62	.000	0	4	31
20	26	58	.000	11	0	85
21	54	57	.000	0	0	23
22	6	55	.000	0	0	88
23	49	54	.000	15	21	89
24	9	52	.000	0	0	49
25	31	50	.000	0	17	48
26	29	47	.000	0	0	31
27	20	43	.000	0	0	64
28	34	41	.000	0	13	68
29	22	37	.000	0	0	63
30	11	35	.000	0	8	73
31	14	29	.000	19	26	34
32	16	24	.000	0	0	34
33	3	19	.000	10	0	63
34	14	16	.000	31	32	35
35	14	15	.000	34	0	97
36	42	93	.401	0	0	67
37	12	40	.803	0	0	75
38	7	33	1.204	0	0	66
39	1	18	1.606	0	0	64
40	45	111	2.007	0	0	72
41	44	77	2.449	0	0	68

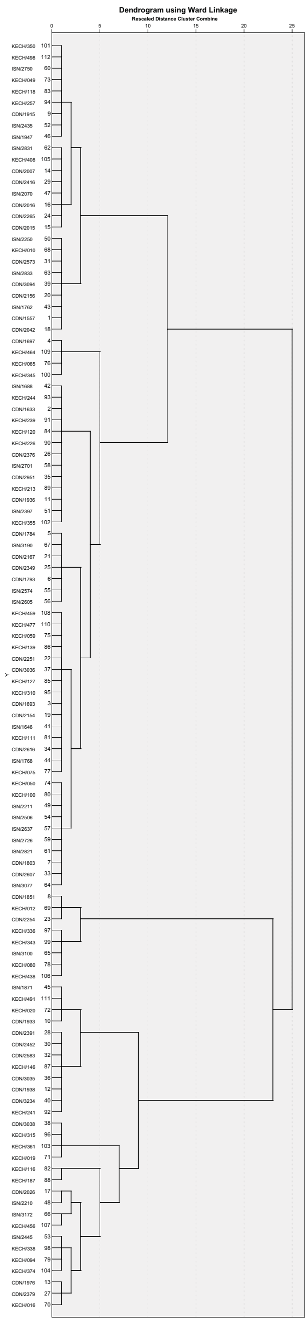
Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
42	2	91	2.899	0	0	67
43	28	30	3.400	0	0	70
44	21	25	3.902	0	0	65
45	51	102	4.458	0	0	73
46	65	78	5.015	0	0	71
47	59	61	5.572	0	0	76
48	31	63	6.235	25	0	52
49	9	46	6.904	24	0	81
50	32	36	7.572	9	0	70
51	60	94	8.241	16	0	81
52	31	39	9.004	48	0	80
53	75	86	9.840	3	0	87
54	8	69	10.683	0	0	74
55	4	109	11.527	0	0	77
56	38	96	12.371	0	0	79
57	17	48	13.222	0	0	95
58	76	100	14.113	0	0	77
59	66	107	15.016	0	0	95
60	53	98	15.919	0	0	82
61	13	27	16.862	0	0	84
62	97	99	17.821	0	0	90
63	3	22	18.891	33	29	83
64	1	20	19.976	39	27	80
65	5	21	21.112	18	44	91
66	7	64	22.316	38	0	76
67	2	42	23.626	42	36	94
68	34	44	24.970	28	41	83
69	79	104	26.315	0	0	82
70	28	32	27.684	43	50	93
71	65	106	29.074	46	0	90
72	45	72	30.466	40	0	92
73	11	51	31.861	30	45	85
74	8	23	33.322	54	0	101
75	12	92	34.797	37	0	93
76	7	59	36.334	66	47	89
77	4	76	37.873	55	58	105
78	82	88	39.479	0	0	106
79	38	103	41.102	56	0	86
80	1	31	43.149	64	52	99
81	9	60	45.214	49	51	97
82	53	79	47.351	60	69	96

Agglomeration Schedule

Stage	Cluster Combined		Coefficients	Stage Cluster First Appears		Next Stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
83	3	34	49.531	63	68	87
84	13	70	51.722	61	0	96
85	11	26	54.133	73	20	94
86	38	71	56.714	79	0	107
87	3	75	59.632	83	53	98
88	6	56	62.767	22	0	91
89	7	49	66.028	76	23	98
90	65	97	69.470	71	62	101
91	5	6	73.277	65	88	100
92	10	45	77.370	0	72	103
93	12	28	81.685	75	70	103
94	2	11	86.010	67	85	104
95	17	66	91.494	57	59	102
96	13	53	97.840	84	82	102
97	9	14	104.342	81	35	99
98	3	7	111.741	87	89	100
99	1	9	120.976	80	97	109
100	3	5	130.537	98	91	104
101	8	65	141.643	74	90	110
102	13	17	153.260	96	95	106
103	10	12	164.927	92	93	108
104	2	3	179.754	94	100	105
105	2	4	201.506	104	77	109
106	13	82	223.766	102	78	107
107	13	38	251.029	106	86	108
108	10	13	287.592	103	107	110
109	1	2	339.207	99	105	111
110	8	10	441.480	101	108	111
111	1	8	555.000	109	110	0




Dendrogram using Ward Linkage
Rescaled Distance Cluster Combine

Appendix 11 GTrek User Guide, Lissenden Gardens GPS Study Information Sheet, Lissenden Gardens GPS Study Consent Form

Prior to the commencement of the Lissenden Gardens Green Zone Study, participants were provided with a GTrek GPS recorder prior to the commencement of the first stage of monitoring and taught how to use it. They were provided with a user guide also an information sheet on the study. All participants were also asked to provide their consent to take part in the study and to have their data used for the purposes of the research. This appendix includes this user guide, information sheet and consent form.

CENTRE FOR URBAN SUSTAINABILITY AND RESILIENCE
CIVIL, ENVIRONMENTAL & GEOMATIC ENGINEERING

Getting acquainted with your GPS logger

Your GTrek GPS logger is ready to use but before you do so it is important to know just a little information.

Your GTrek GPS logger receives data from orbiting satellites that enables the device to measure your location. The data is then saved onto the device until it is transferred from the device onto a computer using software especially designed for the GTrek GPS logger. Please do not try to download the data yourself. I will give you a copy of any data I obtain. Also, please do not worry if the logger runs out of battery or you forget the GPS device and leave it at home by accident, this if fine and some missing data is expected in these projects.

<u>The three-position switch</u>

With the device face up, on the left hand side there is a three position switch:

- OFF - in this position the GTrek GPS logger is switched off and no data will be collected.
- NAV - this function will not be used in this project.
- LOG - in this position, the GTrek GPS logger will detect and log information from the satellites. This effectively means the device is on. When switching the device on, please make sure you push the switch all the way to LOG and do not stop at NAV.

On the opposite side to the three position switch there is a mini USB socket used for charging the battery. If you wish to omit any trips that you make, you can switch the GPS device to OFF on the three position switch. Please don't forget to switch it back on afterwards!

<u>The three lights</u>

On the top surface of the device you will find three lights and a push button:

The satellite fix light (Figure 2) tells you more than one thing and can be amber or yellow:

- Amber light flashing - satellite fix obtained and useful data is being collected.

- Amber light on - satellite fix not obtained and no data is being received. This is normal for up to five minutes after you have switched the device on and when you are inside a building. If this amber light never flashes, even when you are outside, please call or email me so I can investigate the problem.
- Red light is flashing slowly - internal memory is nearly full. If this happens please call or email me so I can arrange data collection.
- Red light is on - data is not being collected, the internal memory is full and has stopped logging new data. This means that the data needs to be downloaded, if this happens please call or email me so I can arrange to download the data.

The power light (Figure 3) can be green or red:

- Green light on - the device is charging.
- Green light off - the unit is fully charged (this light may flicker when downloading data)
- Red light on - the battery power level is low. In this situation the battery should be recharged as soon as possible.

Bluetooth light (Figure 4)

- If a blue light is flashing or is on, it is on the NAV mode. Please switch to LOG mode using the three way switch on the left hand side of the device.

The push button (in the middle of the three lights)

- This push button is deactivated.

Figure 1: GPS GTrek Device

Figure 2: GPS GTrek Device Satellite Symbol

Figure 3: GPS GTrek Device Power Symbol

Figure 4: GPS GTrek Device Bluetooth Symbol

Frequently Asked Questions

Q. Why are you doing this study?

We would like to find out if having private bicycle parking changes people's cycling habits. To do this we would like to monitor cycle mileage of cyclists living in Lissenden Gardens. As a result, we are currently looking for volunteer participants that ride a bicycle, to carry a GPS device with them, for a period of time.

Q. What is this GPS device like?

The GPS devices that we use are about the size of a matchbox. These GPS devices can determine your location, which will be recorded at regular intervals. This logged data is then stored on the device, it is not be transmitted.

Q. What will I need to do if I volunteer to be a participant?

1. Carry the small GPS device in your bag or pocket
2. Charge the GPS device every one to two days. This can be done overnight.

We would like you to carry the GPS device in your bag or pocket for one month, prior to the construction of the proposed cycle parking. Then one month after the cycle parking has been built, we would like you to carry the device again, also for a period of one month.

This location data collected through these two months will then be processed to find out how far you have travelled by bicycle and to observe if there has been any change in the distance that you have cycled. Once analysed, we will share your cycle mileage with you. We are also happy to share the data files of your own GPS tracks with you, which you can look at on Google Earth. After the end of the first month, we will need to download the data from your GPS device. We will organise to do this at a time and location of your convenience.

Q. Why would I take part in this study?

No direct benefit will result to you by taking part in this study, but you will help research that may have the potential to help and improve cycling conditions for many people. If it can be shown that the provision of cycle infrastructure (in this instance cycle parking) alters people's cycling habits and causes people to cycle more, then this creates a good case for further research and investment into cycle infrastructure.

Any publications or reports arising from this study will be made available to you. You will also be given a £20 voucher (from a choice of M&S, Amazon and John Lewis) as a thank you for taking part in the study.

Q. I am happy to take part, what next?

If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. You will then be asked to meet with the researcher at a time and location of your convenience. The researcher will explain the details of the study and how the GPS recording device works. You will also be asked at this meeting (the GPS placement meeting) to provide some information about yourself and details of locations you frequently visit. You will then carry the GPS device for a period of one month, whilst making journeys outside of your home

At the end of the first month survey period we will contact you to arrange a convenient time to download the data from you GPS device. The, after the construction of the cycle parking at Lissenden Gardens you will be contacted again and asked to resume carrying the GPS device.

Q. What will you do with my data? Can I withhold my location for privacy reasons?

Information held about you will consist of your communications with the researcher, the information you provide through the initial GPS placement questionnaire and the spatial data obtained by the GPS device.

All your data will be anonymised and no one will be able to identify you from the data. Only members of our research team will be able to look at the information we collect and all data will be collected and stored in accordance with the Data Protection Act (1998). This means that you will be allocated a participant number and that this will be used in the analysis. Any information regarding your identity will be kept apart from the spatial data collected by the GPS device. Your personal details will be stored in a file separate from the data and this information will be encrypted with a password. When presenting any results from the research, identifiable characteristics of your travel will not published.

If you wish to withhold your data at any time during the study then it is possible to switch the GPS logger off. Also, should you forget to turn the logger off and would like data deleted for a certain range of time please contact Kristy Revell who can permanently delete these locations from the database. Additionally, your data will never be passed on.

Please note that this study is registered with UCL Data Protection (reference number Z6364106/2013/02/43).

Q. What if I change my mind?

Please remember that you do not have to take part in this study and that participation is entirely voluntary. Also, if you agree to take part initially and later change your mind, you are free to withdraw at any time and do not have to give a reason.

Further contact information

This study is supervised by Prof. Nick Tyler CBE, Head of Department, Department of Civil, Environmental and Geomatic Engineering at UCL.

Should you wish to contact Camden Council with regard to this study, please contact Julie Oram at julie.oram@camden.gov.uk.

Thank you for considering taking part in this study. We really do appreciate your assistance.

CENTRE FOR URBAN SUSTAINABILITY AND RESILIENCE
CIVIL, ENVIRONMENTAL & GEOMATIC ENGINEERING

Consent Form

Lissenden Gardens Cycle Parking Study

Name of Researcher: Kristy Revell, PhD student

Contact Details: Department of Civil, Environmental and Geomatic Engineering, University College London.

By completing and returning this form, you are giving us your consent that the personal information you provide will only be used for the purposes of this project and not transferred to an organisation outside of UCL. The information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.

Please initial the boxes to give your consent and sign below:

	Yes	No
1. I confirm that I have read and understand the information sheet for the above study and that I have had the opportunity to ask questions.	☐	☐
2. I agree to take part in the above study.	☐	☐
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.	☐	☐
4. I understand that the data collected during the study may be looked at by individuals from the sponsor of the trial (University College London). I give permission for these individuals to have access to the data.	☐	☐
5. I agree that my data gathered in this study may be stored (after anonymisation) and that anonymised data may be used in future research, public lectures and publications.	☐	☐

Name of Participant ______________________________

Date ______________________________

Signature ______________________________

Appendix 12 SPSS Output: T-test and Homogeneity of Regression of analysis of cycling prevalence

To test for significant differences in cycling prevalence between the sample and control group of the Lissenden Gardens Green Zone study, and to ascertain whether the sample group cycled further and/or more frequently after the intervention, the ANCOVA test was used.

When using ANCOVA, the first step is to test that the covariate is independent from the experimental effect. This can be checked using a t-test to ascertain that pre-intervention indicators are not different for both the sample and control groups. The second step in using ANCOVA is to test the assumption of homogeneity of regression and that the covariate has the same correlation with the dependent variable for both the sample and control groups, to ensure that the ANCOVA test is appropriate.

The results found that ANCOVA was a suitable test for all indicators.

```
T-TEST GROUPS=Group(0 1)
  /MISSING=ANALYSIS
  /VARIABLES=PreAveragecyclemetresovertraveldays PreAveragenumberofcyclejourneyspertravelday
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		23-OCT-2014 19:53:26
Comments		
Input	Data	C:\Users\uceskrl\Dropbox\GPS\Processing\Statistics\FinalResults.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	10
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=Group(0 1) /MISSING=ANALYSIS /VARIABLES=PreAveragecyclemetresovertraveldays PreAveragenumberofcyclejourneyspertravelday PreAveragecyclemetresperjourney /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.02
	Elapsed Time	00:00:00.01

```
[DataSet1] C:\Users\uceskrl\Dropbox\GPS\Processing\Statistics\FinalResults
.sav
```

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
PreAveragecyclemetresovertraveldays	Control	5	5083.22	2496.061	1116.273
	Sample	5	3853.40	2946.399	1317.669
PreAveragenumberofcyclejourneyspertravelday	Control	5	1.327	.3257	.1457
	Sample	5	.832	.6448	.2884
PreAveragecyclemetresperjourney	Control	5	3845.94	1810.773	809.802
	Sample	5	3957.92	2808.879	1256.169

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of
		F	Sig.	t
PreAveragecyclemetresovertraveldays	Equal variances assumed	.004	.954	.712
	Equal variances not assumed			.712
PreAveragenumberofcyclejourneyspertravelday	Equal variances assumed	2.417	.159	1.532
	Equal variances not assumed			1.532
PreAveragecyclemetresperjourney	Equal variances assumed	.582	.467	-.075
	Equal variances not assumed			-.075

Independent Samples Test

		t-test for Equality of Means		
		df	Sig. (2-tailed)	Mean Difference
PreAveragecyclemetresovertraveldays	Equal variances assumed	8	.497	1229.813
	Equal variances not assumed	7.790	.497	1229.813
PreAveragenumberofcyclejourneyspertravelday	Equal variances assumed	8	.164	.4948
	Equal variances not assumed	5.917	.177	.4948
PreAveragecyclemetresperjourney	Equal variances assumed	8	.942	-111.974
	Equal variances not assumed	6.835	.942	-111.974

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PostAveragecyclemetres(

F	df1	df2	Sig.
1.988	1	8	.196

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group + PreAveragecyclemetresovertraveldays + Group * PreAveragecyclemetresovertraveldays

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresovertraveldays

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	64406459.1[a]	3	21468819.69	5.476	.037
Intercept	1708446.137	1	1708446.137	.436	.534
Group	8254525.148	1	8254525.148	2.106	.197
PreAveragecyclemetresovertraveldays	41566166.52	1	41566166.52	10.602	.017
Group * PreAveragecyclemetresovertraveldays	6878080.613	1	6878080.613	1.754	.234
Error	23522548.15	6	3920424.691		
Total	287042930.0	10			
Corrected Total	87929007.22	9			

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresovertraveldays

Source	Partial Eta Squared
Corrected Model	.732
Intercept	.068
Group	.260
PreAveragecyclemetresovertraveldays	.639
Group * PreAveragecyclemetresovertraveldays	.226
Error	
Total	
Corrected Total	

a. R Squared = .732 (Adjusted R Squared = .599)

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Descriptive Statistics

Dependent Variable: PostAveragenumberofcyclejo

Group	Mean	Std. Deviation	N
Control	1.42	.454	5
Sample	.83	.846	5
Total	1.12	.712	10

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PostAveragenumberofcyc

F	df1	df2	Sig.
.692	1	8	.430

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group + PreAveragenumberofcyclejourneyspertravelday + Group * PreAveragenumberofcyclejourneyspertravelday

Tests of Between-Subjects Effects

Dependent Variable: PostAveragenumberofcyclejourneyspertravelday

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.121[a]	3	.707	1.734	.259
Intercept	.600	1	.600	1.472	.271
Group	.455	1	.455	1.117	.331
PreAveragenumberofcycle journeyspertravelday	.172	1	.172	.423	.540
Group * PreAveragenumberofcycle journeyspertravelday	.343	1	.343	.841	.395
Error	2.446	6	.408		
Total	17.213	10			
Corrected Total	4.568	9			

Tests of Between-Subjects Effects

Dependent Variable: PostAveragenumberofcyclejourneyspertravelday

Source	Partial Eta Squared
Corrected Model	.464
Intercept	.197
Group	.157
PreAveragenumberofcycle journeyspertravelday	.066
Group * PreAveragenumberofcycle journeyspertravelday	.123
Error	
Total	
Corrected Total	

a. R Squared = .464 (Adjusted R Squared = .197)

```
UNIANOVA PostAveragecyclemetresperjourney BY Group WITH PreAveragecyclemetresperjourney
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /PRINT=ETASQ HOMOGENEITY DESCRIPTIVE
  /CRITERIA=ALPHA(.05)
  /DESIGN=Group PreAveragecyclemetresperjourney Group*PreAveragecyclemetresperjourney.
```

Univariate Analysis of Variance

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PostAveragecyclemetresp

F	df1	df2	Sig.
7.823	1	8	.023

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group + PreAveragecyclemetresperjourney + Group * PreAveragecyclemetresperjourney

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresperjourney

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8893740.27[a]	3	2964580.089	6.965	.022
Intercept	7402385.829	1	7402385.829	17.391	.006
Group	1784029.867	1	1784029.867	4.191	.087
PreAveragecyclemetresperjourney	8779366.493	1	8779366.493	20.626	.004
Group * PreAveragecyclemetresperjourney	2344164.874	1	2344164.874	5.507	.057
Error	2553853.702	6	425642.284		
Total	157407848.2	10			
Corrected Total	11447593.97	9			

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresperjourney

Source	Partial Eta Squared
Corrected Model	.777
Intercept	.743
Group	.411
PreAveragecyclemetresperjourney	.775
Group * PreAveragecyclemetresperjourney	.479
Error	
Total	
Corrected Total	

a. R Squared = .777 (Adjusted R Squared = .665)

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Appendix 13 SPSS Output: ANCOVA Results of analysis of cycling prevalence

To test for significant differences in cycling prevalence between the sample and control group of the Lissenden Gardens Green Zone study a one-way analysis of covariance (ANCOVA) was conducted. The covariate was the pre-intervention indicator of cycling prevalence. The dependent variable was the post-intervention indicator of cycling prevalence. The results found that there was no significant effect of the intervention on any of the post-intervention indicators of cycling prevalence.

Between-Subjects Factors

		Value Label	N
Group	0	Control	5
	1	Sample	5

Descriptive Statistics

Dependent Variable: PostAveragecyclemetresovert

Group	Mean	Std. Deviation	N
Control	5405.85	2306.294	5
Sample	3518.58	3799.624	5
Total	4462.22	3125.682	10

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PostAveragecyclemetreso

F	df1	df2	Sig.
.425	1	8	.533

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + PreAveragecyclemetresovertraveldays + Group

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresovertraveldays

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	57528378.5[a]	2	28764189.23	6.623	.024
Intercept	421058.279	1	421058.279	.097	.765
PreAveragecyclemetresovertraveldays	48623909.13	1	48623909.13	11.196	.012
Group	1418939.231	1	1418939.231	.327	.585
Error	30400628.76	7	4342946.966		
Total	287042930.0	10			
Corrected Total	87929007.22	9			

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresovertraveldays

Source	Partial Eta Squared
Corrected Model	.654
Intercept	.014
PreAveragecyclemetresovertraveldays	.615
Group	.045
Error	
Total	
Corrected Total	

a. R Squared = .654 (Adjusted R Squared = .555)

Estimated Marginal Means

Group

Dependent Variable: PostAveragecyclemetresovertraveldays

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	4850.662[a]	946.636	2612.223	7089.102
Sample	4073.774[a]	946.636	1835.335	6312.213

a. Covariates appearing in the model are evaluated at the following values: PreAveragecyclemetresovertraveldays = 4468.31.

```
UNIANOVA PostAveragecyclemetresperjourney BY Group WITH PreAveragecyclemetresperjourney
  /METHOD=SSTYPE(3)
  /INTERCEPT=INCLUDE
  /EMMEANS=TABLES(Group) WITH(PreAveragecyclemetresperjourney=MEAN)
  /PRINT=ETASQ HOMOGENEITY DESCRIPTIVE
  /CRITERIA=ALPHA(.05)
  /DESIGN=PreAveragecyclemetresperjourney Group.
```

Univariate Analysis of Variance

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PostAveragecyclemetresp

F	df1	df2	Sig.
.425	1	8	.533

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + PreAveragecyclemetresperjourney + Group

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresperjourney

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6549575.39[a]	2	3274787.697	4.680	.051
Intercept	12278874.79	1	12278874.79	17.548	.004
PreAveragecyclemetresperjourney	6549420.193	1	6549420.193	9.360	.018
Group	6435.032	1	6435.032	.009	.926
Error	4898018.576	7	699716.939		
Total	157407848.2	10			
Corrected Total	11447593.97	9			

Tests of Between-Subjects Effects

Dependent Variable: PostAveragecyclemetresperjourney

Source	Partial Eta Squared
Corrected Model	.572
Intercept	.715
PreAveragecyclemetresperjourney	.572
Group	.001
Error	
Total	
Corrected Total	

a. R Squared = .572 (Adjusted R Squared = .450)

Estimated Marginal Means

Tests of Between-Subjects Effects

Dependent Variable: PostAveragenumberofcyclejourneyspertravelday

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.779[a]	2	.889	2.232	.178
Intercept	.263	1	.263	.660	.443
PreAveragenumberofcycle journeyspertravelday	.898	1	.898	2.253	.177
Group	.140	1	.140	.351	.572
Error	2.789	7	.398		
Total	17.213	10			
Corrected Total	4.568	9			

Tests of Between-Subjects Effects

Dependent Variable: PostAveragenumberofcyclejourneyspertravelday

Source	Partial Eta Squared
Corrected Model	.389
Intercept	.086
PreAveragenumberofcycle journeyspertravelday	.244
Group	.048
Error	
Total	
Corrected Total	

a. R Squared = .389 (Adjusted R Squared = .215)

Estimated Marginal Means

Group

Dependent Variable: PostAveragenumberofcyclejourneyspertraveld

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	1.259[a]	.302	.544	1.974
Sample	.990[a]	.302	.275	1.705

a. Covariates appearing in the model are evaluated at the following values: PreAveragenumberofcyclejourneyspertravelday = 1.080.

Appendix 14 SPSS Output: T-test and Homogeneity of Regression and ANCOVA Results of analysis of total carbon impact

When the Lissenden Gardens Green Zones research was originally conceived it was considered that if the provision of secure and accessible cycle parking encouraged participants who use the parking to cycle further or more frequently, then this could lead to a modal shift in transport and therefore a change in the overall carbon impact of an individual, as a result of their transport choices. Therefore, ANCOVA was used to ascertain this for certain and to control for variances in the pre-intervention carbon impact of participants.

First the independence of the covariate and the treatment effect was ascertained. Next assumption of homogeneity of regression was tested. It found that the assumption of homogeneity of regression stood. ANCOVA was a suitable test.

A one-way analysis of covariance (ANCOVA) was conducted. The covariate was the carbon impact of all modes, before the intervention. The dependent variable was the carbon impact of all modes, after the intervention. The results found that there was no significant effect of the intervention on the carbon impact of the sample group.

```
T-TEST GROUPS=Participant(0 1)
  /MISSING=ANALYSIS
  /VARIABLES=PrecarbonImpact
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		25-OCT-2014 15:12:41
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	10
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=Participant(0 1) /MISSING=ANALYSIS /VARIABLES=PrecarbonImpact /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.07

[DataSet1]

Group Statistics

	Participant	N	Mean	Std. Deviation	Std. Error Mean
PrecarbonImpact	0	5	2226.761	2164.8915	968.1689
	1	5	1180.734	1716.9204	767.8302

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
PrecarbonImpact	Equal variances assumed	.103	.756	.847	8
	Equal variances not assumed			.847	7.605

Page 1

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PostcarbonImpact

F	df1	df2	Sig.
1.043	1	8	.337

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Participant + PrecarbonImpact + Participant * PrecarbonImpact

Tests of Between-Subjects Effects

Dependent Variable: PostcarbonImpact

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1297107.70[a]	3	432369.235	1.671	.271
Intercept	2377794.969	1	2377794.969	9.191	.023
Participant	88506.376	1	88506.376	.342	.580
PrecarbonImpact	1140173.958	1	1140173.958	4.407	.081
Participant * PrecarbonImpact	365204.955	1	365204.955	1.412	.280
Error	1552253.554	6	258708.926		
Total	12093744.39	10			
Corrected Total	2849361.258	9			

Tests of Between-Subjects Effects

Dependent Variable: PostcarbonImpact

Source	Partial Eta Squared
Corrected Model	.455
Intercept	.605
Participant	.054
PrecarbonImpact	.423
Participant * PrecarbonImpact	.190
Error	
Total	
Corrected Total	

a. R Squared = .455 (Adjusted R Squared = .183)

Estimated Marginal Means

Between-Subjects Factors

		N
Participant	0	5
	1	5

Descriptive Statistics

Dependent Variable: PostcarbonImpact

Participant	Mean	Std. Deviation	N
0	1005.521	356.6737	5
1	917.434	761.7576	5
Total	961.477	562.6684	10

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PostcarbonImpact

F	df1	df2	Sig.
3.943	1	8	.082

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + PrecarbonImpact + Participant

Tests of Between-Subjects Effects

Dependent Variable: PostcarbonImpact

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	931902.749[a]	2	465951.374	1.701	.250	.327
Intercept	2280636.152	1	2280636.152	8.326	.023	.543
PrecarbonImpact	912504.536	1	912504.536	3.331	.111	.322
Participant	19729.768	1	19729.768	.072	.796	.010
Error	1917458.509	7	273922.644			
Total	12093744.39	10				
Corrected Total	2849361.258	9				

a. R Squared = .327 (Adjusted R Squared = .135)

Estimated Marginal Means

Participant

Dependent Variable: PostcarbonImpact

Participant	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
0	915.112[a]	239.245	349.388	1480.837
1	1007.842[a]	239.245	442.118	1573.567

a. Covariates appearing in the model are evaluated at the following values: PrecarbonImpact = 1703.747.