Final OMEGA Project Report:

An Assessment of the Potential of Carbon Offset Schemes to Mitigate the Climate Change Implications of Future Growth of UK Aviation

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Acronyms

AEIG	Atmospheric Emissions Inventory Guidebook
ATM	Air Traffic Management
CAA	Civil Aviation Authority
CCX	Chicago Climate Exchange
CDG	Paris Charles de Gaulle
CDM	Clean Development Mechanism
CERs	Certified Emissions Reductions
CFS	Co-operative Financial Services
CO_2e	Carbon Dioxide Equivalent
DEFRA	Department of Environment, Food and Rural Affairs
DfT	Department for Transport
EMEP/CORINAIR	CORe INventory of AIR emissions
ERUs	Emission Reduction Units
EUAs	EU Allowances
EU ETS	European Union Emissions Trading Scheme
GCD	Great Circle Distance
GHG	Greenhouse Gases
GS	Gold Standard
ICAO	International Civil Aviation Organisation
IPCC	Intergovernmental Panel on Climate Change
lCERs	Long-term Certified Emissions Reductions
LHR	London Heathrow
LULUCF	Land Use, Land Use Change and Forestry
Mt	Million tonnes
NGO	Non-Governmental Organisation
NS-SEC	National Statistics Socio-Economic Classification
ONS	Office for National Statistics
PDS	Project Design Standards
RECs	Renewable Energy Certificates
RFI	Radiative Forcing Index
tCERs	Temporary Certified Emissions Reductions
UN	United Nations
UNEP	United Nations Environment Programme
VCS	Voluntary Carbon Standard
VERs	Verified Emissions Reductions
VOS	Voluntary Offset Standard
WMO	World Meteorological Organization
WRI/WBCSD	World Resources Institute/World Business Council for Sustainable Development

Executive Summary

Introduction

Carbon offsetting is a mechanism for compensating for greenhouse gas emissions generated by a particular activity by paying for equivalent emissions savings or reductions to be made elsewhere in the economy. This OMEGA study was designed to clarify the role, the effectiveness, and the credibility of offsetting for air travel and to investigate attitudes towards the offset concept amongst airline passengers. It involved literature reviews, an examination of carbon offset providers, and a survey of passengers travelling through Manchester Airport.

Offsetting is a problematic response to climate change for a variety of reasons, nevertheless it offers an incentive for organisations and individuals to take action to limit greenhouse gas emissions and voluntary carbon markets are evolving rapidly. The scholarly literature on carbon offsetting – whilst presently limited – is also developing rapidly as offsetting receives increasingly critical scrutiny.

Literature Review

The literature review outlines and evaluates key issues associated with carbon offsetting schemes and reveals:

- Concern over the principle of offsetting, in that it is not a sufficient measure to address climate change, and could in fact slow the transition to low carbon technologies, operating systems and business practices.

- Major issues associated with the design and performance of schemes including problems of accounting carbon costs and savings; the need to prove 'additionality'[1], the lack of regulation within the market, the degree of inefficiency within offset projects, the fact that they may not be permanent; and the tendency of some to have adverse co-benefits.

- On the other hand, offsetting schemes represent a pragmatic means to encourage action to limit climate change impacts; the concept is easy to understand and offsetting may be undertaken by many individuals and organisations.

- Offsetting schemes provide two benefits. Firstly funding to deliver genuine CO_2e savings, the implementation of low carbon technologies and a contribution to efforts to stem climate change; and secondly an opportunity to engage with the consumer and raise awareness of the financial and climate costs of their choices.

The literature review gave rise to the following recommendations:

- Offset should form part of an integrated climate change reduction strategy that is focused primarily on reducing greenhouse gas emissions and the transition to a low-carbon economy.

- Offsetting schemes need to be transparent, rigorously monitored and audited particularly with regard to the assessment of CO_2e savings achieved (some organisations have adopted in-house programmes to provide the appropriate rigour).

[1] Offset projects must take place in countries not subject to Kyoto protocol reduction targets or be able to prove that emissions savings would not have happened as a result of business-as-usual.

- Offsetting funds should only be used to purchase (and retire) carbon credits from emissions trading schemes where demonstrable emissions reductions can be guaranteed.

- Emissions reductions schemes should be preferred over sequestration projects which have attracted particular criticism for lack of permanence and difficulties in cost/benefit accounting.

- Offset providers should seek to be accredited by an internationally recognised standard (such as the Gold Standard Foundation).

A Review of Offset Providers

The contribution of voluntary offsets to limit climate change is dependent upon the effectiveness of the schemes employed and the level of uptake. The level of uptake corresponds to the level of awareness, the presence of confusion amongst users, the ease of paying, acceptance of the value of such schemes, and level of trust in offset companies.

The review of voluntary offset providers describes and evaluates the key elements and structure of such schemes. Web sites of 42 online providers of aviation offset services were examined in November 2007[2]. This revealed:

- Significant differences in the cost charged for offsetting the same flight on different web sites (the cost of offsetting London (LHR) to Paris (CDG) varied between £0.31 and £12.95).

- While offset providers demonstrated consistency in the calculation of flight distances, they differed significantly in the sophistication of their assumptions and emissions calculations and not all provided details of how costs were estimated.

- Some emissions calculators take into account details of phases of flight and aircraft type whilst others used standard emission factors for 'domestic', 'short' and 'long' haul journeys. Other variables considered in more complex offset calculators included differentials relating to the climate costs of different 'classes' of air travel (economy, business, first), passenger load factor and the weight of air cargo.

- A proportion of offset providers include only CO_2 emissions in their calculations while some include a radiative forcing index (RFI) multiplier ranging from 1 – 3 for non-CO_2 aircraft engine emissions that contribute to climate change.

- Variability in the unit cost of carbon savings (this ranged from £2.00/tCO_2e to £18.00/tCO_2), which significantly affected in the cost to offset a given flight.

- Offset products available on different web sites varied considerably in terms of transparency of systems, the quality of accounting, risk of double accounting and 'leakage' (emissions displaced to other activities), and being able to confirm 'additionality'.

- Efforts are separately underway at a UK level (through DEFRA) and at an international level (ICAO) to standardise methods of calculating emissions from flights to be offset and to achieve verification of offset products themselves. Nonetheless, convergence in methodologies and greater consistency in assurance procedures is still needed to raise confidence levels.

[2] This market is expanding rapidly with new providers emerging every month.

- The process of purchasing offsets creates an opportunity for providers to inform consumers and thereby promote attitudinal change and increase public engagement with the climate change challenge. There was considerable variability in the extent to which this opportunity was exploited by different providers.

The review concluded that within the voluntary carbon market there was the need for:

- Greater transparency – including details of emissions calculations, carbon cost assumptions and use of quality assured offset projects.

- Standardisation of emissions calculation assumptions, especially with regard to the use of RFI and the level of sophistication in the underlying emissions model.

- Clear pricing mechanisms that enable informed consumer choice (i.e. where higher unit costs for carbon reduction can be justified for quality reasons, e.g. greater levels of verification – this should be explained to potential customers).

- An awareness building exercise to promote the value of offsets, the way in which the concept works and guarantees of quality.

Such actions are required if the offset market is to maximise both the level of uptake by users and the carbon savings achieved from a given level of investment.

Survey of Passenger Attitudes to Offset Provision

The third part of this OMEGA project involved a survey of attitudes to offsetting amongst passengers travelling through a UK airport to reveal the level of awareness of offsetting, attitudes towards such schemes, and factors that might affect uptake. A questionnaire was designed in consultation with stakeholders from government, industry, NGOs and research institutions and a survey of 487 passengers undertaken at Manchester Airport in January and February 2008.

The principle results of the survey indicated that:

- Almost 8 out of 10 people questioned had previously heard of offsetting but less than half were aware that such schemes could be used to reduce the climate impacts of their flight.

- While more than three quarters of passengers accept that air transport contributes to climate change, relatively few (less than 10 per cent) are willing currently to change their behaviour about flying or to purchase offsetting.

- One reason for this lack of conversion between attitudes and behaviour may be that many passengers believe that they are not primarily responsible for the climate impacts of their flights. They look instead to the Government or to airlines to address those impacts.

- Low uptake of offset schemes arises also from lack of awareness of their existence and little understanding of their purpose or how they operate.

- The preferences expressed by respondents suggest that the uptake of offsetting schemes could be increased by ensuring that their benefits are transparent and well publicised, that they

support both projects in developing countries and projects in the UK local to the travellers and that they meet UN quality standards.

- More detailed analysis of the results indicate a small minority of passengers (less than 10 per cent) that are strongly supportive of efforts to mitigate the climate impacts of flying. This group is generally willing to pay the full cost of offsetting for a flight.

- These 'lead-edge' aviation offset consumers were characterised as expressing strong agreement with statements that climate change is a genuine threat, air transport has an influence on climate, individuals can limit the impact of air transport on climate through their actions, and that individual passengers are primarily responsible for offsetting the climate impacts of flying.

- A much larger proportion of passengers (of the order of about one third of all passengers surveyed) appear willing to make some contribution to climate mitigation; however, dramatically improved consumer confidence (particularly about guaranteed benefits) is required if passenger uptake is to be significantly increased.

- Many passengers are concerned at the lack of standardisation in carbon markets and in institutional (government and industry) responses to climate change. Thus offsetting is regarded as relatively futile unless it occurs in a context of much more robust, standardised and widespread climate change mitigation activity. This is consistent with the view that offsetting is not in itself a sufficient response to climate change, but that it can nevertheless offer an immediate, pragmatic way in which individuals and organisations can begin to engage with the challenge.

Recommendations arising from this study include:

- Further debate should occur in the public arena to clarify issues of responsibility and influence in relation to offsetting the climate impacts of flights and to emphasise the opportunities that offsetting offers to consumers.

- Much more attention should be paid to communicating the purpose, principles and methods of offsetting to potential consumers.

- Providers should do much more to improve consumer confidence in offsetting by demonstrating greater transparency and accountability in their services.

- Offset providers should give much more information to customers about the operation of their schemes and individual projects. This should include technical details of the calculation of costs, far more information about project benefits, carbon accountancy, additionality, verification, and even the sustainability performance of the offsetting companies themselves.

- The is a need for greater transparency and standardisation across the voluntary carbon offset market with clearer communication to encourage consumers to take responsibility for their emissions and increase willingness to invest in verified offset projects.

Conclusions

Offsets provide a means of compensating for the carbon dioxide and other climate change emissions resulting from human activities. They should however be an action of last resort after other means

of avoiding and/or reducing emissions have been used and should not slow the move towards a low carbon economy.

Offsets can be purchased by individuals wishing to compensate for their choices and in this regard, they represent one of the few opportunities for immediate and direct action to minimise climate change by the consumers of products and services. This is important in respect of air transport because of the magnitude of climate change emissions associated with flights and because, there is often no suitable low carbon alternative to aviation for long distance high speed travel.

Given that offset schemes are currently voluntary, if a greater uptake is to be achieved then much more needs to be done to raise awareness of the existence and benefits of such schemes.

Standardisation of methods of calculating the CO_2e emissions from particular flights and of emissions savings made by particular offset schemes is necessary to minimise confusion and mistrust and build the credibility of the offset industry amongst consumers.

This study has revealed a core of passengers who wish to offset the full climate change emissions of their flights but a much larger proportion who wish simply to make a compensatory payment. Clear and transparent systems catering for different customer demands are therefore required. This can extend to providing details of the social co-benefits that can arise from particular offset activities that may make them more attractive to consumers.

Finally the process of engagement with the consumer provides an opportunity for awareness building that can further influence attitudinal change that can support the move towards a low carbon society.

There is always the risk that offsets can be used to justify energy intensive lifestyles, as paying to compensate may be less 'painful' than, for example, reducing consumption and/or accepting changes to service/product quality. In the context of the significant proportion of air transport demand in the UK that is leisure travel, as long as the general public choose to fly, offsetting provides a pragmatic way to compensate for the resultant climate impacts.

This study has identified the need for further research, (a) to develop a standard methodology for calculating offset emissions, (b) to assess the market expansion potential of offering a fixed rate offset product, and (c) to ascertain whether the attitudes expressed in the passenger survey undertaken here are representative of the wider general public.

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1. Introduction

Carbon offsetting has emerged recently as a means of 'cancelling out' greenhouse gas emissions from one activity by equivalent emissions reductions elsewhere. There is a diverse and rapidly-growing voluntary carbon market, but offsetting is not a straightforward solution to the challenge of climate change due to doubts about the accountability, credibility, effectiveness and transparency of the schemes. However, offsetting provides stakeholders with opportunities to make an immediate, practical response to the climate impacts of air travel. With support from the Omega knowledge transfer partnership, a study was undertaken to:

- Establish current understanding of the nature and quality of carbon offset services
- Review online carbon offset providers offering services to air transport passengers
- Investigate the attitudes of air passengers to offsetting at a major UK airport

These elements, conducted towards the end of 2007 (literature review and provider review) and the early part of 2008 (passenger survey), are reported here in three discrete sections each with their own conclusions. This is supplemented by a final section that attempts to draw-out the core findings from the project as a whole.

2. Literature Review

2.1 Background

Human activities are widely acknowledged to impact upon the global climate system (Houghton 2004; IPCC 2007b, 2007c, 2007d; Stern 2007). Many human activities require the conversion of energy from fossil fuels, with the result that greenhouse gases – such as carbon dioxide (CO_2) – are emitted. Human activities also influence climate in other ways: through land clearance and emissions of aerosols, for instance. These anthropogenic impacts upon climate are superimposed upon other patterns of climate change involving complex interactions between the atmosphere, biosphere, and oceans that occur naturally. Significant efforts have therefore been made to create an international framework for the assessment and monitoring of climate change, to devise mechanisms for reducing human-induced climate change, and to predict and adapt to its impacts.

Many potential responses to climate change have received scrutiny from scientists, economists and policymakers; carbon offsetting is one response that has attracted considerable attention and that has been contested on various grounds. Carbon offsetting represents one way in which, arguably, some of the overall human impacts on climate change might be reduced. Offsetting involves compensating for the greenhouse gas emissions produced by one activity with an equivalent carbon dioxide emissions saving elsewhere (DEFRA 2007: 2). Such an approach is feasible because CO_2 has a long atmospheric residence time and is relatively evenly mixed in the atmosphere. Although offsetting on its own is not a sufficient response to the challenges of climate change, in conjunction with other methods – such as initiatives to reduce greenhouse gas emissions through encouraging lifestyle changes – offsetting can help to raise awareness of climate issues and may also deliver reductions in greenhouse gas emissions (DEFRA 2007: 2; Friends of the Earth 2006).

Offsetting involves the purchase of 'carbon credits' that have been generated by projects that have achieved reductions in carbon emissions: through small-scale renewable technology or energy efficiency projects, for example (Brouwer *et al*. 2007: 5; DEFRA 2007: 2). Yet offsetting can only be effective in reducing climate change if those credits are derived from regulated, verified emissions reductions. Where this has not been the case, offsetting projects have been subject to intensive

scrutiny and to critical judgements about their effectiveness – especially from environmentalists who seek more radical responses to the challenge of climate change. In particular, offsetting projects that involve the sequestration of carbon have been called into question (Friends of the Earth 2006); instead, offsetting companies have been encouraged to seek 'Gold Standard' accreditation for their projects in order to guarantee their effectiveness. Establishing consumer confidence in offsetting is vital if this new market is to succeed in delivering environmental benefits.

This review of the literature on offsetting has been undertaken to inform research into the credibility and effectiveness of offsetting, and to outline the range of issues involved. First, some terms are briefly defined below. The following sections provide a discussion and evaluation of the issues involved in offsetting schemes – and of their applicability to emissions from air transport. Those sections offer critical comments on various aspects of carbon offsetting which, in turn, inform the final section on conclusions and recommendations. Carbon offsetting represents a dynamic, emerging market and the literature on this subject is rapidly expanding. This review of the literature serves to identify the major challenges and opportunities associated with offsetting.

2.2 Definitions

Carbon offsetting has been defined as the purchase of emission reduction credits generated by projects and activities that reduce carbon emissions (DEFRA 2007). More precisely, a credit refers to one tonne of CO_2e (carbon dioxide equivalent); thus a carbon offset 'negates the release of one tonne of CO_2e […] by avoiding the release of, or removing from the atmosphere the same amount of CO_2e somewhere else' (Friends of the Earth 2006: 1). Another definition was provided by Brouwer *et al.* (2007: 5), who stated:

> Carbon or greenhouse offsets are certified emissions reductions or sequestration that can be purchased by an individual, business, or government to offset the emissions resulting from their activities. Offsetting essentially involves balancing greenhouse gas emissions from one activity with purposeful greenhouse gas reductions or sequestration from another activity in order to maintain 'carbon neutrality'.

Definitions of offsetting involve diverse and sometimes vague concepts, however. Even in the definitions presented here, some ambiguities are apparent: whether it is 'carbon', CO_2, CO_2e or 'greenhouse gas emissions' that are offset; whether offsetting must involve *reductions* of carbon emissions or whether sequestration is a legitimate form of offsetting; and whether or not offsets must be 'certified' and 'purposeful' (Brouwer *et al*. 2007: 5).

2.3 Climate change and economic instruments

The most authoritative source of information on climate change is the Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988. The role of the IPCC is 'to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation' (IPCC 2007a). While the IPCC does not undertake research, it produces Assessment Reports based mainly on peer reviewed, published scientific and technical literature.

The IPCC Assessment Reports provide comprehensive scientific, technical and socio-economic information relating to the nature, causes and possible impacts of climate change, and on relevant response measures (IPCC 2004). The work of the IPCC is undertaken mainly through three working

groups, which assess the scientific aspects of the climate system and climate change (Working Group I); the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adapting to it (Working Group II); and options for limiting greenhouse gas emissions and otherwise mitigating climate change (Working Group III). The output of these working groups is combined in Assessment Reports (IPCC 2007b; IPCC 2007c; IPCC 2007d); the Fourth Assessment Report (AR4), *Climate Change 2007*, is due to be published imminently.

Notwithstanding the consensus reported in the IPCC Assessment Reports, the literature on the science and economics of climate change is diverse and rapidly expanding: the global climate is the result of complex, dynamic interactions between the Earth's atmosphere, biosphere and oceans, and climate change represents a political and highly contested issue (Yamin and Depledge 2004). Nevertheless, the debate about climate change has progressed from whether the phenomenon exists to how appropriate solutions can be found. Recently, a wide range of regulatory and economic measures to mitigate or offset the effects of climate change has been proposed and some have received extensive scrutiny.

While the development of an equitable and effective international regulatory framework has been relatively problematic, economic measures have considerable potential to provide short-term responses to climate change, as the IPCC has acknowledged:

> Both bottom-up and top-down studies indicate that there is substantial economic potential for the mitigation of global GHG emissions over the coming decades, that could offset the projected growth of global emissions or reduce emissions below current levels *(high agreement, much evidence)*.' (IPCC 2007d: 11)

As a result, the development of economic instruments to reduce – or to mitigate the impacts of – climate change has become a significant theme at the global scale.

Consideration of the economics of climate change is not new, however; this subject has received attention for at least a decade. A concise overview of the economics of global warming was provided by Pearce (1998: 323-336); he also discussed the role of carbon taxes in responding to global warming (Pearce 1998: 337-349). More recently, Stern (2007) conducted an independent, authoritative assessment of the economics of climate change; he argued that a secure understanding of the economics of climate change is required for an effective global response to the challenge to be developed. In his review, Stern (2007) considered carbon pricing and emissions markets, although he made little explicit mention of carbon offsetting. Nevertheless, Stern (2007) emphasised the need for credibility, flexibility and predictability in their design, and argued that unless carbon emissions are rapidly stabilised at manageable levels – and reduced by 1-3 per cent annually thereafter – per capita consumption could decline by 20 per cent globally.

2.4 Offsetting schemes: main issues

Studies of carbon offsetting belong within the context of voluntary carbon markets. Bayon *et al.* (2007) provide an introduction to the subject of voluntary carbon markets, including a discussion of various organisations and some central concepts, such as 'additionality'. These authors provide a useful classification of the main types of offsetting projects, shown in Figure 1. Bayon *et al.* (2007: 108) argue that offsetting projects can be categorised into two main groups: those that reduce greenhouse gas emissions at source and those than reduce greenhouse gas levels in the atmosphere through sequestration. Emissions reduction projects rely on achieving actual cuts in fossil fuel combustion – either directly, through energy efficiency projects, or indirectly, through renewable

energy certificates (RECs). Emissions reductions can also be achieved through the destruction of greenhouse gases, as by the flaring of methane or by the destruction of trichloromethane (HFC-23) and nitrous oxide (N_2O). Sequestration projects, in contrast, aim to remove carbon dioxide from the atmosphere. These projects aim to increase the number and efficiency of natural carbon sinks (forests, oceans and agricultural soils). Sequestration projects include land use projects (forestry and no-till farming) and geological sequestration projects; of these projects, agroforestry, afforestation, reforestation and forest conservation projects – are the most common (Bayon *et al.* 2007, 109, 112; Pearce 2003).

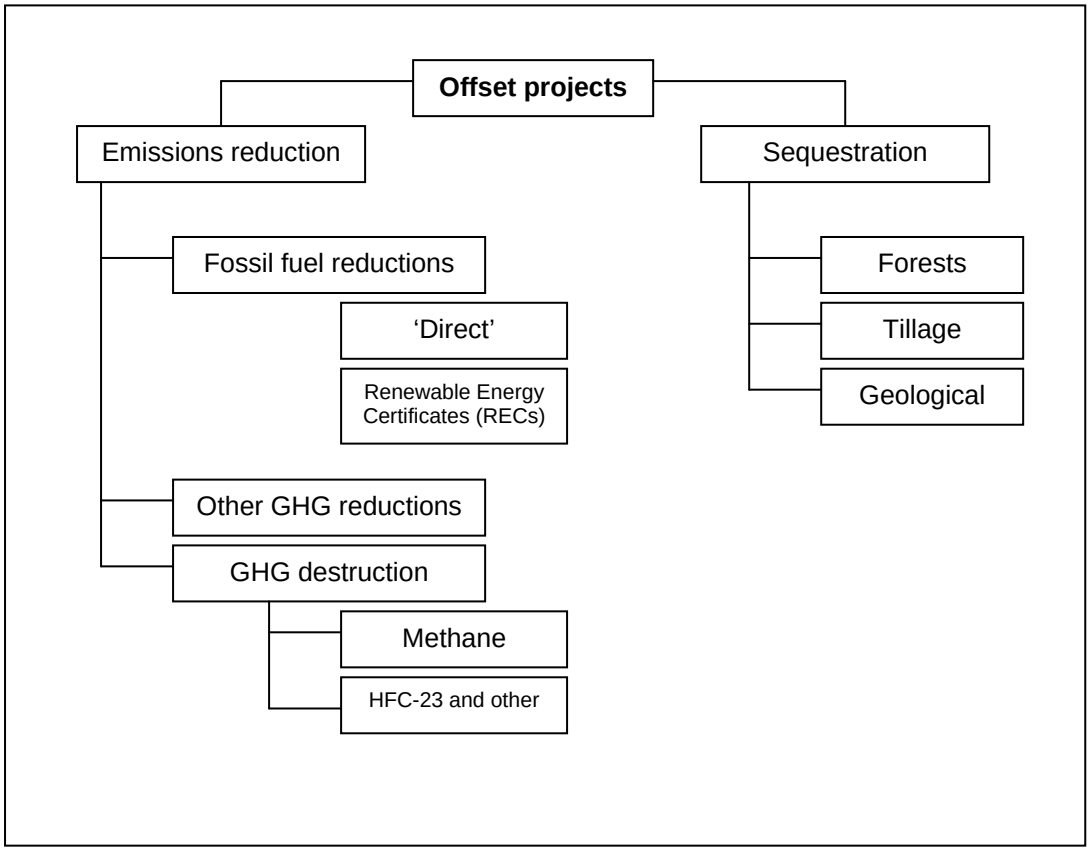

Figure 1: Common emissions reduction and sequestration projects

Source: Bayon *et al.* (2007: 108)

Many issues are associated with carbon offset schemes. These issues relate variously to the measurement of emissions and to the permanence and credibility of offsets. The main areas of concern are as follows: (a) offsets are not a sufficient measure to address climate change; (b) offsetting does not address all climate impacts; (c) offsetting requires an accurate measure of the emissions to be offset; (d) offsetting requires an accurate measure of the carbon saved elsewhere; (e) offsetting requires an appropriate price to be put on one tonne of CO_2e; (f) offsetting requires demonstrating additionality; (g) offsetting schemes may be overpriced and are vulnerable to fraud; (h) offsetting schemes can be inefficient; (i) offsets may not be permanent; (j) offsetting schemes may create problems of leakage; (k) offset projects have mixed co-benefits; and (l) offsetting schemes help to delay the transition to a low-carbon economy. These issues are discussed in turn below.

2.4.1 *Offsets are not a sufficient measure to address climate change*

Many commentators have acknowledged that carbon offsetting schemes are not a sufficient response to the challenge posed by climate change (DEFRA 2007a; Friends of the Earth 2006; Gössling *et al.* 2007; Smith 2007). DEFRA (2007b: 2) stated that carbon offsetting is not a cure for climate change: instead, the most appropriate action to take is to reduce emissions at source. Gössling *et al.* (2007: 241) argued that 'carbon offsetting schemes remain an ambiguous solution' to climate change. Nevertheless, while offsetting is not a cure for climate change, it can help to raise awareness of climate change and can motive individuals and organisations to reduce the impact of their actions (DEFRA 2007a). Offsetting may form a pragmatic, useful element of an overall climate change strategy as it can be done by everybody. Brouwer *et al.* (2007: 12) reported that 'the willingness of the general public to invest in climate change mitigation may be much higher than is generally assumed'; in addition, offsetting offers consumers a practical means of assessing the emissions from their own activities. Therefore, DEFRA (2007) concluded that offsetting – if undertaken rigorously and robustly – can lead to carbon dioxide reductions in the area local to the offsetting project (often in developing countries).

2.4.2 *Offsetting does not address all climate impacts*

The global climate system is dynamic and involves a myriad of feedback mechanisms – both positive and negative – and complex interactions between the atmosphere, biosphere and oceans. In addition, human impacts upon climate are complex and varied. Carbon offsetting schemes do not address all of these variable impacts upon climate: in general, they are limited to consideration of several major greenhouse gases, such as CO_2 and methane (CH_4). The most potent greenhouse gas (defined in terms of global warming potential) is sulphur hexafluoride (SF_6), which is not addressed by offsetting schemes; neither is another greenhouse gas – perfluorocarbon (PFC) – covered by offsets. In addition to the impacts of greenhouse gases, other climate effects occur due to the impacts of aerosols (such as sulphates). These non-greenhouse gas climate impacts are not accounted for in offsetting schemes. Therefore, even if their estimates of CO_2e emissions are accurate, offsetting schemes only partially reflect the climate impacts of human activities. Some commentators have argued that failure to tackle the range of pollutants that contribute to climate change could cause the most highly-respected carbon offset schemes to fail (*New Scientist*, 4 August 2007: 5). On the other hand, scientific consensus has been established about the role of CO_2 as the greenhouse gas of greatest concern (Houghton, 2004); hence attempts to offset CO_2 emissions alone could potentially make a substantial contribution to mitigating climate change.

2.4.3 *Offsetting requires an accurate measure of the emissions to be offset*

A major obstacle for offsetting schemes is that they depend upon deriving an accurate measure of the CO_2e emissions to be offset. This is problematic generally, but is exceptionally difficult in the case of aviation, for instance. For flights, calculating emissions is not straightforward for several reasons: the fuel consumed does not scale linearly with distance travelled due to the extra fuel required to climb to cruise altitudes; aircraft engines vary in their efficiency at different altitudes; fuel efficiency is affected by the loading of the aircraft; and significant variations in fuel consumption are caused by weather. In addition, airframe-engine combinations vary widely in their fuel efficiency, and air passengers (and offsetting companies) are unlikely to know precisely which aircraft type is used for each flight (Jardine, 2005: 2-3). For aviation, offsetting providers attempt to overcome this problem by selecting representative aircraft types in order to calculate the fuel burn, but such an approach does not guarantee an accurate assessment of the actual emissions produced. Again, from a pragmatic point of view, offsetting companies argue that scientific uncertainty about the precise emissions due to any one activity should not preclude action to offset at least a nominal

level of its emissions. Attempts to standardise emission calculations have recently been made by ICAO (2008) and DEFRA (as part of guidance on corporate reporting and in the development of a code of practice for offset providers – for a detailed account of revisions to air transport related emission factors see DEFRA 2008a).

2.4.4 Offsetting requires an accurate measure of the carbon saved elsewhere

Similarly, if offsetting is to work effectively, the schemes require an accurate measure of the carbon saved elsewhere. Such a measure is extremely difficult to achieve. Offsetting schemes have hitherto relied on small-scale projects that introduce new technologies, such as treadle-pumps, in place of fossil-fuel intensive technologies, such as diesel-fired pumps. However, the CO_2e savings associated with these technology transfers are often not quantifiable: for how long would a treadle-pump have to be used – or by how many people – in order to offset 1 tonne of CO_2e emissions from a diesel-powered pump? Other offsetting projects have involved afforestation, reforestation or other land-use changes, yet biochemical processes are highly variable and it is extremely difficult to quantify the CO_2e savings associated with ecological changes of this sort. Therefore, offsetting schemes rely on estimates of CO_2e saved which may be highly inaccurate and which may be considerably over-estimated. In their survey of 41 offsetting companies, Gössling *et al.* (2007: 240) found that 'only a few' apparently used scientifically-sound approaches as the basis for their emissions calculations.

2.4.5 Offsetting requires an appropriate price to be put on one tonne of CO_2e

Another issue surrounding the use of offsetting schemes is that they require an appropriate price to be put on one tonne of CO_2e; this is the basis of the cost that is charged to the consumer. However, deriving a universally accepted cost of one tonne of CO_2e is not straightforward. Jardine (2005) has acknowledged that offset providers face three choices when determining the cost of carbon: the social cost of carbon emissions; the cost of abatement; and the market price of carbon. For offsetting companies, the cost of abatement appears to be the most appropriate choice of carbon price, since these companies invest in abatement technologies (Jardine 2005: 9). However, other costs of carbon might arguably be used instead; the social cost of carbon, for instance, more fully reflects the global incremental damage caused by emissions that are not offset (Pearce 2003). In addition, the use of the cost of abatement is not straightforward because that cost varies widely depending upon the type of projects selected, their location, and their effectiveness – and the latter cannot always be known with certainty.

2.4.6 Offsetting requires demonstrating additionality

One of the most difficult challenges faced by offset schemes is the need for additionality, which requires offset providers to demonstrate that the emissions reductions they achieve would not otherwise have occurred under a 'business as usual' scenario (Friends of the Earth 2006: 2). Thus projects undertaken in Kyoto-signatory countries are potentially problematic if they may have been introduced in order to meet emissions reductions targets agreed under the Kyoto Protocol, while projects in non-Kyoto countries may have otherwise occurred under the Clean Development Mechanism (CDM). Some geological sequestration projects – such as enhanced oil recovery, achieved by injecting waste CO_2 into fields with hard-to-reach oil reserves – do not meet the criterion of additionality because they may be profitable without carbon finance (Bayon *et al.* 2007: 114). The requirement to demonstrate additionality presents particular challenges to industries – such as aviation – in which emissions reductions are most likely to be achieved through fuel efficiency, since fuel efficiency is a constant commercial goal under 'business as usual' scenarios and thus an effective offsetting project would deliver an immediate commercial benefit.

2.4.7 Offsetting schemes may be overpriced and are vulnerable to fraud

As a result of the rapid emergence of the voluntary carbon market, offsetting schemes are as yet unregulated (Hileman 2007). Hence the schemes may be overpriced and the system is vulnerable to fraud, as several commentators have highlighted (Smith 2007; *The Guardian*, 16 June 2007: 14-15). Co-operative Financial Services (CFS) offers offsets to its customers as part of products such as mortgages, but doubts over the legitimacy of many offsetting schemes led CFS to develop an original approach to monitoring and auditing projects (Business in the Community 2007: 27). CFS acknowledged that wide variation exists in the quality of offsetting projects available on the market, and that companies involved in poorly managed offsetting schemes face significant reputational risk. CFS argues that companies should adopt a rigorous approach to offsetting projects, including rigorous monitoring of the benefits at all levels. Other proponents of offsetting have argued that schemes should endorse and seek certification by the Gold Standard scheme – a rigorous process to ensure that emission reductions are verified, additional and consistent with sustainable development. The Gold Standard scheme has registered seven schemes, two of which have reportedly delivered around 350,000 tonnes of verified Gold Standard carbon reductions (The Gold Standard Foundation 2007; *The Guardian*, 16 June 2007: 15).

2.4.8 Offsetting schemes can be inefficient

Concerns have also been expressed about the efficiency of offsetting schemes (van Kooten *et al.* 2004). In particular, concerns have been expressed about the practice of purchasing credits in order to retire them from the market. In principle, retiring carbon credits should result in actual emissions reductions; in practice, however, an oversupply of credits in the EU Emissions Trading Scheme (ETS) resulted in excessive allowances to pollute, with the result that the credits that were retired had no impact upon actual carbon emissions (*The Guardian*, 16 June 2007: 14-15). Even where offsetting involves investment in carbon-reduction projects, rather than simply in purchasing credits from emissions trading schemes, some commentators have argued that the money spent on offsetting could be used to deliver greater environmental benefits elsewhere. Some projects – such as tillage sequestration projects – are less effective at capturing CO_2 than others (Bayon *et al.* 2007: 114; Manley *et al.* 2005). The most appropriate types of offset projects in terms of environmental benefits – those that generate credits by achieving fossil fuel reductions – are acknowledged to be relatively inefficient from a return on investment point of view (Bayon *et al.* 2007: 109). Authors such as Bayon *et al.* (2007: 109) have argued that flaring methane (which is a more potent greenhouse gas than CO_2 in terms of global warming potential) or destroying HFC-23 can generate far more credits per dollar invested. However, there may be limited trading in credits for more efficient emissions reductions of this type; for example, very few companies create HFC-23 (Bayon *et al.* 2007: 112). Instead, most offsetting schemes focus predominantly on the impact of CO_2 emissions, which is far more widely emitted and which can be more easily accounted and traded than other greenhouse gases. Thus the voluntary market does not provide the most appropriate pricing signals to encourage the type of low-carbon development advocated by many environmentalists.

2.4.9 Offsets may not be permanent

Some commentators have argued that, however suitable offsets may be in the short term, they are rarely permanent (Kim *et al.* 2007; Lohmann 2003). Sequestration projects have attracted particular criticism in this respect: of all offsets, those achieved through sequestration are least the likely to be permanent. Forestry projects may be destroyed by fire, disease or logging. If forests planted or extended as a result of offsetting schemes are logged, then the carbon storage they provide depends partly on the final use of the trees, which is difficult to ascertain (Bayon *et al.* 2007: 113). Tillage

sequestration projects may be even less permanent than forestry projects; the carbon sequestered can be released to the atmosphere once again if farming practices subsequently change (Bayon *et al.* 2007: 114). Uncertainty about the permanence of offsets presents particular difficulties for carbon accounting. Nevertheless, one response to these criticisms is that – while sequestration projects are not permanent – they offer an immediate means of slowing down the rate of greenhouse gas accumulation in the atmosphere; hence they might help to mitigate climate change during a critical period while other technologies are developed (Bayon *et al.* 2007: 112).

2.4.10 Offsetting schemes may create problems of leakage

Even where offsetting schemes generate *bona fide* greenhouse gas sequestration or emissions reductions, problems of leakage may occur. This is the case where, for instance, a successful offset project simply drives the undesirable activity to another location. Again, sequestration projects attract particular criticism: for instance, it is difficult to ensure that the transformation of agricultural land into forested land in one area – or the prevention of deforestation through conservation measures – do not simply displace clear-cutting to create agricultural land elsewhere (Bayon *et al.* 2007: 113). Problems of leakage may apply to other offset projects besides those focused on sequestration: even investment in low-carbon technologies in one area may simply create an incentive for investment in cheaper, 'dirty' technological processes elsewhere. Offsetting schemes require to be fully integrated within regional, national and international carbon strategies if problems of leakage are to be overcome.

2.4.11 Offset projects have mixed co-benefits

Considerable debate has focused on the co-benefits associated with offset projects: the side-effects of projects that may be positive or negative, intended or unintended (Elbakidze and McCarl 2007). Critics of offsetting argue that offset projects provide limited or negative co-effects, and many anecdotal examples have been cited (see Smith 2007; *The Guardian*, 16 June 2007: 14-15). Extensive, monoculture forestry projects intended to sequester CO_2 may not provide the many co-benefits associated with indigenous forests: they contribute little to the conservation of biodiversity, and they may reduce water supplies (Bayon *et al.* 2007: 113). Methane projects involving livestock may lead to elevated nutrient discharges in local water, and offensive odours (Bayon *et al.* 2007: 110). The destruction of HFC-23 yields few, if any, social or environmental co-benefits (Bayon *et al.* 2007: 112). More serious criticisms have been directed at projects that have allegedly resulted in conflict between local communities and conservation projects, land evictions and other human rights abuses; such projects have been condemned as contrary to sustainable development (Smith 2007).

On the other hand, some commentators have emphasised the many potential co-benefits that might occur with offset projects (Osborne and Kiker 2005). Fossil fuel reduction projects, in particular, have many potential environmental and human health co-benefits: reduced resource depletion, improved local and regional air quality, reduced water and soil pollution, and reduced frequency and severity of human respiratory complaints. Reduced fossil fuel dependence may yield national security benefits; incentives may also be created for improving and transferring renewable energy technology, which can in turn generate employment in this sector. Small-scale, renewable energy projects could lead to reduced deforestation by reducing demand for wood fuel. Furthermore, direct emissions reductions – such as those from energy efficiency projects – often result in greater efficiencies and long-term cost savings (Bayon *et al.* 2007: 109). Such co-benefits can be multiple: methane flaring can generate renewable energy in addition to the destruction of the greenhouse gas (Bayon *et al.* 2007: 110). Forestry projects – while being dubious in terms of permanence and

leakage – nonetheless have many co-benefits: increased forest productivity, ecological conservation, reduced erosion, hydrological regulation and economic development (Bayon *et al.* 2007: 113).

2.4.12 Offsetting schemes help to delay the transition to a low-carbon economy

In spite of the many potential co-benefits of offset projects, many commentators remain sceptical of offsetting schemes, arguing that they simply help to delay the necessary transition to a low-carbon economy. Schemes that attempt to deliver improved efficiencies in 'dirty' industrial sectors have been criticised for continuing the dependence of production processes on fossil fuels. Thus geological sequestration projects – such as enhanced oil recovery simply promote additional fossil fuel combustion (Bayon *et al.* 2007: 114). Indeed offsetting schemes may worsen the climate impacts of industrial production by reassuring producers and consumers that appropriate environmental action is being taken with respect to climate change. Further, investment in offsetting may divert resources from attempts to reduce the carbon intensity of current system of production and consumption. An alternative view is articulated by other organisations, such as DEFRA (2007a), which regard offsetting as a pragmatic tool in the difficult transition from production processes based on intensive use of fossil fuels to a low-carbon economy. Thus DEFRA (2007a) argued that offsetting projects – especially those approved by the United Nations – offer a mechanism for investment in clean technology in the areas which lack it the most, and that such investment can lead to the spread of low-carbon development across entire regions, further reducing climate change impacts. Other commentators have argued that offsetting schemes send the right signals to stakeholders: for example, tillage sequestration projects indicate to farmers that no- or low-till farming practices are desirable, while forestry projects are valuable in raising public awareness of the need for action to mitigate climate change since they are one of the easiest types of offset for consumers to understand (Bayon *et al.* 2007: 113-114).

2.5 Offsetting schemes: an evaluation

Given the range of issues described above, offsetting schemes are now widely acknowledged to be problematic responses to the challenge of climate change. Most significantly, in offsetting schemes, commercial advantage and environmental benefits have become entangled to the extent that a crisis of legitimacy has occurred in the voluntary carbon market. This lack of credibility has been acknowledged, for example by Brouwer *et al*. (2007: 7), who stated: 'The most important reason for travellers to protest against paying [for carbon offsetting] is passenger disbelief that the carbon travel tax and the proposed trees for travel program will have any real impact.' Offsetting schemes are conceptually problematic: they have arisen not from attempts by environmentalists and climate scientists to design an appropriate response, but from politicians and business executives trying to meet the demands for action while preserving the commercial status quo (*The Guardian*, 16 June 2007: 15). Such criticisms indicate that offsetting schemes require careful design and rigorous monitoring; however, appropriate forms of offsetting may nevertheless play an important role in an overall response to climate change, as acknowledged in a balanced statement that captures the main strengths and weaknesses of offsetting, published by Friends of the Earth, Greenpeace and WWF-UK (Friends of the Earth 2006).

Business in the Community (2007: 2) acknowledged that 'climate change has risen to the top of the corporate environmental agenda'. Citing Tony Juniper, Executive Director of Friends of the Earth, the organisation stated:

> There is a hierarchy of preferred action on the road to a low carbon society. At the top is the need to change energy intensive lifestyles, for example by flying less. Next is the more efficient use of energy. At the bottom is carbon offsetting. If comprehensive measures to

> avoid and cut emissions across activities are not taken as a first step, offsetting schemes simply encourage us to carry on with unsustainable lifestyles. (Tony Juniper, cited in Business in the Community 2007: 26)

Hence carbon offsetting should be regarded as a last resort, rather than a priority action. Where offsetting projects form part of a broader climate change strategy, Juniper argued that the choice of projects should be considered carefully to ensure that the expected benefits are achieved; however, he argued that this task is hindered by the lack of a legal standard for offsetting schemes.

Efforts have been made to develop a suitable standard for offsetting schemes. In January 2007, DEFRA (2007b) launched a consultation on whether a Code of Best Practice for carbon offset providers should be developed. DEFRA (2007b) stated that the aim of establishing such a Code is 'to ensure consumer confidence in an emerging market and continued growth of that market through that confidence'. DEFRA (2007b) proposed that the Code should be voluntary and that offset providers could choose whether to seek accreditation for some, or all, of their offsetting products. The Code would 'provide signals to the UK offset sector on the quality and verification standards to which they should aspire, so that market participants can focus their attention on developing the UK's position as a global market leader in the field'; the Code would also 'encourage the provision of credit types which are consistent with the Government's policies on meeting its Kyoto obligations and strategy for supporting the development of a robust and liquid global market infrastructure for carbon trading' (DEFRA 2007b).

In its consultation, DEFRA (2007) argued that the most suitable carbon credits for offsetting are those from the regulated market, due to their robust and verifiable nature: they include Certified Emissions Reductions (CERs), EU Allowances (EUAs) and Emission Reduction Units (ERUs) (definitions of these terms are provided in DEFRA 2007: 50-51). Amongst a range of specific questions, the DEFRA (2007) consultation considered the following:

- Should the UK Government publish a Code for offset providers?
- Should the Code be mandatory or voluntary?
- Are the most appropriate credits to demonstrate best practice in offsetting one, or a combination of, CERs, EUA or, less easily, ERUs?
- If EUAs are included in the Code, would the 'double-counting' issue be addressed in an appropriate manner?
- Should a government-agreed database of emissions figures be used as the approved method of calculating emissions to be offset?
- Should the quality mark be used only for accrediting offsetting products and not for businesses that have offset their own emissions?
- Should consumers be allowed to choose which projects they fund from an offset providers portfolio?
- What evidence should offset providers have to show to demonstrate compliance with the Code?
- Should the administration of the quality mark scheme be financed by fees charged for upfront accreditation and from annual subscriptions from those using the accreditation quality mark?

The DEFRA (2007) consultation also considered the timescale for purchasing and cancelling credits, and the need for a periodic review of the Code. These efforts resulted in the publication of a draft Code of Practice in February of this year (DEFRA 2008b).

2.6 Offsetting and air transport

Given that the voluntary carbon market is relatively new and rapidly expanding, offsetting has only recently been considered in relation to the climate impacts of air transport and the associated literature is limited. However, several studies of offsetting in relation to air transport have been published. One recent study of offsetting – which focused on the willingness of air travellers to offset their CO_2 emissions – was produced by Brouwer *et al.* (2007). Those authors found that 'a substantial demand for climate change mitigation action' exists among travellers from Europe, North America, Asia and the rest of the world, although significant differences existed between those groups (Brouwer *et al.* 2007: 1). Europeans were found to be most aware of climate change and most willing to pay for carbon offsets, whereas North Americans and Asians are less informed and less willing to act. Overall, however, the authors argued that the willingness of air travellers to pay for offsetting represents a 'convenient truth': the market potential for carbon offsets is substantial and carbon offsets could account for more than €23 billion in climate change mitigation activities annually (Brouwer *et al.* 2007: 12, 13).

In another study, Gössling *et al.* (2007) have also considered the efficiency and credibility of voluntary carbon offsetting schemes for aviation. Those authors acknowledged the possibility that air travel might become more expensive or even restricted in the future; they also discussed the substantial differences between the approaches used by organisations offering to offset the carbon emissions of flights. Those differences centred on the calculation of emissions, compensation measures chosen, price levels, company structures and evaluation processes (Gössling *et al.* 2007: 223). As a result of their analysis, the authors concluded that the subject of voluntary offsets for aviation is an increasingly contested issue, and that increased regulation is needed in this area.

While studies of offsetting and air transport are scarce in scholarly literature, offsetting has received considerable attention within the air transport industry as a strategy to assure stakeholders that the industry is taking action to mitigate its climate change impacts. For example, Jets.com, a jet charter company, and Carbonfund.org, a carbon solutions organisation in North America, have collaborated to create a Carbon Neutral Flights Programme through which Jets.com customers may offset the emissions created through their use of private jets, with offsets being achieved through reforestation programmes in North America (*Airline Industry Information*, 5 September 2007). Another example of an air transport offsetting scheme is Delta Air Lines' carbon offset program, which allows consumers to pay a contribution ($5.50 for domestic round-trip flights, $11 for international) to fund forestry projects. A similar scheme was launched by Eindhoven Airport in May 2007, although, three months later, only 0.5 per cent of all passengers had participated (Beirne 2007: 38). Air Canada has also introduced an offsetting programme, arranged through Zerofootprint, a not-for-profit organisation (*Airline Industry Information*, 29 May 2007). However, in contrast to these airlines, and due to concerns about the unregulated nature of offsetting schemes in general, EasyJet has opted to develop its own carbon offset programme using only UN-accredited carbon credits (*Maclean's*, 14 May 2007: 8). Hence offsetting schemes form an increasing part of the air transport industry's response to concerns about climate change, but these schemes are in their infancy and their uptake is subject to internal and external scrutiny.

2.7 Literature Review conclusion and recommendations

In this literature review, many issues associated with carbon offsetting schemes have been outlined and evaluated. The main areas of concern focus on the fact that offsets are not a sufficient measure to address climate change; they are beset by problems of accounting carbon costs and savings; they must demonstrate additionality; they are unregulated and sometimes inefficient; they may not be permanent; and they have mixed co-benefits. On the other hand, offsetting schemes represent a

pragmatic means to encourage action to limit the magnitude of climate change: they are relatively easily understood and they may be undertaken by many individuals and organisations. Analysis of the emerging literature leads to the following recommendations:

- Offsetting schemes should be transparent and rigorously monitored and audited at all levels; some organisations have adopted in-house offsetting programmes in an attempt to provide appropriate rigour.
- Offsetting funds should not be used to purchase (and retire) carbon credits from emissions trading schemes unless such a strategy will demonstrably lead to actual emissions reductions.
- Sequestration schemes have attracted particular criticism for their lack of permanence and for the difficulties in accounting their costs and benefits; hence emissions reductions schemes are preferable.
- Offset providers should seek to be accredited by an internationally recognised standard (such as the Gold Standard Foundation).
- Offsetting schemes should form part of an overall, integrated climate change policy that is focused primarily on reducing greenhouse gas emissions and that contributes to the overall transition to a low-carbon economy.

Given these caveats, offsetting represents an opportunity to achieve environmental gains in a manner that is practical and easily understood by business. As Bayon *et al.* (2007: 107) stated, offsetting has 'helped breathe new life into a global market in voluntary carbon emissions reductions that, one way or another, will play an important role in our efforts to stem climate change for years to come.'

3 Review of Carbon Offset Providers

Carbon offset providers enable organisations and individuals to indirectly reduce their carbon footprint by purchasing carbon credits that have been generated through projects that have reduced carbon emissions elsewhere e.g. renewable technology projects or energy efficiency projects (Carbon Trust 2006; DEFRA 2007b: 2). Although carbon markets are not a new phenomenon, the demand for such offset services has developed at an escalating rate in recent years: between 2005 and 2006 worldwide purchases of voluntary carbon offsets rose from 6 million tonnes of CO_2e ($MtCO_2e$) to 10 $MtCO_2e$ (Capoor & Ambrosi 2007: 20). Given the concerns raised in the previous section, this review aimed to fully describe the range of offset services provided on-line to air passengers.

The review did not aspire to establish which of the providers could be considered the best; no attempt was made to rank the performance of individual providers, rather this review describes where the market as a whole currently stands. At the end of 2007, there were over 40 offset companies with their services available via the internet[3]. This number continues to grow as more companies set up as online carbon offset providers. The review relates to 42 of those providers (see Appendix B) – focusing specifically upon the providers of aviation emissions offsets. Given the focus upon internet based providers any companies without a web presence have not been included; however, the nature of the market suggests it is unlikely that any aviation offset providers have been omitted.

[3] These offset providers are internationally based.

In order to complete the study within a realistic timeframe, the internet search for providers (as well as the cataloguing of information provided on their websites) took place in November 2007 and any new providers emerging after this date have not been included in this review. Thus, this study reflects the context at the end of 2007.

Before presenting the results of the review of the offset providers, it is important to clarify the offset process as a whole. From the perspective of air passengers there are essentially two core elements to the offset process (please see Figure 2). First, carbon emissions resulting from flights need to be calculated in order to establish the contribution to climate change made by individual passengers (i.e. the extent of carbon liability associated with a given flight). Second, actions have to be put in place to compensate for this carbon liability. These relate to carbon emissions reduction initiatives variously referred to as abatement projects, mitigation schemes, carbon reduction projects, etc. It is these carbon emission reduction projects that have received the greatest attention from the quality assurance perspective. Consequently, standards used to in the voluntary market by some providers include: the clean development mechanism (CDM) established by the UN under its Framework Convention on Climate Change; the Gold Standard established under the leadership of the WWF; the Voluntary Carbon Standard (VCS) published by the Climate Change Group in collaboration with the International Emissions Trading Association and the World Economic Forum Global Greenhouse Gas Register; and VER+ (Verified Emissions Reductions+) developed by TÜV SÜD, a designated operational entity for the validation and verification of CDM projects[4].

The efficiency (in terms of CO_2 saving per monetary unit invested) of these carbon saving actions is currently the primary determinant of the unit price for carbon (e.g. £/tonne CO_2). Determining the cost to offset a particular flight brings together the carbon liability with the unit cost of carbon savings; presenting offset customers with a monetary value to compensate for their flight emissions.

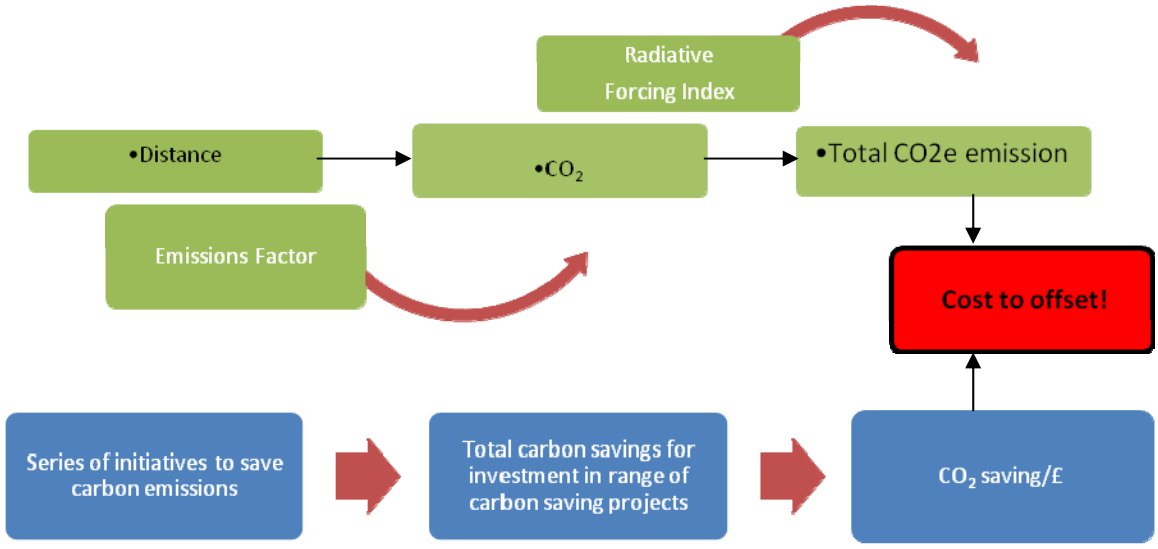

Figure 2: The carbon offset process for air passengers

[4] For a comprehensive review of carbon offset standards please see Kollmus, A., Zink, H. & Polycarp, C. 2008, *Making Sense of the Voluntary Carbon Market: A Comparison of Carbon Offset Standards*, WWF Germany

In order to structure comments on the range, nature and quality of offset provision, the review reflects the two elements of the offset process described above and the issues emerging from the literature review.

3.1 The Carbon Calculator

Carbon Calculators are central to carbon offsetting schemes as they ultimately determine the emissions a certain activity is deemed to produce and consequently the cost to offset the carbon emitted. As determined by the Tufts Climate Initiative (2007: 25), commercial carbon calculators "have to fulfil three requirements: they have to educate the consumer, be user friendly and accurate"; and above all the calculators need to be as transparent as possible. The calculations used in carbon calculators can be highly complex and can vary significantly between providers. At the most rudimentary (and most commonly used) level, aviation calculators estimate emissions based upon limited factors, for example:

Distance travelled x an emissions factor = carbon emitted

and often these distances may be banded; whilst more complex calculators offering more accurate estimates of emissions have to consider "the type of aircraft used by the traveller, its fuel use, occupancy rate, route, cruising altitude, the time of day flown and even particular weather conditions" (Gössling *et al.* 2007: 234). With most of the carbon calculators, there is usually a commonality and consistency with distance; however after that step, more inconsistencies and uncertainties are encountered within the calculations e.g. with respect to the use of a Radiative Forcing Index (RFI).

To obtain a more comprehensive view of the different outcomes arising from the various approaches to carbon emission calculations, two sample destinations were used:

1. *Short-haul: London, Heathrow – Paris, Charles de Gaulle*

2. *Long-haul: London, Heathrow – Sydney, Kingsford-Smith*

The calculators of the different providers could then be compared for their results on the flight distance they provided and outcome of emissions calculations[5] (see section 3.2 for the implications for the cost to offset these sample flights). In addition, the number of calculators that provided evidence of the inclusion (or deliberate omissions) of an RFI (and if so the value), occupancy efficiency, and class of passenger were also noted.

3.1.1 Distance

Flight distance is important when determining emissions as, aside from the fact that more emissions are produced on longer journeys, a disproportionate amount of fuel is used during take-off (when the engine is at high thrust) meaning that long-haul flights are often more energy efficient than short-haul flights as they use up less fuel per passenger mile on average than short-haul flights (RCEP 2002: 23 - 24). For the aviation calculator we should assume that all the providers use distance in their calculations, however not all of the providers show the distance that they have used. For example, the carbon calculators of some 8 providers (out of the 31 (short-haul) and 29 (long-haul)

[5] A few of the providers were not included in sample analysis presented here where: no carbon calculator was available; the calculator did provide for the input of any flight specific data; and where the calculator did not provide for the input of details on the sample flights.

providers with a calculator able to calculate emissions for the sample flights) only indicated the amount of carbon the journey produces but not the distance. This raises questions about the accuracy and transparency of the calculator; these offset providers may well calculate a distance that is similar to others but if the consumer is not being told the distance used for their offset then they may be vulnerable to overpaying (or indeed underpaying) for their particular flight. This could potentially lead to credibility issues for the particular offset provider, as well as increasing mistrust in the market.

When the distance calculated by all the providers was examined, it became clear that most providers use the great circle distance (GCD) formula only to determine length of flight path[6]. For example the GCD from London Heathrow to Paris (CDG), provided by Air Routing International, is 346 km and 19 out of the 24 providers from which a calculated distance was available were within ±5 km of this GCD. Similarly, for the long-haul flight from London to Sydney the GCD is 17009 and 18 out of 22 providers gave flight path lengths within ±30 km of this distance. With one exception all other providers gave distances in excess of the GCD (longest flight paths for trips to Paris was 406 km and to Sydney was 17120 m) which can be explained by providers, such as **atmosfair**, adding to distances to account for air traffic management factors (e.g. planned deviations from most direct route, holding patterns, etc.) (atmosfair 2008: 10).

Overall, therefore a reasonably consistent pattern is evident; however, not all of the sites provide comprehensive details on how distances are arrived at. This could add to mistrust of the providers even where only small differences in calculated flight path lengths are apparent.

3.1.2 Use of RFI

Offsetting involves compensating for the greenhouse gas emissions produced by one activity with an equivalent carbon dioxide saving elsewhere (DEFRA 2007b: 2). Such an approach is feasible only because CO_2 has a long atmospheric residence time and is relatively evenly mixed in the atmosphere at the global scale. However, aviation also emits other GHGs including nitrogen oxide (NO_x), nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur oxides (SO_x), unburned hydrocarbons (HC) and smoke (ICAO 2007). Additionally, when water is emitted in the stratosphere, it can cause the formation of ice clouds known as contrails and contrail-cirrus, which can contribute even further to warming by reducing the amount of radiation from the earth's surface escaping back into space (Tufts Climate Initiative 2007).

To account for the climatic impacts of these additional gases, it has been argued by many that there is a requirement for a metric to be added to the carbon calculations – known as the radiative forcing index (RFI). The RFI accounts for the historic impact of non-CO_2 emissions and relates this to the radiative forcing of CO_2 emissions from the same activity. This enables all climate change emissions to be bundled together as a CO_2e (equivalent) total. In 1999 IPCC estimated the RFI for the world aviation fleet of 1992 to be 2.7 (with a range of 1.9 to 4.0), whereas more recently Sausen *et al.* (2005) estimated the RFI associated with the air fleet in 2000 to be 1.9 (taking into account improved understanding of the radiative forcing associated with contrails).

The use of an RFI as a climate metric within carbon calculators is a much debated aspect of aviation carbon offsetting. When aviation emissions are calculated, including a RFI value into the equations is often considered to be more accurate as, as discussed above, unlike many other sectors, CO_2 is not

[6] The great circle distance is the distance between the origin and destination of two points, for example two airports, derived from the latitude and longitude co-ordinates. It is essentially the shortest path between two points on the surface of a sphere (ICAO 2008a).

the only output that has climate changing effects. 19 out of the 42 offset providers stated explicitly that they use an RFI figure within their emissions calculations. Seven of those providers using an RFI used the value assigned by the IPCC in 1999 of 2.7, ten used a figure of 1.9 or 2 in line with the Sausen *et al.* (2005) paper, **atmosfair** uses a RFI of 3, and **The Better World Club with LiveNeutral** included an RFI within its calculator but did not state what value it used. Of those offset providers who did not use an RFI within their calculations, 5 of the providers specifically stated why they had omitted an RFI from their calculations. Reasons for not using an RFI in the calculations included:

Virgin Blue: *"…current level of uncertainty surrounding the magnitude of their impact"*

TerraPass: *"…no consensus yet exists"*

Pure Trust: *"…science is so uncertain and hence controversial"*

To include an RFI multiplier within a standardised calculator is problematic. Those applying the precautionary principle argue that *some* additional factor should be used in order to make allowance for the additional (non-CO_2) climate impacts of aviation, even if those impacts have not been precisely quantified. On the other hand, others are uncomfortable with the principle of using a multiplier to determine a level of financial liability given the extent of scientific uncertainty surrounding the concept.

In theory, as stated by Gössling *et al.* (2007: 235), "the use of different RFI standards heavily influences the calculation of the amount of CO_2-e generated by a given flight". However, they go on to acknowledge that there does not appear to be a correlation between the use of an RFI and the differences in emissions calculated between providers, nor the cost of offset. It appears when looking at our results that they confirm the Gössling *et al* (2007) findings. To take two examples[7], offset provider **A** who use a RFI of 3 calculate emissions of the sample flight from London Heathrow to Paris Charles de Gaulle at 0.07 tonnes, whereas offset provider **B** who do not use an RFI in their calculations arrive at a total of 0.1 tCO_2. Thus, it seems likely that the effect of using an RFI in certain schemes may be obscured by other differences in the carbon calculators. At present it would appear that the best situation would be for offset organisations to provide information on the use of an RFI and the concerns surrounding it, and then to have an option of including it within the calculators, at the consumers discretion. This should satisfy those who feel that the precautionary stance should be taken, whilst allaying the concerns of those opposed to the use of RFI as the metric or to any given multiplier.

3.1.3 Occupancy Efficiency

When a plane is at full occupancy then it flies at maximum payload efficiency, and thus burns less fuel per passenger km than a flight that is not full (Tufts Climate Initiative 2007). Thus, to consider a load factor in the emissions calculations adds another level to the sophistication to the model. **atmosfair** (2008: 8) address occupancy efficiency by applying a common average of 80% efficiency for charter flights, and for scheduled flights an efficiency of between 60 – 75% dependent upon the flight region (75% when flight type is unknown). As of 2007, only 5 of the studied providers state that they include occupancy efficiency within the calculations: **Air France with Action Carbone**, **atmosfair**, **Climat Mundi**, **Offsetters** and **Uncook the Planet**. Other providers claiming to utilise the emission factors made available by DEFRA will be incorporating an average fleet load factor; however, this is not always acknowledged in the explanation accompanying the emissions calculator.

[7] For these examples, the offset providers' names have been kept confidential.

3.1.4 Class Type

Some of the providers give the consumer the option to choose the class of seat that they are to travel in – economy, business or first class. As the seats in business and first class take up more room than the economy seats and associated passenger services and baggage allowances account for more weight, then passengers travelling in these classes are in effect responsible for more emissions (Tufts Climate Initiative 2007) as they have reduced the overall occupancy capacity of the plane and thus created a higher overall fuel burn per seat. **atmosfair** (2008: 8) proclaim that "in an extreme case a Business seat can require more space than two Economy seats". Whilst, as Tufts Climate Initiative (2007) declare, "research has shown that first class travel on long-haul flights could have an impact 6 times as large as an economy traveller", only 5 of the offset providers evaluated include the class type into their emissions calculations. Significantly, in the recent update to the emission factors produced by DEFRA for use in corporate emission inventories and offset calculators, the range has been extended to include factors for all seating classes (see DEFRA 2008a).

Using the same sample journeys, the difference in the cost to offset an economy seat and a business or first class seat can be illustrated – see Table 1.

Offset Provider[8]	**Cost of offsetting for sample short-haul journey:**					
	Economy		**Business Class**		**First Class**	
	CO_2 Emissions	***Cost***	**CO_2 Emissions**	***Cost***	**CO_2 Emissions**	***Cost***
A	0.07 tonnes	*£4.29*	0.10 tonnes	*£4.29*	n/a	*n/a*
B	0.20 tonnes	*£9.84*	0.30 tonnes	*£9.84*	0.50 tonnes	*£9.84*
C	0.14 tonnes	*£0.99*	0.28 tonnes	*£1.98*	0.42 tonnes	*£2.97*
D	0.10 tonnes	*£1.39*	0.23 tonnes	*£3.13*	0.23 tonnes	*£3.13*
E	0.11 tonnes	*£1.00*	0.16 tonnes	*£2.00*	0.26 tonnes	*£4.00*

Table 1: Difference in cost when offsetting Economy, Business, or First Class for sample journey of London, Heathrow to Paris, Charles de Gaulle

The above table demonstrates how the consequence of offsetting different flight class differs from provider to provider. For example, offset provider **B** calculates that the difference between emissions for economy and business, and business and first class is 0.10 tonnes and 0.20 tonnes respectively, yet it does not charge extra to offset the first class seat despite the fact it is claimed to generate 0.30 tonnes of CO_2 more than the economy class seat. Offset providers **C, D,** and **E**, however, all charge a higher offset cost for the business and first class flights; although this is not always in proportion to the calculated increases in emissions. Whilst the obvious advantage of charging extra for the business and first classes is that their higher emissions are accounted for, it could be argued that there is an additional advantage in that it educates the public about the difference in emissions between the classes on a plane. For the short- haul flights given above, the

[8] Due to the sensitive nature of the figures, the offset providers' names have been kept confidential.

difference in offset cost is fairly minimal but if it were to be a considerable increase, it may encourage consumers to think twice about their chosen class of travel. For providers such as offset provider **B**, who do not charge any extra cost to the premium classes, there appears to be no other reason for them to include it in their calculator, other than to educate customers as to the significance of emissions outputs associated with different class of seat.

As this review of the potential elements in carbon calculators has demonstrated, there is considerable variability in application of different emission factors to the calculated flight distances to arrive at total emissions for our sample flights. The outcome for the two flights is summarised on the two frequency graphs presented in Figures 3 and 4.

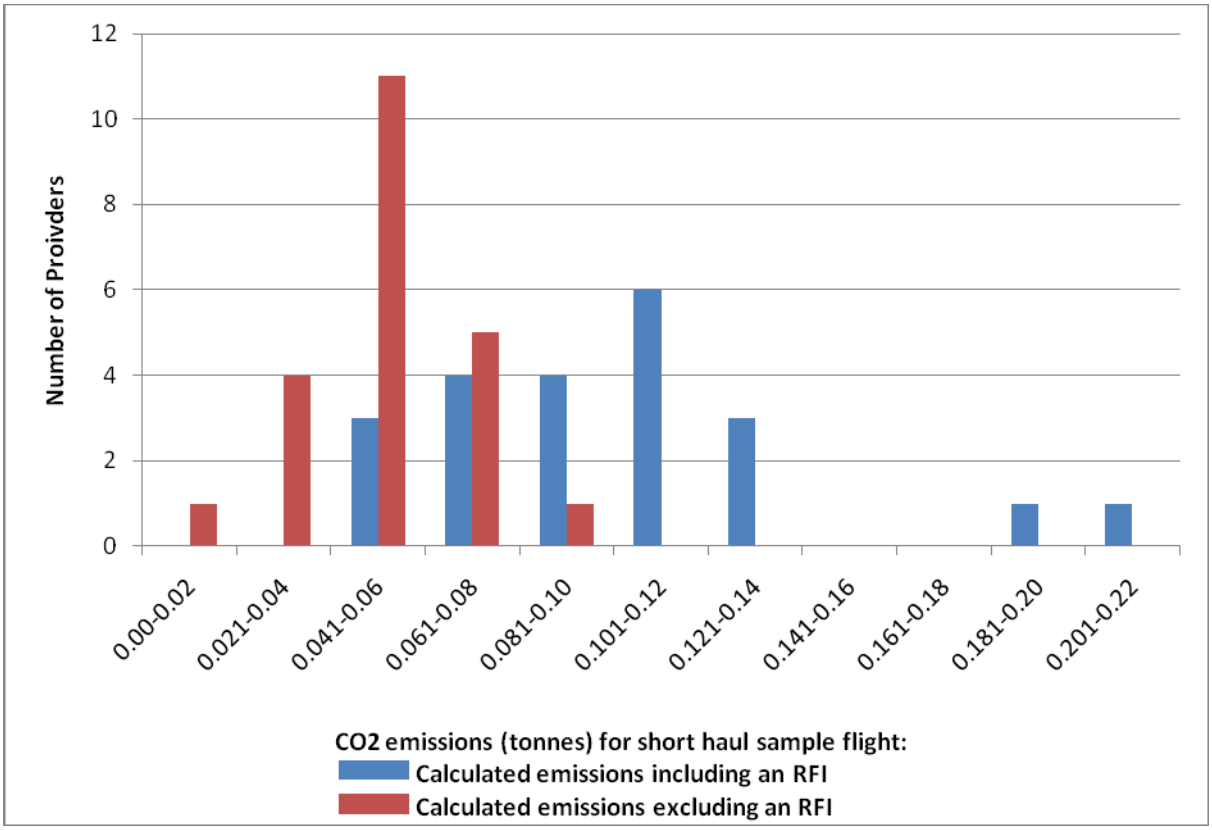

Figure 3: Range of emissions calculated by offset providers for short-haul sample flight of London, Heathrow to Paris, Charles de Gaulle[9]

Examining the profile of the climate change emissions for the flight to Paris reveals that the majority of providers (11 out of 22 companies able to calculate for this sample flight) give totals that fall into the range 0.04-0.06 tonnes for CO_2 only. This is comparable to the 0.055 tonnes of CO_2 that the calculators provided by DEFRA[10] (without incorporating the 9% increase to path length – or uplift - recommended by the Department to take into account ATM induced modifications to the most

[9] In Figures 3 and 4, in order to establish differences in the output of carbon calculators the influence of RFI was factored out of this sample. This was only possible for the subset of providers (22 organisations for the short-haul and 17 for the long-haul flights) that (a) were able to calculate emissions for the sample flight and (b) made explicit reference to the RFI value used in their calculator.

[10] Note the emission factor used here is that for domestic flights (less than 400 km) as identified in the 2007 guide for emissions inventory calculations – the 2008 updated figures have not been used as they were released after the survey of providers was completed and companies claiming to use the DEFRA figures would have been using the 2007 version.

direct route) and ICAO produce[11]. However, there still exists a considerable spectrum in the emissions totals for the whole group, with outputs ranging from 0.02 to 0.1 tonnes of CO_2. As might be expected the range of emissions extends when all emission values with and without RFIs are compared (see Figure 3). However, as previously noted there is no consistent pattern here as the CO_2e total of the company applying the highest RFI of 3 is 'only' 0.07 tonnes.

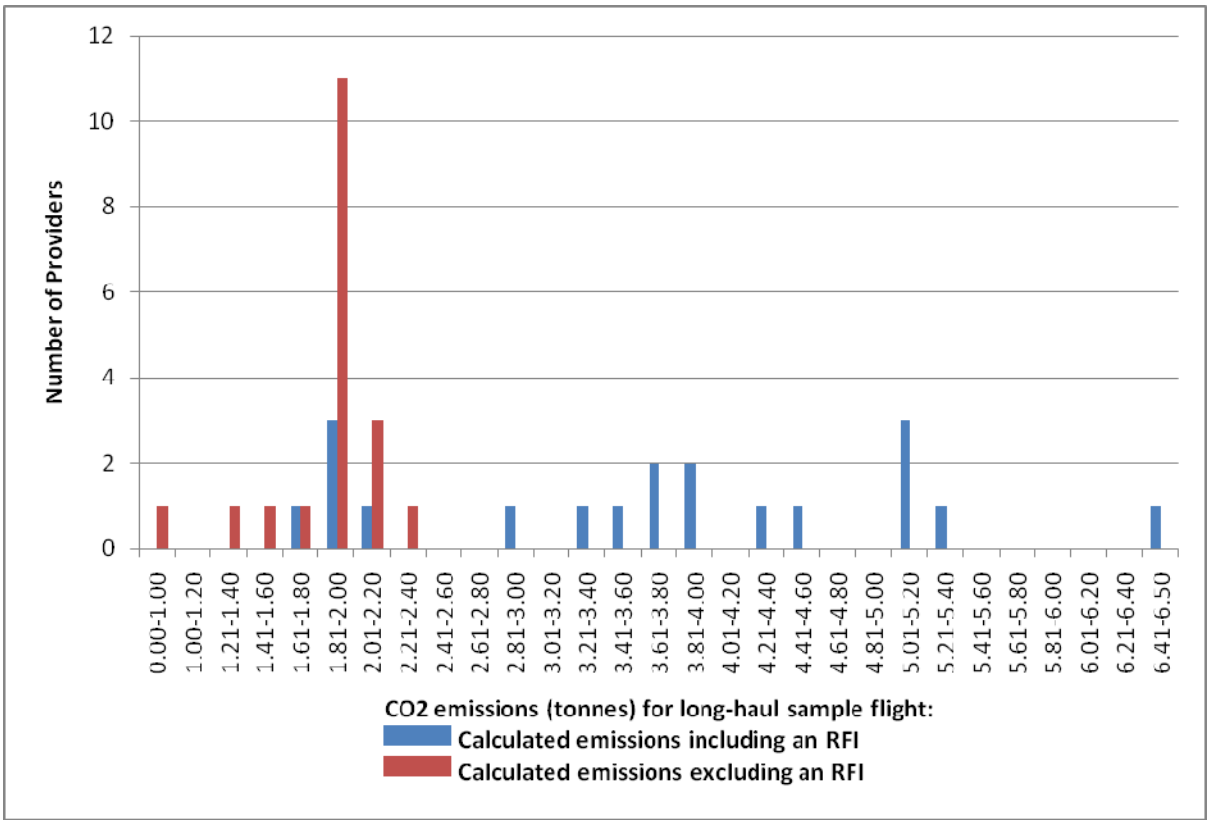

Figure 4: Range of emissions calculated by offset providers for long-haul sample flight of London, Heathrow to Sydney, Kingsford-Smith

The profile of CO_2 emissions calculated for the flight to Sydney reveals that the majority of providers (11 out of 17 companies able to calculate for this sample flight) give a total that falls into the 1.80-2.01 tonnes of CO_2 range. Again this is comparable to the 1.80 tonnes of CO_2 calculated using GCD and the DEFRA emission factor for long-haul (without incorporating the 9% uplift); however, it is somewhat higher than the 1.43 tonnes CO_2 from the ICAO carbon emissions calculator. The spectrum of emissions totals for the group as a whole ranges from 0.96 to 3.76 tonnes of CO_2. As with Figure 3, the range of emissions changes when all calculator outputs are viewed (with and without RFI). However, again there is no consistent pattern here as the CO_2e total of the company applying the highest RFI of 3 is 2.15 tonnes, which falls some way short of the highest emissions total of 6.99 tonnes.

[11] ICAO published a methodology for a carbon calculator in 2008 to be used for measuring the carbon emissions generated from flights (available at http://www2.icao.int). The calculator uses the great circle distance (plus a correction factor for uplift: Less than 550km = +50km; 550km – 5500km = +100km; more than 5500km = +125km) and considers aircraft types, routes, passenger loads and cargo carried within its calculations (ICAO 2008a). ICAO has recommended that the calculator is used by airlines for use within offsetting programmes, with the goal to streamline the calculators used in the carbon market to increase consistency (ICAO 2008b).

Overall, therefore, whilst there may be entirely reasonable justifications for the range of emissions calculated, a customer not aware of the sophistication of the model being applied, who is presented with little or no explanation of the calculator, could reasonably become very suspicious of the different emissions totals presented by different offset providers. This in turn could quickly lead to mistrust of the market. The need for a standardised emissions calculator is therefore clear, and the steps made by DEFRA and ICAO in this respect are to be welcomed. However, as indicated above even these calculators show some discrepancies for long-haul journeys; with the DEFRA method resulting in an emissions total for CO_2 over 20% higher – over 30% higher if uplift is taken into account - than the ICAO calculator. This example has used the DEFRA emission factors from 2007 for the reasons outlined earlier; but differences between the calculators are evident even where the 2008 updated emission factors as used as illustrated in the Table 2.

Calculator	**Emission Factor (gCO_2/pkm)**	**Total Emissions for sample flight to Sydney (tCO_2)**
ICAO (for economy seat)	Variable*	1.43
DEFRA long-haul average (Option 1)[12]	81.5	1.39(1.51)
DEFRA long-haul economy (Option 1)	59.5	1.01 (1.10)**
DEFRA long-haul average (Option 2)	100.9	1.71 (1.87)
DEFRA long-haul economy (Option 2)	73.7	1.25 (1.37)

*ICAO use a variable CO_2 per passenger figure dependent upon specific data for city-pair identified by the user. The latter influence aircraft types and load factors used in calculating emissions.
**Figures in parentheses indicate total CO_2 emissions where the DEFRA recommended uplift factor of 9% on flight distance has been applied.

Table 2: A comparison of DEFRA and ICAO CO_2 emissions results for a flight from London, Heathrow to Sydney, Kingsford-Smith

Thus, even where the more sophisticated range of DEFRA emission factors are applied to the sample flight to Sydney, no total emissions result agrees with the total ICAO calculated for an economy flight. This is not to suggest that the reasoning underpinning either the ICAO or DEFRA calculators is unsound; rather these differences serve to illustrate the complexity of the activity being modelled and the influence of different assumptions on the manipulation of identical core data[13]. Entirely legitimate variations in the use of the core data can result from decisions regarding:

- Appropriate load factors
- The suite of sample aircraft used to compose the operating fleet

[12] The update to DEFRA's emission factors for air transport attempts to account for freight carried on passenger aircraft. This is done in two ways: Option 1 uses the CAA tkm split between passengers and freight directly to apportion CO_2 between passengers and freight; and Option 2 modifies this ratio in recognition of the fact that Option 1 results in emissions for freight that are significantly higher than for dedicated cargo services using similar aircraft. In other words by taking into account the additional weight of equipment specific to passenger services (e.g. seat, galleys, etc) Option 2 allocates a greater proportion of the CO_2 liability to passengers, resulting in a greater CO_2 emission factor – see DEFRA 2008a: 7.

[13] Both ICAO and DEFRA calculators derive their emissions for flights and per passenger emission factors from the aircraft specific fuel consumption/emission factors defined in the AEIG (2006) *EMEP/CORINAIR Atmospheric Emissions Inventory Guidebook*, available at the EEA website http://reports.eea.europa.eu/EMEPCORINAIR4/en/B851vs2.4.pdf.

- Variations in fleet mixes used to reflect domestic, short-haul and long-haul operations
- Application of an uplift factor
- How to account for freight carried on passenger flights
- Average seating configurations
- The allocation of carbon liabilities between different seating classes

Until agreement over the influence of such variables is achieved attempts to encourage offset providers to adopt a common standardised emissions calculator will be undermined and customers will continue to be faced with considerable variation in the emission results from different providers. It is worth highlighting that, in order to achieve agreement over a standard emissions calculator; sophistication may have to be sacrificed for ease of use and greater transparency of the underpinning rationale. Until this is achieved, inconsistencies will perpetuate concerns over the credibility of the sector and inhibit attempts to expand the uptake of offset services for aviation.

3.2 The cost of to offset

Analysis of the literature on offsetting suggests that there are a number of approaches to determining the cost to offset climate change emissions, these include (DEFRA 2007a: 1):

1. the social cost of carbon (the full global cost today of an incremental unit of carbon emitted now; the global cost of the damage it imposes over the whole of its lifetime);
2. the abatement cost (i.e. the cost of a particular carbon saving project); and
3. the market price of carbon (where carbon credits are being purchased).

In the case of commercial offset providers is would seem that a combination of options 2 and 3 is the most logical choice given that it reflects (when administration costs are included) the real costs of delivering carbon savings.

3.2.1 Cost and quality of carbon saving projects

Some of the most critical concerns surrounding carbon offsetting originate from the carbon abatement/saving projects themselves. A number of these have already been documented, notably that many schemes have used small scale projects (e.g. introducing the treadle pump) creating emissions savings which are difficult to quantify, schemes that rely on inaccurate or overestimated savings, projects that are inefficient or are not permanent, and projects that may be prone to leakage or have mixed co-benefits.

Project location is an important aspect of carbon offsetting for a variety of reasons. Those factors that favour locating projects in developing countries include (Tufts Climate Initiative 2007; Hanson, 2004 in Tufts Climate Initiative 2007):

- Optimised cost effectiveness due to relatively low wage economies
- The opportunity for developing countries to benefit from inward investment in new technologies and more sustainable practices
- The fulfilment of a ‘moral obligation’ owed to developing countries that are suffering the climate change consequences of actions primarily undertaken in the developed world (p.20)

Alternatively, reasons for locating offset projects in developed countries include (Tufts Climate Initiative 2007):

- The expectation that, as the majority of offset customers are based in the developed world, more local opportunities to compensate for the climate effects would support the domestic economy and may enhance participation in the service
- The higher carbon intensities of the economies and life styles prevalent in developing countries would benefit most from offset efforts
- More effective monitoring and auditing of projects will take place if they are based in the developed world
- As many projects are of an experimental nature, where they fail the effects will be less severe in developed countries

Hence, the choice of where a project is located is not a straightforward one. From the providers reviewed here the countries that host most projects are, in order of popularity: India, the US, UK and China. In total the offset providers have projects in 37 different countries. Approximately a third of the offset providers have projects based in more than one country, with **Climate Neutral Group** having projects in 10 different countries.

There are serious issues regarding certain types of projects that could have a considerable influence upon the overall quality and costs of the offset. There has been significant debate over the effectiveness of some offset projects, especially sequestration projects (often described as Land Use, Land Use Change and Forestry – known as LULUCF). The issues regarding forestry projects are of particular importance as 23 of the providers reviewed have sequestration projects as part of their package and a quarter of providers use forestry projects as their only form of offset. The use of LULUCF is attractive to offset organisations as the projects often face lower financial and bureaucratic barriers, and are often considered as having an additional value for biodiversity and local communities (Hamilton *et al.* 2007: 27). However, many academics have queried the quality of LULUCF projects in relation to the permanence of emissions sequestered, leakage, the implications for selling future emissions reductions, and also the argument that it detracts from the attempts to address the carbon intensity of current activities.

Permanence is a vital issue with carbon offset projects as not only do most consumers buy offsets thinking that they are making a long lasting contribution, but also they put their faith in the provider to ensure that their offset contribution was not given in vain (if they buy offsets from a company selling forestry projects they do not expect the forest to be cut down and their offset essentially reversed, unless they have been informed about the possibility of this occurring). The significance of the issue of permanence has been acknowledged in the draft Code of Best Practice for Carbon offset Provides issued by DEFRA in February 2008. Here reference is made to tCERS (temporary carbon emissions reductions) and lCERS (long-term carbon emissions reductions) forestry projects (p. 12). Temporary savings must be renewed or replaced after five years when they expire, to ensure that carbon reductions are maintained.

Likewise, leakage is a problematic area for carbon offset projects. Leakage occurs when the process of offsetting in one area leads to increased emissions from another area (Bayon *et al.* 2007: 21). Again this can be a problem more associated to LULUCF projects.

Some of the providers' websites address these issues, but a large proportion of the providers do not mention the issues at all. Providers such as **Climate Planet** and **Climate Care** who provide consumers with background information about carbon sequestration projects, with reference to its pros and cons, help to improve credibility by enabling the consumer to make an informed decision

about the offset they are buying. However, those that do not mention these issues leave themselves open to criticism and also fail to educate the consumers effectively about all aspects of carbon offsetting.

The timing of offset sales relative to the project is also an important issue when looking at project type. There are two types of projects:

1. Ex-ante – Where offsets are sold before they have been achieved.
2. Ex-post – Where offsets are sold after the emissions reduction have occurred.

Although ex-ante is more risky form of offsetting, it is often used as the costs are lower (Bayon *et al.* 2007: 22) which can prove to be an incentive to consumers and also, in many cases, provides the initial funding for the project itself (Clean Air-Cool Planet 2006: 6). However, selling future emissions reductions can be considered risky as there is the potential for the projects to fail and the offsets to never occur (ibid.).

Another interesting aspect of the offset projects is whether or not the consumer has a choice about which particular projects their money goes towards. Of the 42 offset providers reviewed, 32 did not allow the consumers to choose which projects to support. In some cases, the website provided an explanation as to why they could not choose; but on the whole there was no reference to the lack of choice. Choice of offset project, as with location, may prove to be important to the consumer when they are deciding whether or not to enter an offset scheme. For example, if the only scheme available to them is a sequestration project and they have heard only damning reports then they may be dubious about using the provider and offsetting schemes as a whole.

One way through this mine-field of issues associated with carbon reduction projects is to seek verification from third parties as to the legitimacy of the savings made. As already noted a number of such schemes exist (see introduction to Section 3 and the WWF 2007 evaluation). However, it should be recognised that rate of return on a particular carbon saving initiative can vary with the level of assurance (e.g. CDM Certified Emissions Reductions (CERs) projects can be more expensive to purchase than Verified Emissions Reductions (VERs) due to the more rigorous nature of the monitoring and accountancy regime associated with this form of verification - DEFRA 2007b: 20). Nevertheless, whilst DEFRA states that it 'does not set standards for the actual projects or technologies used to offset' (p.12) it will only accredit providers that sell Kyoto compliant credits from the regulated market (e.g. CERs, European Union Allowances and Emissions Reduction Units)

3.2.2 Cost to offset sample flights[14]

Given the range of issues influencing the quality and efficiency of carbon emissions reductions efforts, it is hardly surprising that the unit cost of carbon varies considerably from £2.00/tCO_2e to £18.00/tCO_2 across the providers reviewed (see Figure 5). This in turn results in the wide variation in the cost to offset the sample flights as illustrated in Figures 6 and 7.

[14] It should be noted that these prices were as quoted on websites in November-December 2007 (currencies were converted using the online Universal Currency Converter provided by XE.com, available at http://www.xe.com/ucc) and may not represent offset prices currently calculated by the same providers today.

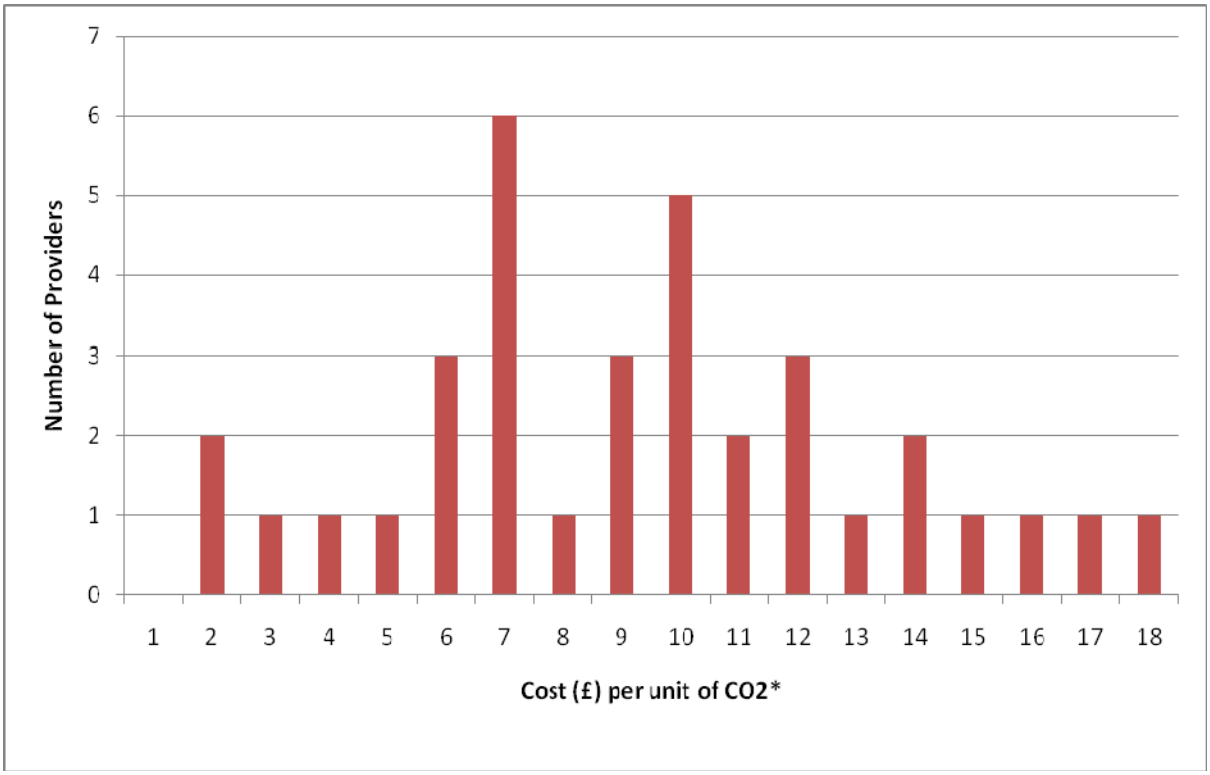

Figure 5: Cost per unit of CO2
*Of those who provide the information on their websites, and rounded to the nearest pound.

For the short-haul flight from London Heathrow to Paris Charles de Gaulle, there was a variation in cost of between £0.31 and £12.95; with just less than half of the sample (15 out of 32 providers) falling into the price range of £1 ± 50p. Although small in absolute terms, this range clearly represents a considerable proportion of the total cost. For the long-haul sample flight to Sydney Kingsford Smith the price range extended from nearly £9.48 to £643.39; with more than a third of providers (20 out of 29) falling into the £30 ± £10 range. Again this represents a large spectrum; although the proportional spread for the majority of providers is somewhat narrower than for the short-haul flight.

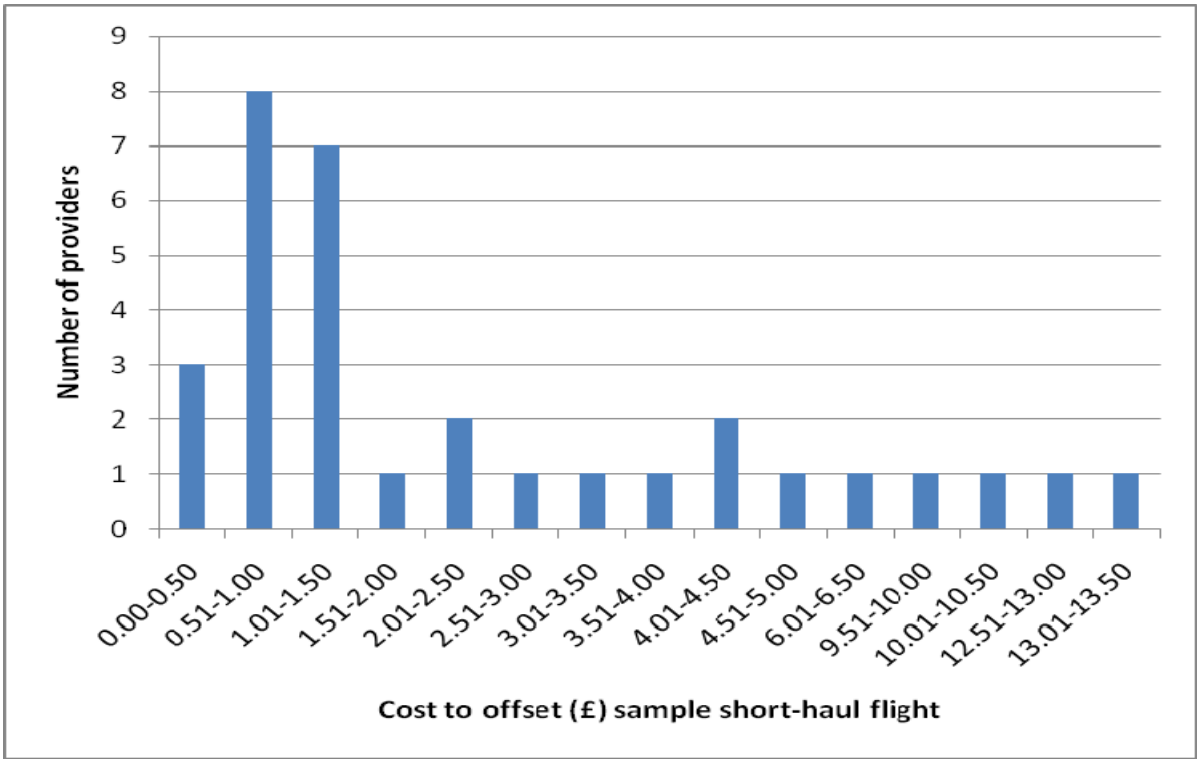

Figure 6: Frequency distribution of cost to offset short-haul sample flight of London, Heathrow to Paris, Charles de Gaulle

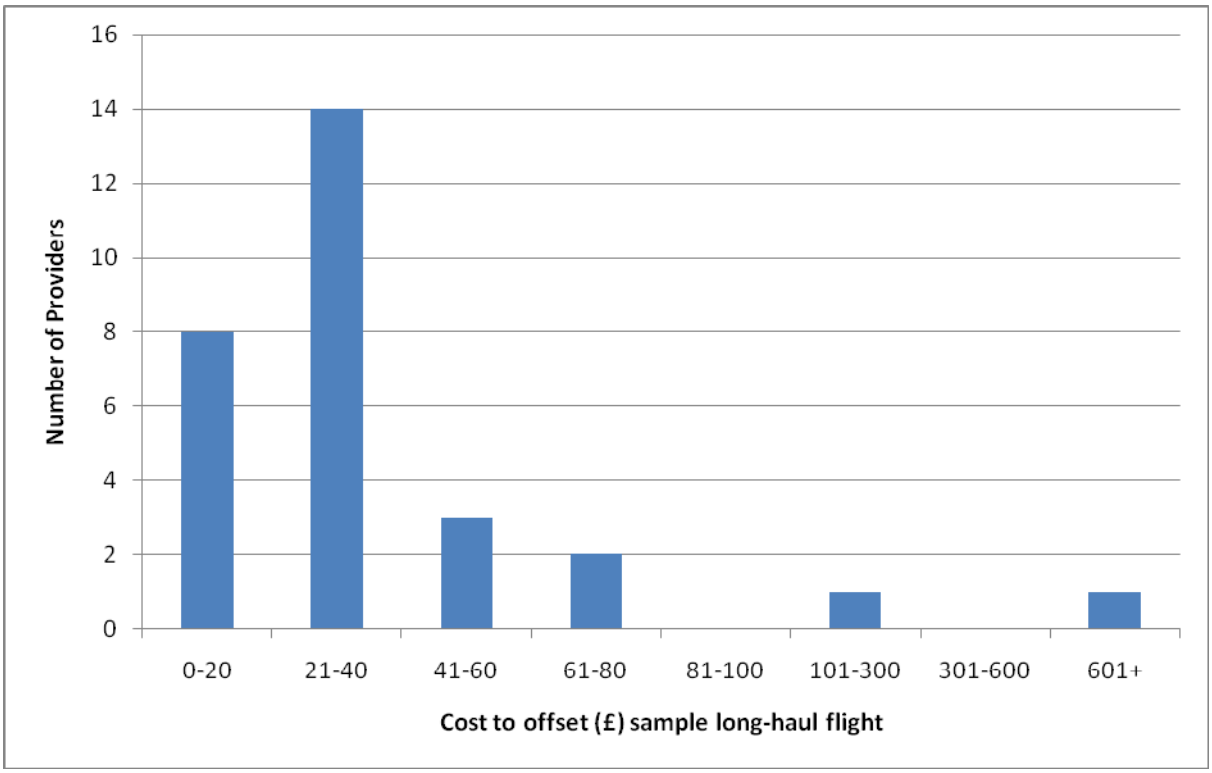

Figure 7: Frequency distribution of cost to offset long-haul sample flight of London, Heathrow to Sydney, Kingsford-Smith

As has been noted, one explanation for this variation in price may be related to the type of project a provider is using to offset. However, if we look at this in further detail we can see that, for the long-

haul sample flight, the five most expensive offsets and the five cheapest offsets all use a similar variety of project types including forestry, energy efficiency, and renewable energy schemes. Furthermore, there is also a difference in cost between providers who offset in the same way. For example **Conservation International** offset one tCO_2 at approximately £6.00, whilst **Carbon Balanced (World Land Trust)** price the offset of one tCO_2 at £15.00. Both of the providers offset through forestry projects, and on an international basis, yet differ quite considerably in their cost of carbon. Thus, from the offset providers reviewed, project type does not appear to be the primary determinant of the cost to offset.

With such a variety in offset costs, and no obvious reason why this should be so, the need for greater transparency could not be clearer; particularly with respect to other contributions to the price of offset. These could include administration costs and mark-up (offset providers include both profit and not-for-profit companies, as well as charities). The significance of these costs is revealed in the proportion of fund allocation given by some of the providers; in our sample this varied from 54-100% (see Figure 8) and would therefore appear to be a key determinant of unit price.

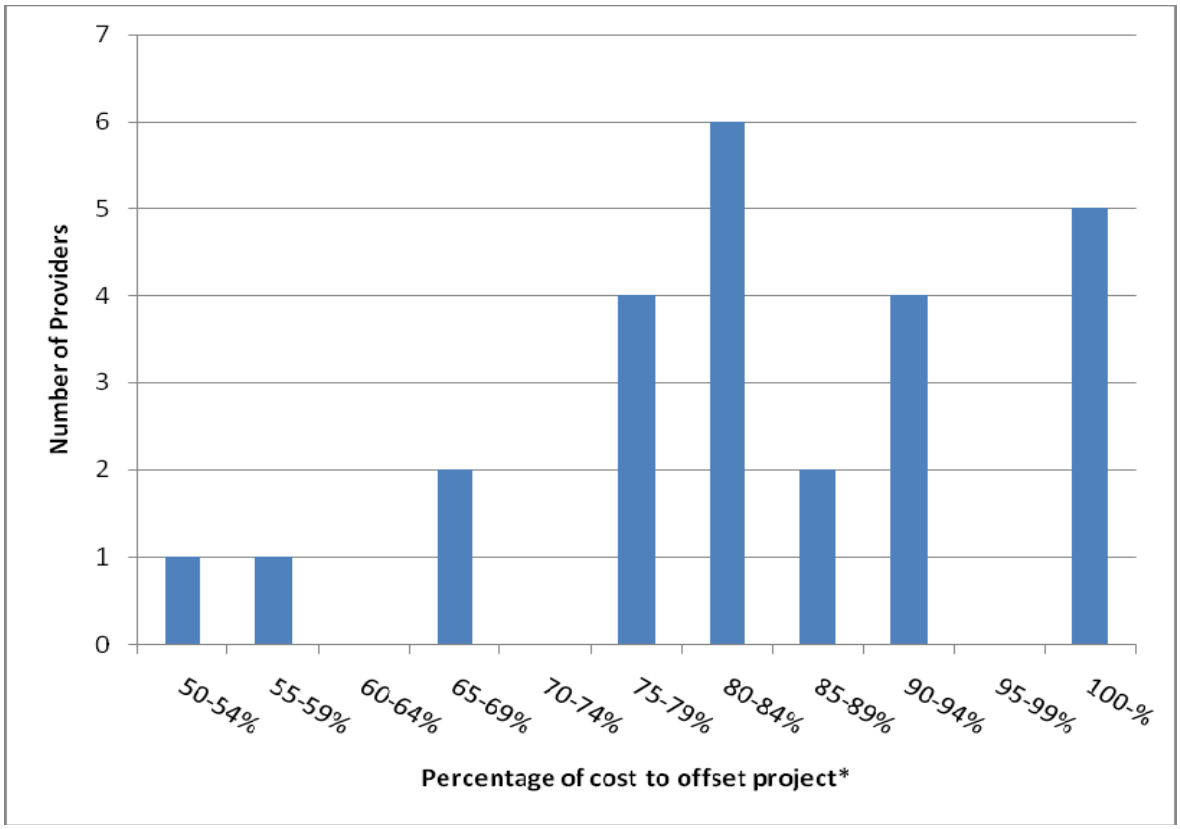

Figure 8: Percentage of cost going directly to the offset project
*Of those who provided the information on their websites

Despite the comments made by DEFRA regarding the influence of enhanced project assurance on cost, it is also argued by some that there is no correlation between the cost to offset and the overall quality of the carbon saving projects. Clean Air-Cool Planet (2006: 13-14) state that 'One can develop and procure offsets that are quite inexpensive yet credible' and further affirm 'consumers should think first about the quality of the offset they are purchasing'.

One way of concentrating the focus on the quality of offset services would be to establish a standard price for carbon. Analysis of the offset literature suggests that deriving a valid cost for one tonne of carbon is not straightforward and it also must be highlighted that the lack of a regulated market only

adds to inconsistencies. The cost of the commodity is an important issue in any market, and is especially so for a carbon market. Stern (2007) states that 'a broadly similar global carbon price is an urgent challenge for international collective action', and creating a standard price for carbon would reduce or 'eliminate the asymmetry between early and late joiners [or between offset providers]'. In essence, it would help regulate the offset providers (aligning them with one-another) by helping to remove inefficient carbon emissions reductions from the market along with any fraudulent providers.

3.3 Transparency

Given the range of influences on offset services highlighted to this point, it is hard to over-emphasise the importance of transparency to the credibility of the market. Ideally, customers should be able to understand every important aspect of what they are buying into from the calculation of a carbon liability to allocation of their donation to a particular carbon saving initiative. Correspondingly, the review examined the websites of the offset organisations for the information they provided on a range of key service issues[15].

3.3.1 Provider history

Access to a brief history enables the consumer to get an overall feel for the provider's 'ethos', as well as detail on the track-record of the organisation. Of the 42 providers reviewed, only 7 made a concerted effort to supply the consumers with their history. An example of good practice here is **TerraPass** who help build customer confidence by describing how and why the company was started and their future goals.

3.3.2 Progress/annual report

Consumers should have access to the companies' progress or annual reports so that they can be sure that they are buying from a reputable organisation and also establish how the company has performed in the past. This to a certain extent ties in with providing a company history and creating a transparent business. **Carbon Balanced (World Land Trust)** is a good example here as they have made their most recent annual report easily accessible on their website and even explained why it is important in terms of transparency to provide access to audited company records. In total only 9 of the offset providers in this study made available annual reports on their websites.

3.3.3 Project selection

It is important that offset providers demonstrate how and why they chose their emissions reductions initiatives. By giving a detailed explanation of their selection process providers can assure customers of the quality of their offsets. 19 of the providers gave details of the rationale behind project selection. For example, **Climat Mundi** explains that:

> *'In order for us to select a project for funding, it must meet a strict set of criteria guaranteeing that reductions in CO_2 emissions are additional, measurable, permanent, and do not generate leakage'*.

They go on to explain each criterion in turn. This demonstration of project selection increases the transparency of the company and also assists in educating the consumer to some of the complex issues surrounding carbon offsetting projects.

[15] The criteria for comparison were taken from Clean Air-Cool Planet (2006: 9).

3.3.4 Monitoring

Credible monitoring is needed to verify that a offset provider is actually reducing the emissions that it claims (Gillenwater *et al.* 2007: 85) and providers should be transparent about how they, and any intermediaries, are monitored. This is a difficult aspect to evaluate when looking at the providers in this review as although 16 detail the verification party that they use, very few provide informative details on how they monitor projects. An offset company that succeeds in making their monitoring transparent is **TerraPass** which provides details on: purchasing history (examining customer records and offset purchase contracts), offset quality (examining the carbon offset portfolio to ensure that they meet the stated standards) and consumer protection (ensuring that the company publicly discloses the contents of every **TerraPass** credit purchased). This breakdown of the monitoring process helps the consumer to understand exactly what value the scheme is providing.

3.3.5 Fund allocation

Consumers should be able to find out how much of their donation actually goes to the offset projects and what is spent on administration, etc. Thus, offset organisations should provide a breakdown of fund allocation (including spend on educational/awareness-raising activities, etc.); or at the bare minimum give the proportion offset monies invested in emission reductions. 25 of the offset providers in this study disclosed their fund allocation and the percentage invested in emissions reductions ranged from 54% to 100% (see Figure 8).

3.3.6 Additionality

Given the importance of additionality to the authentication of offsets, providers should advise the consumers about this issue and also demonstrate how their projects satisfy the criterion. Taiyab (2006: 3) states that if an offset scheme is to be additional then 'emissions reductions must be 'additional' to those that would have otherwise occurred under a business-as-usual scenario'. For example, if the projects would have occurred anyway, despite the offset provider introducing them, then the offset cannot be considered to be additional. A difficulty with evaluating additionality is that 'there is no correct technique for determining additionality because it involves the evaluation of counterfactual circumstances' (Gillenwater *et al.* 2007: 86). Thus, when reviewing the offset providers, a scheme was considered to demonstrate additionality if it provided information directly relating to the issue. This meant that the statements made by providers had to be taken at face value for want of a more detailed audit, which was beyond the scope of this study. More than half (23) of the providers attempted to inform their customers about the issue of additionality; these ranged from simple statements, such as 'the project meets additionality standards higher than those of the CDM', to more detailed commentary on; the importance of additionality, project specific information about how additionality is demonstrated in an individual case, and even links to articles in the issue.

3.3.7 Double-counting

When an offset provider sells offset credits (emission reductions), they must be able to prove ownership of those credits to avoid double-counting. Double-counting describes circumstances where, for example, emissions avoided as a result of investment in a renewable energy project and sold as an offset are also being claimed as a reduction by the energy provider. As with additionality, providers were assessed on their ability to explain to the consumer the concept of double-counting and illustrate how they prevent it within their offsets. Again statements made by providers have been taken at face value. 13 of the providers informed the consumer about double-counting. As

acknowledged by a number of authors, this is an issue that could be dealt with in a straightforward manner by having publicly available, accurate inventories (Bayon *et al.* 2007: 22) against which providers would have to demonstrate ownership of their offset credits (Gillenwater *et al.* 2007: 86).

Overall, transparency is difficult to achieve but vitally important. As with any company working within a market, consumers should ideally be able to able to see exactly what is going on, and offset providers must be able to demonstrate detailed accounts of the flow of monies and resources that enable services to be provided.

Since there are many aspects that contribute to a fully transparent scheme, for an offset provider to achieve complete openness is rare and none of the offset providers reviewed here address all the issues highlighted in Section 3.3. There are those who come close, and by providing a relatively transparent offset scheme, the providers are enabling the consumers to evaluate the quality of the overall scheme and specific offsets products.

3.4 Third Party Verification

The voluntary carbon offsetting market has developed outside of the regulated and government targeted market (DEFRA 2007b: 15), and therefore has no standards or ethics to which it must adhere (other than general trading standards). This lack of regulation has become an area of concern and, in the face of a recent backlash against the carbon offset market and continuing scrutiny of their practices and projects, many providers are now attempting to obtain independent third party verification. By obtaining external verification for their projects directly or through the purchase of offsets that already adhere to specific standards, carbon offset providers can raise the credibility of their service. Such standards may include criteria 'by which their projects are chosen and evaluated […] impact upon local communities, additionality and leakage' (Tufts Climate Initiative 2007: 15). The verification should also have the ability to assess whether the offset products are making the emissions savings claimed by the provider. This raises an important distinction between the verification and monitoring of offset provider processes and the assurance activities related to the carbon emissions reduction products themselves.

There are a number of "standards, protocols and verification methods" (Carbon Trust 2006: 11) in use within the voluntary carbon market, many of which are proprietary to the individual offset provider (ibid). However, there has been an emergence of several key standard providers, which the WWF (Kollmuss *et al.* 2008) have compared in a comprehensive report[16]. The report outlines the main offset standard types:

1. Full-fledged carbon offset standards – which offer accounting standards; monitoring, verification and certification; and registration and enforcement systems. Examples of full-fledged standards include CDM, VER+, CCX, and GS and VCS once they have established their inventories.
2. Project Design Standards (PDS) – which include accounting standards and some monitoring standards or guidelines, but do not offer certification of offsets or a registry. Examples include CCBS.
3. Offset Standard Screens – these are not full standards by themselves but they can accept projects that were implemented under other standards (e.g. CDM) and which adhere to their screening standards. Examples include VOS.

[16] The report compares the following standards: CDM; Gold Standard (GS); Voluntary Carbon Standard (VCS); VER+; The Voluntary Offset Standard (VOS); Chicago Climate Exchange (CCX); The Climate, Community and Biodiversity Standards (CCBS); Plan Vivo System; ISO 14064-2; and the WRI/WBCSD GHG Protocol for Project Accounting.

4. Offset Accounting Protocols – which provide definitions and procedures to account for the GHG reductions from the offset projects, but have no associated regulatory or administrative bodies. Examples include ISO 14064-2, and WRI/WBCSD's GHG Project Protocol.
5. Other Standards Types – these include all of those which do not fit within any of the other categories. Examples include Plan Vivo.

Although such standards are a step in the right direction, there are still weaknesses with the different standard providers: there is currently no agreed standard for methods of monitoring, no set frequency of monitoring, and no guidelines detailing the requirements for verification (Gillenwater *et al.* 2007: 86). Consequently, many of the independent verifiers use different standard, and as Kollmuss *et al.* (2008) state "verification is only as good as the accounting standards it verifies against". Kollmuss *et al.* (2008) further declare that the standards (which they reviewed) are still young and have few implemented projects; and as a result it is difficult to assess, at present, their effectiveness.

Of the offset providers reviewed in this paper, over half (25) provided information on their use of a third party for verification. These ranged from the use of standard auditing bodies such as The Gold Standard, to using large companies like PriceWaterhouseCoopers that provide auditing services, to even using a variety of different standard providers for different projects (e.g. **Virgin Blue** use the Australian Greenhouse Office and a second unspecified party for their verification). Altogether, 16 different standard providers were used by the offset organisations reviewed. In addition to the variety of independent verification services available it is worth noting that auditors can even differ in their interpretation of key issues such as what constitutes an 'additional' project (Ribón and Scott 2007: 9 – 10). This, as in other areas of carbon offsetting, raises the issue of the need for 'a consistent set of internationally accepted standards…and procedures by which those reductions are calculated, monitored, and verified' (Rau, 2007; in Bayon *et al.* 2007: 91).

In the UK, the first steps have been taken to establish a 'Code of Best Practice' for the carbon offsetting market. Among other things, the aim of the code is to 'provide signals to the UK offset sector on the quality and verification standards which they should aspire to' and the code will also develop quality mark which can be attached to accredited products (DEFRA 2007b: 2 – 3). Reaction to DEFRA's code has been mixed: whilst, for example, Gillenwater *et al.* (2007: 86) consider the attempt at developing a standardised set of practices to be a 'laudable' effort, others feel that it diminishes the capacity for innovation and flexibility in the market (Ribón and Scott 2007: 12). However, as is often the case, especially where climate change is concerned, the first attempts at regulation/standardisation are not often universally accepted from the outset. Nevertheless, standardisation is likely to be an important issue for the future of the voluntary offset market.

3.5 Educating the public

As previously acknowledged, carbon offsetting should be considered as the 'last resort' option after an individual or business has done everything else possible to reduce their carbon footprint; offsetting is the final stage in accounting for the emissions which cannot be reduced or eliminated altogether. Thus, some commentators (e.g. Rousse, 2008) argue that a primary role for offsetting organisations is to send the right signals by informing customers about climate change and the actions they could take to reduce the climate consequences of their activities. Ideally therefore, offset providers' websites should contain easily accessible information about the climate change issue in general, what carbon offsetting is and how it works (including the issues and concerns surrounding offsetting, e.g. additionality and double-counting), as well as about other steps the consumer can take to reduce their overall carbon footprint. This basic level of knowledge should

then help customers make informed choices about offset purchases and alternative courses of action.

Given the need for interpretation when evaluating the quality of educational information presented by offset providers, and in order to aid differentiation, only broad categories of performance were defined. These were:

1. ***Poor****: Little or no educational information available about climate change or aspects of carbon offsetting*
2. ***Adequate****: Detailed information available on climate change and/or carbon offsetting. Some also contained guidance on how to reduce overall carbon footprint; but where this was the case little or no information was provided on either climate change more generally or offsetting (i.e. only two of the three issues were addressed)*
3. ***Comprehensive****: Comprehensive and detailed information available on climate change, carbon offsetting and other ways that the consumer can reduce their overall carbon footprint.*

More than three quarters of the offset organisations were regarded as providing adequate (18) or comprehensive (17) information on their websites; demonstrating a relative strength in the market place. An example of good practice is provided by **Carbonfund.org** which has a comprehensive section on climate change; a 'Save Energy' section which is broken down into ways to reduce emissions from car use, travel, 'in the air and far away', savings at home, savings at the office, and reducing emissions in the daily life; links to other resources; and a detailed outline of offsetting. The information is easily accessible and clear to understand, highlighting the provider's interest in educating the consumer as well as selling carbon offsets – they even have a tagline of "Reduce what you can, Offset what you can't". Symptomatic of poor educational provision were websites (7 in total) that gave: little/no information on climate change; no examples of ways for customers to limit their carbon footprint, and extremely limited information on the offsetting itself.

The issue of education leads, essentially, back to that of transparency. Those providers which do not provide adequate information inhibit consumer understanding of the purpose and practice of the offset market.

Analysis of the offsetting literature revealed that discussions of carbon offsetting involve multiple and sometimes vague concepts and terminology. This is an additional area where educational information can be of further use for the consumer and may highlight certain offset providers as being superior to others. **Carbon Planet** has a section on their site called 'Carbopedia' which they use as a "repository for information on Global Warming, Carbon Emissions and Carbon Credits" which includes a glossary section. Within this glossary are explanations of, for example, what CO_2e stands for and its relevance, the Kyoto Protocol, and a simple definition of sequestration. Similarly, **Climate Care** has a 'Jargon Buster' which provides the consumer with easy to understand explanations for some of the key terms and aspects of climate change and carbon offsetting. This simple element added to the site helps to increase the consumer's knowledge about climate change and offsetting, and consequently will assist in raising awareness of the key issues involved. However, it must be noted that confusion may still persist if different websites give conflicting definitions of key terms and concepts. Again this raises the need for a standardised set of definitions and concepts to increase coherence across the market.

3.6 Conclusions from the review of offset providers

Gillenwater *et al.* (2007: 86) concluded that due to the "lack of standards, policing and credibility" there is a serious risk of the voluntary offset market collapsing. This study suggests that this risk is significant given the threat to credibility arising from the inconsistencies in offset provider performance revealed by our survey. Particular areas of concern relate to:

- **Carbon calculators** – inconsistent outcomes and a lack of comprehensive explanation of the assumptions underpinning the calculators were evident across the market. Thus, whilst the emissions totals calculated may be entirely consistent with those internal assumptions, even the most persistent of customers are often unable to verify that this is the case. Furthermore, without a reasonably detailed understanding of the principles underpinning the calculators, potential customers may reasonably feel rather suspicious of the process of determining their carbon liability, which after all will ultimately affect the price of their particular offset.
- **Attempts to standardise carbon calculators** – the work of DEFRA and ICAO in developing carbon calculators for use by offset providers is to be broadly welcomed. However, this survey established clear differences in the emissions outcomes for the sample long-haul flight. This simply serves to highlight the complexity of the models being applied and the those factors influencing the manipulation of the core engine performance data in order to arrive at the most accurate outcomes possible for given flights. Unfortunately, these entirely laudable attempts to improve the accuracy of calculators result in different outcomes and thus potentially undermine the goal of standardisation. The pressing need for consistency may require the sacrifice of some of this sophistication for ease of use and greater transparency of the underlying model. This raises the key 'fit for use' issue; if the intent is to establish a reasonable carbon liability that can be used to justify an appropriate offset price then a more simplified model may be appropriate. However, if the calculator and ensuing offset costs are to be used to stimulate further reductions to the carbon intensity of air services then calculators have to have sufficient resolution to 'capture' those factors likely to be influenced by improvements in efficiencies. For example, if an airline makes particular attempts to improve load factors and/or reduces baggage allocations then they would want that to be reflected in a lower carbon liability and thus offset price for their passengers – a simple model that uses generic load factors and set passenger/freight ratios would not allow this to occur. Linking the cost of offset to behavioural change in this way presupposes that carbon liability is the primary determinant of the price to offset – this survey reveals that this is anything but the case.
- **Unit price for carbon offsets** – this varied considerably from £2/tCO_2e to £18/tCO_2 and was seen to be a function of; the nature of the portfolio of carbon saving investments; the specific costs of different emission reduction initiatives (including the variable costs of the verification); the cost of carbon traded on the market, and the proportion of funds allocated to investment in emissions reductions (ranging from 54 to 100%). The lack of a standard price for carbon has been lamented by many commentators (see Stern, 2007) as a core obstacle to market induced carbon reductions. Presently, the most effective way of reducing offset costs is simply to move to a cheaper provider; rather than to reduce the carbon emissions associated with the activity giving rise to the need to offset in the first place.
- **Cost to offset a given flight** - given the variables outlined above, the range in offset costs for the sample flights demonstrated here is hardly surprising. Furthermore, increasing price does not necessarily go hand in hand with increasing carbon liability or the quality of offsets (as determined by levels of verification, etc) (e.g. one of the offset providers who calculates a relatively high carbon liability for the long-haul sample flight of 5.17 tonnes, offsets this at

the relatively lower price of £14.52). This lack of apparent explanation for the price to offset further undermines the credibility of the market.

- **Transparency and education** – these qualities become all the more important in the light of the variation in the cost to offset as the detail provided to customer can help clarify differences in service provision and indeed build confidence in individual providers. Unfortunately, again the pattern of performance is inconsistent, with no one providers addressing all the transparency issues identified in the survey. Educational material was generally more comprehensive across the market; but the poor performance of a minor or suppliers could still undermine the majority.

Overall, these inconsistencies can only serve to make potential customers suspicious of the market and thereby inhibit the uptake of offset services, which is one of the few practical steps that aviation customers can currently take to help mitigate the climate change consequences of their actions. If wider participation in this market is to be encouraged then a fundamental requirement would appear to be for greater standardisation and transparency; as an industry dealing in financial assets the offset sector should expect to be subject to similar tests for credibility, accounting robustness and economic efficiency as other financial markets (see Rau 2007 in Bayon, 2007)

4. Survey of Air Passenger Attitudes to Offsetting

4.1 Introduction

Given recent concerns about the climate impacts of air transport, and the potential for considerable growth in the offsetting market for air travel, a study was undertaken to investigate the attitudes of air passengers to offsetting at a major UK airport. The research was designed and developed in consultation with a range of key stakeholders in government, industry, NGOs and research institutions. Consequently, many experts have provided suggestions, guidance and critical comments on the progress of the study. The study therefore comprises a multi-sector, interdisciplinary project that has attempted to take account both of lead-edge scientific expertise and of the pragmatic requirements of policymakers, regulators and air transport industry representatives. In addition, the study has attempted to include NGO, industry and academic perspectives on the role and value of offsetting within wider responses to the challenge of climate change.

In investigating public attitudes to offsetting and aviation, this study engaged with diverse views about the role of offsetting in overall climate change mitigation strategies. Hence, in addition to general views of the purpose and value of offsetting, the study sought to investigate some specific aspects of schemes, including the factors that might make air travellers more willing to pay for offsetting. For instance, the possibility that air passengers might be more willing to offset the impacts of their flights if the schemes supported local projects was explored. Another issue of particular interest was whether passengers would prefer to pay the full cost of offsetting the impacts of their flight, or simply to pay a fixed rate charge regardless of the distance flown. Such questions are potentially important for the design and operation of effective offsetting schemes for air transport.

One issue that required particular consideration is that fact that, as already noted, the climate impacts of air transport are greater than those of the carbon dioxide (CO_2) emitted by aircraft. This is because aircraft have other radiatively-significant effects: by producing other greenhouse gases, by producing sulphate aerosols, and by contributing to the formation of contrails and contrail-cirrus. The extent of these additional effects is the focus of much scientific debate with earlier estimates

that in combination their influence could be as much as 2.7 times the effect of CO_2 alone (IPCC 1999) more recently revised to a 1.9 times the effect of CO_2 alone (Sausen *et al*, 2005). Whilst not intending to add to this scientific debate here, in order to acknowledge the potential contribution of non-CO_2 influences on climate arising from aviation we used the broader language of 'compensating for climate change impacts' in addition to the simpler terminology of carbon offsetting.

A questionnaire survey of 487 passengers was undertaken at Manchester Airport in January and February 2008. The results were subjected to statistical analysis using SPSS for Windows 12.0.1, and qualitative responses were investigated using textual analysis. Some implications for air transport management and policy were derived. Overall, the study revealed some significant features of the attitudes to offsetting expressed by air passengers at a major UK airport. The study also allowed passenger attitudes to the broader issue of mitigating the climate change impacts of air travel to be explored.

4.2 Passenger survey aims, research questions and scope

The aims of the research were as follows:

- To assess the likely level of uptake of an offset scheme for air passengers depending upon how it is structured, both financially and practically
- To investigate attitudes of air passengers travelling through a major UK airport towards the issue of air travel and climate change
- To assess the willingness of air passengers to contribute to an offsetting scheme with projects focusing on the area local to the airport
- To explore issues relating to how and where offset funds are spent

Those aims were developed into the following research questions:

- Are air passengers more willing to offset if the scheme supports local projects?
- Would air passengers prefer to pay to offset their actual climate impacts, or simply to pay a fixed amount towards offsetting?
- Would air passengers prefer to pay to offset in the cost of their ticket, or separately?

In particular, the project attempted to determine the extent to which the likely level of uptake of offsetting is determined by:

- Awareness of climate change
- Awareness of offsetting schemes
- Willingness to accept personal responsibility for the climate change effects
- The ability of air passengers to pay for offsetting
- The willingness of air passengers to pay for offsetting
- The influence of different charging schemes, location of projects, auditing and accreditation, effectiveness and additionality
- The influence of ease of payment: type and location of payment facility, issues relating to 'opt in' or 'opt out' of schemes, and method of payment
- Proposals for a simple industry-wide offsetting scheme, with the cost included in the ticket price

The aims, research questions and scope of the project were presented to a range of key stakeholder organisations (listed in Appendix A) for consultation.

4.3 Survey methodology

4.3.1 Questionnaire design

A questionnaire was designed to investigate the aims and research questions defined above; the questionnaire is reproduced in Appendix C. As far as possible, the questions were calibrated with those used by the Office of National Statistics (ONS), following advice from stakeholders in the Department for Transport (DfT). Demographic information was collected in line with procedures outlined by the ONS, including a standard classification of occupational categories, based on the NS-SEC self-coded method.

The questionnaire was trialled in a pilot survey of 60 respondents at Manchester Airport, and further refinements were made based on analysis of the pilot data. In addition, a further meeting with stakeholders was held at this stage to ensure that the questionnaire was fit for purpose, given early indications from the pilot data. Extensive consultation occurred with many stakeholders (listed in Appendix A) throughout the design stage about the content, wording and emphasis of the questions. The main issues that emerged as a result of the consultation (and which subsequently informed the design of the questionnaire) are discussed in turn below.

- **Language: 'climate' or 'carbon', 'compensation' or 'offset'? -** Given that the climate impacts of air transport are greater than the effects of aviation-derived CO_2 alone, and that making adequate allowance for this distinction was regarded as an important aspect of the project, there were difficulties in finding suitable language to express these ideas without using the complex terminology of radiative forcing. As several stakeholders acknowledged, the language about 'compensating' is more accurate than 'offsetting' as a term for describing many offsetting schemes – some of which may not actually offset anything because of double-counting issues or other flaws. However, insisting on this distinction presented difficulties in the wording of the questionnaire: the concept of offsetting *itself* is poorly understood by many people, and the use of more complicated language was likely to further confuse participants. Terms such as 'schemes for offsetting' were considered, rather than 'climate change compensation'. In general, since the idea of compensation for climate impacts was the main theme we sought to explore, we preferred to use the term 'compensating' wherever possible, since it avoided the need to deal with claims that 'offsetting' is not always strictly accurate. On the other hand, 'compensation' in an environmental sense is a complex term that would inevitably be less widely understood than 'offsetting'. In a compromise solution, we used both terms in the questionnaire, although not interchangeably. Where 'compensation' was likely to be understood by participants – or where there was an opportunity for the interviewers to explain the meaning of the term – we retained it. Where it was likely to be misunderstood – or difficult to clarify in any particular question – we replaced 'compensate' with 'offset'.

- **Choice of assumed cost levels -** One desired outcome of the study was an indication of whether air passengers would prefer to pay the full cost of offsetting the climate impacts of their flights, or simply to pay a fixed rate charge. The need to address this research question presented challenges in phrasing questions about willingness to pay, particularly given the significant differences in costs charged by commercial offset providers (as our review of offsetting schemes has demonstrated). It was necessary to assume representative costs for the climate impacts of flights of varying distances, in order to present the respondents with meaningful choices about their offsetting preferences. Given that we sought to include wider climate impacts of aviation (beyond those of CO_2 alone) in the study, a discrepancy therefore existed between the prices we suggested and the prices that some respondents

might have previously been charged by offsetting schemes. Several stakeholders commented that the prices we suggested seemed too large by a factor of two or three. Those increases reflected the additional climate impacts of air transport beyond the strict carbon effects of aircraft, and they were based on assumptions that the radiative forcing of air transport is roughly 2-4 times that of aviation-induced CO_2 (Forster *et al*. 2006; IPCC 1999). Recent scientific work indicates that the radiative forcing index due to aviation may in fact be lower, at around 1.9 (Sausen *et al*. 2005); nevertheless, our assumption seems reasonable because the variation in schemes due to the use of different costs of carbon is far greater than the effect of discrepancies in the value of radiative forcing index adopted. Crucially, our intention was simply to provide illustrative figures to respondents and not to claim scientific precision for those figures. The assumed nature of those costs is made clear in the questionnaire (see Appendix C).

- **'Local' projects -** Some stakeholders acknowledged the issues surrounding the definition of 'local' projects in the study. Local projects could be interpreted as meaning local to the airport, or alternatively local to the home of the respondent. The airport used in the study attracted passengers from a large area of the UK, with some passengers travelling distances of several hundred kilometres to reach the airport. Consequently, it was difficult to envisage how an offset scheme that supported 'local' projects could work in connection with a major airport. Nevertheless, in this study we assumed that local projects were those located in the same region as the airport. A further issue with 'local' projects is that it is unclear how a scheme using such projects could guarantee additionality for their offsets: the emissions savings would need somehow to be accounted separately from national carbon emissions reductions.

4.3.2 Data collection

A market research company, KGS Limited, was contracted to administer the survey. This had the advantage that the same interviewers undertake the regular passenger surveys on behalf of the Civil Aviation Authority (CAA), and they were already familiar with the procedures for conducting surveys at Manchester Airport. Within the airport, the best location for the survey was considered to be airside, after passengers had completed the check-in, security and border control procedures, as they might then be more willing to participate. This meant that the interviewers would need to undergo security checks and to be issued with airside passes. A further advantage of contracting the survey to KGS Limited was that those interviewers had already undergone this screening process.

A preliminary meeting was arranged with the interviewers, who were briefed on the purpose, aims, approach and methods of the study. This meeting allowed an opportunity for some misconceptions about offsetting to be addressed. The main survey was undertaken between 28 January and 6 February 2008. A total of 487 questionnaires were completed. All three terminals at Manchester Airport were used, and a cross-section of air passengers was sought for the sample: this included business and leisure travellers. The completed questionnaires were returned to Manchester Metropolitan University for analysis.

4.3.3 Data analysis

The questionnaire data were stored and analysed using Microsoft Excel. Particular efforts were made to capture the qualitative responses, which revealed the views of some participants towards offsetting in considerable detail. A process of data consolidation took place which included, for example, determining which airlines were used from the flight number information given by respondents, and calculating approximate flight distances based on passengers' reported

destinations. The responses were categorised using grouping variables, and the qualitative responses were coded around dominant themes using sub-categories.

Some assumptions were made during the data analysis, to ensure the task remained manageable and the results were meaningful. The main assumptions were:

- Distance travelled to the airport was assumed to be the direct distance, calculated using a 1:625,000 Ordnance Survey map, Philips Northern England 1:1,000,000 map and Philip's British Isles 1:4,000,000 map. Passengers reporting UK origins only were considered: this excluded a small number of passengers who had not travelled from a UK point of origin on the day of travel. The reason for the small number was probably that most questionnaires were completed in the morning, when departures outnumbered arrivals, and when the number of transit passengers was small.

- Distance flown was assumed to be the approximate great circle distance between Manchester Airport and either the point of origin or the final destination, calculated using an online flight time/distance calculator (provided by Air Routing International; available at http://www.airrouting.com/content/tdcalc.html, accessed 24 March 2008). This introduced a potentially significant source of error to the study, since many (if not all) flights are significantly longer than the great circle distance. Nevertheless, subsequent analysis indicated that inaccurate flight distances did not appear to have an effect on the results – or their effect was concealed by other, larger variations.

- Currencies were converted using the online Universal Currency Converter (provided by XE.com; available at http://www.xe.com/ucc, accessed 24 March 2008). Again, this assumption may have introduced an important source of error, given the importance to this study of capturing accurate information about willingness to pay for offsetting. Subsequent analysis suggested that any errors introduced by the use of the Universal Currency Converter did not appear to influence the results, however – or these may also have been obscured by larger variations in the data.

The results were analysed using SPSS for Windows 12.0.1. Descriptive and illustrative statistics were obtained, including frequency tables, histograms, cross-tabulation matrices and chi-square values. Tables and simple bar charts were selected as the clearest means of presenting the data. Hypothesis testing was undertaken using the variables listed in Appendix D. Each independent variable was cross-tabulated with each dependent variable, and the results were assessed in terms of the chi-square values, significance levels and degrees of freedom. In general, a significance level of $p<0.05$ was selected, although in many cases the significance level was much smaller, indicating that the results obtained were extremely unlikely to have occurred by chance.

The results were presented to stakeholders for checking and to invite comments on their interpretation. A meeting was held to develop ideas about profiling those air passengers who might be regarded as 'lead-edge' in their use of offsetting schemes, and to refine ideas about how offsetting might be further promoted in the light of the survey results.

4.4 Results

The main responses to the questions are presented in the form of simple bar charts.

Initially, respondents were asked the reason for their flight:

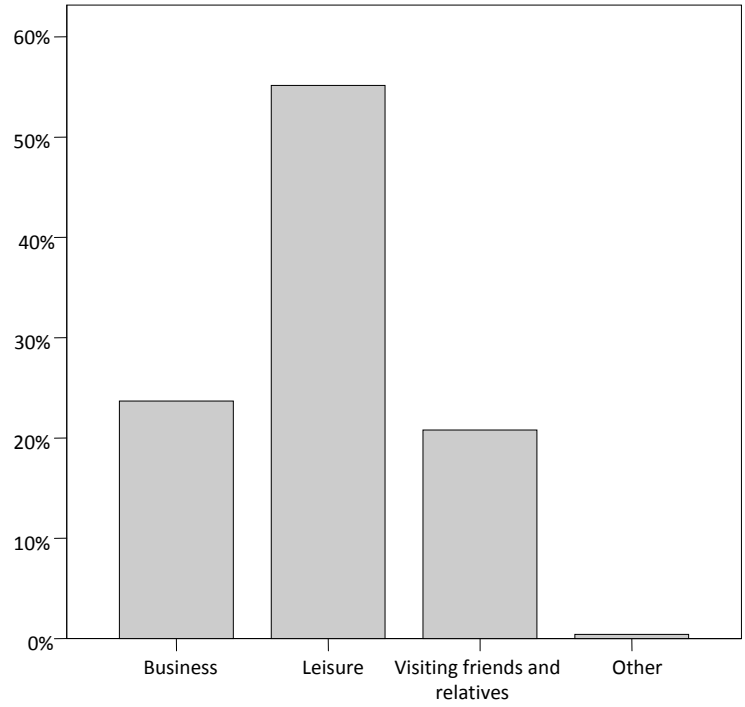

Figure 9: Reason for flight

In Q1, respondents were presented with three statements about climate change. First, they were asked if they believed climate change was a genuine threat:

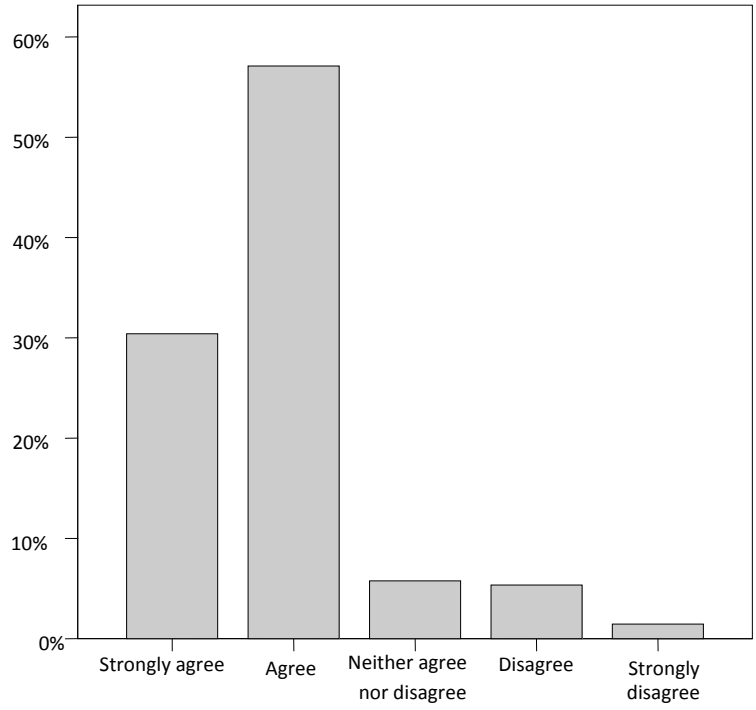

Figure 10: 'Climate change is a genuine threat'

Second, respondents were asked if they believe air travel contributes to climate change:

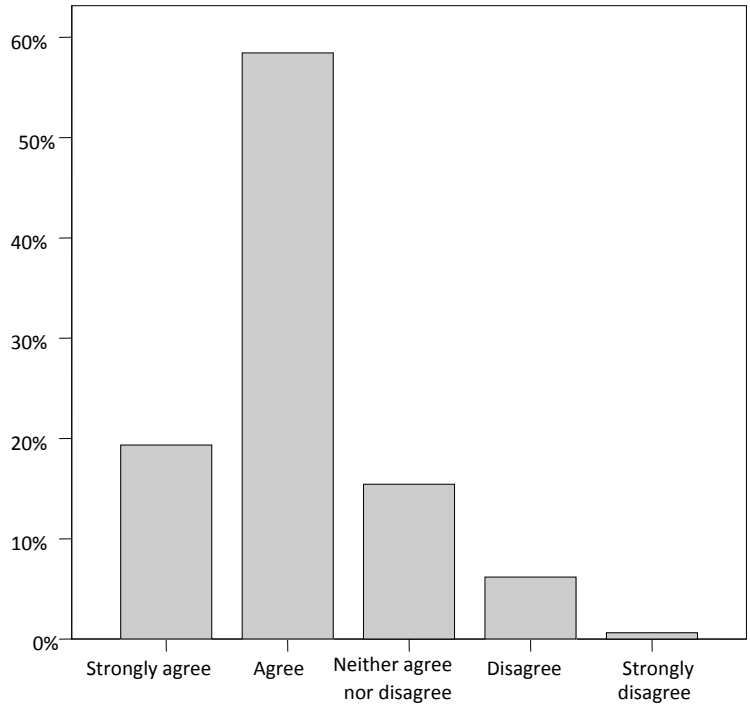

Figure 11: 'Air travel has an influence on climate'

Third, respondents were asked if they believed they can limit the impacts of air travel on climate by their actions (for instance, by flying less frequently, by flying shorter distances, by using other modes of transport, or by offsetting the climate impacts of their flight):

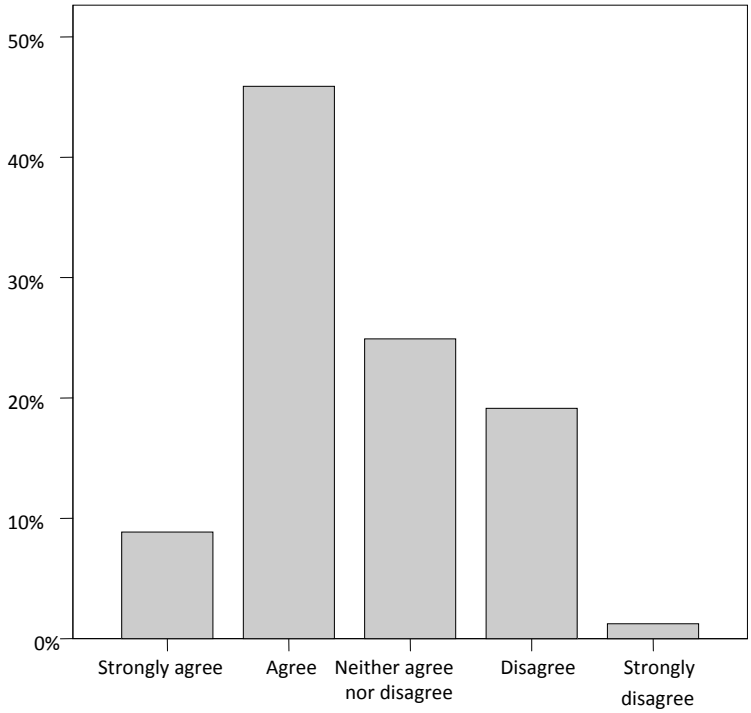

Figure 12: 'I can limit the effect of air travel on climate through my actions'

In Q2, respondents were asked whether their attitudes towards air travel and climate change influenced their choices about flying:

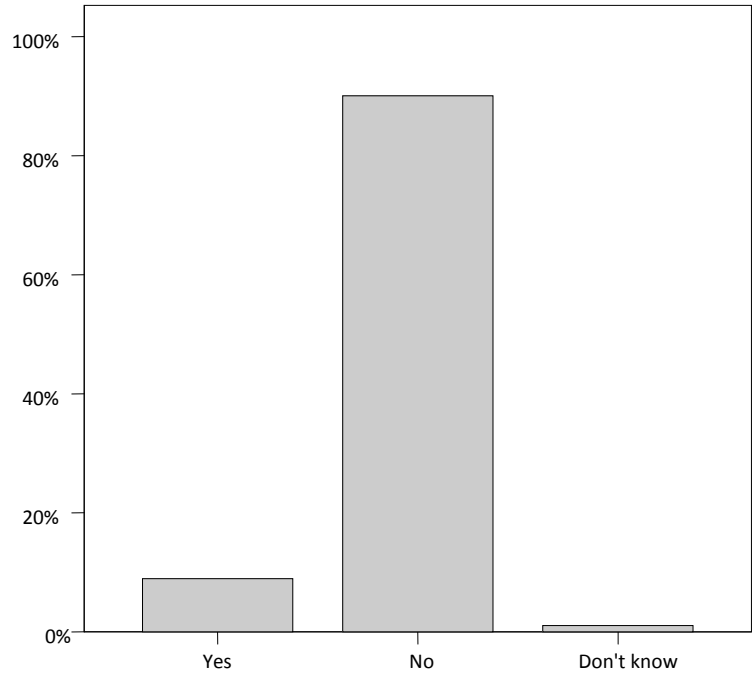

Figure 13: Does you view of air travel and climate influence your choices about flying?

In Q3, respondents were asked who should be primarily responsible for offsetting the climate impacts of flights: individual passengers, airlines, airports, the Government, or another party:

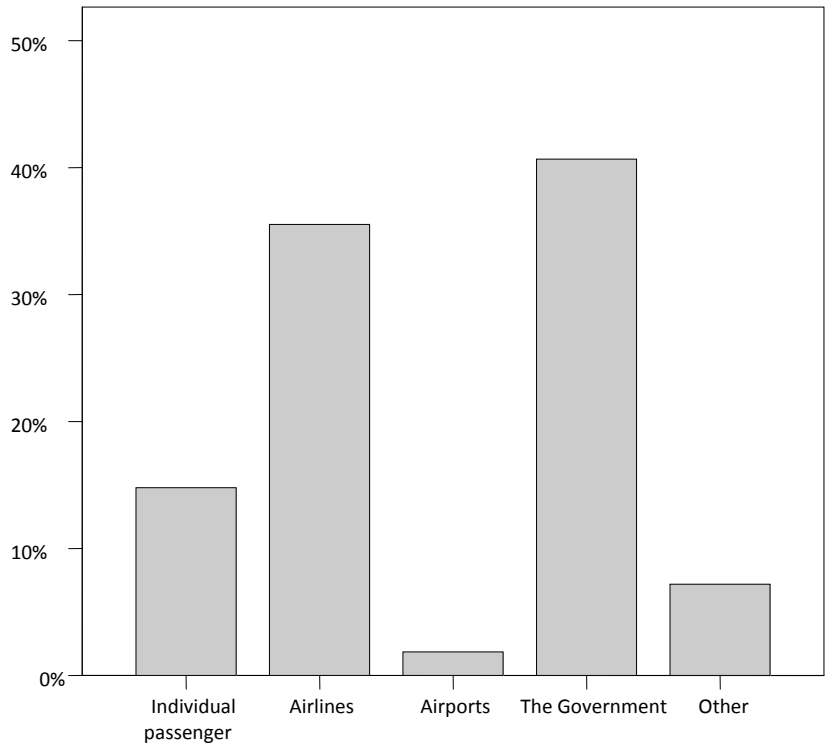

Figure 14: Who should be primarily responsible for offsetting the climate impacts of flying?

Where respondents replied 'other' and provided further information, their responses were categorised as follows: (a) all of the parties listed; (b) collective responsibility (everyone in all countries); (c) aircraft manufacturers; (d) both airlines and government; (e) people with private jets; (f) other countries; (g) none of the parties listed (including views that 'climate change will happen regardless', and 'don't believe it has an impact'); and (h) don't know.

In Q4, respondents were asked if they had previously heard of offsetting schemes in general:

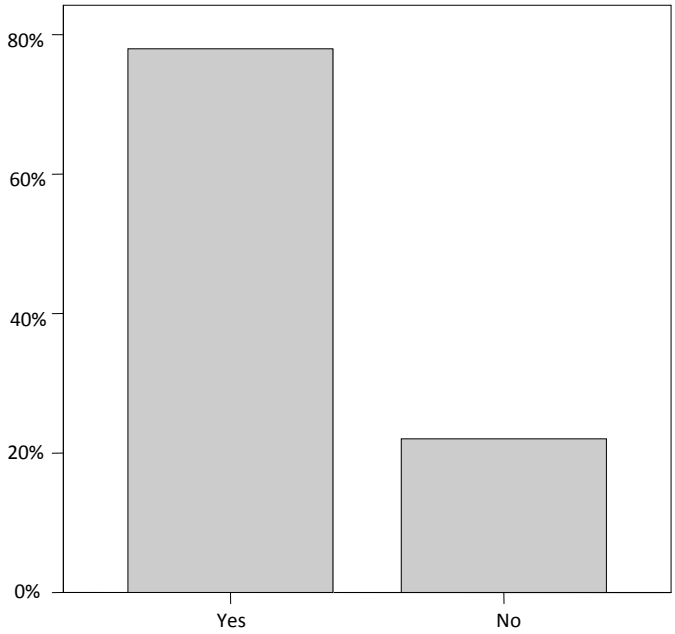

Figure 15: Had you heard of offsetting schemes before today?

In Q5, respondents were asked if they had previously heard of offsetting schemes specifically for air travel:

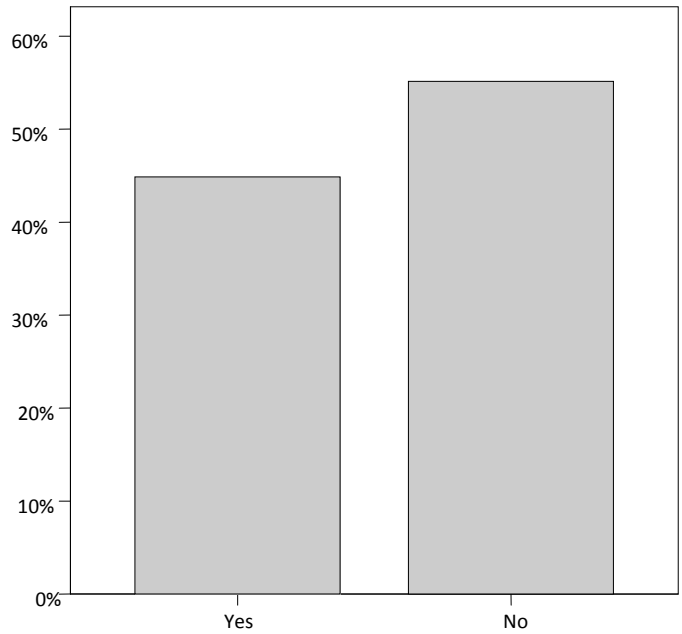

Figure 16: Had you heard of offsetting schemes for flights before today?

In Q6, respondents were asked if their airline or travel company offered them the option to offset the climate impacts of their flight:

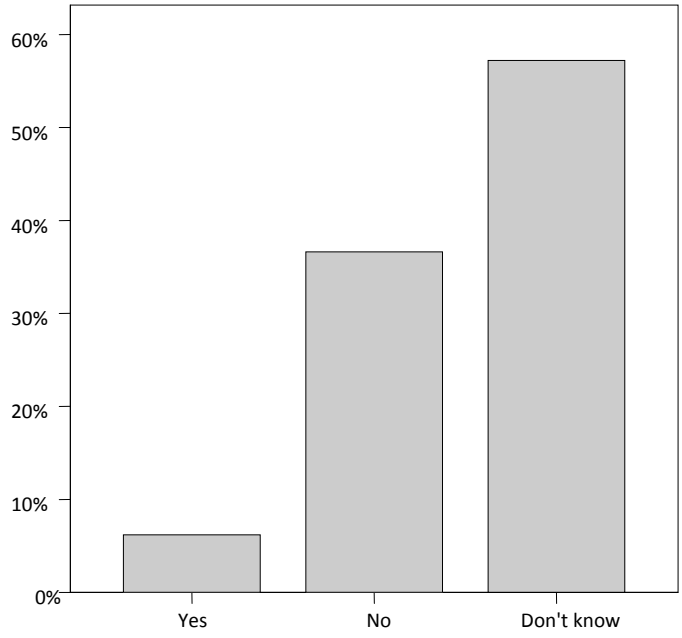

Figure 17: Does the airline you are flying with today offer offsetting?

It is worth emphasising that the responses to Q6 reflect passengers' understandings of the services offered by airlines and travel companies – and are not necessarily accurate. For instance,

passengers travelling with certain airlines or travel companies (such as First Choice Holidays) may have contributed to an 'opt-out' offset scheme as part of their holiday package, but may not have been aware of that fact.

In Q7, respondents were asked if they had already – or intended to – offset the climate impacts of their flight:

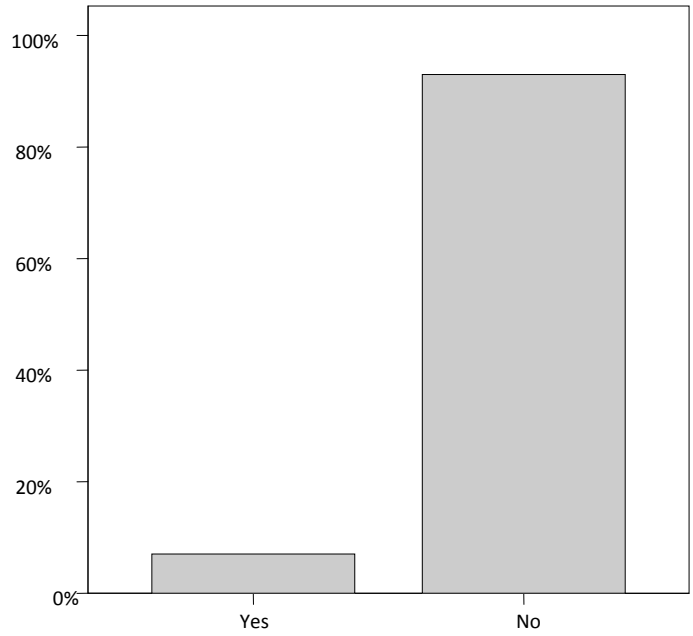

Figure 18: Have you offset the climate impacts of this flight?

In Q8, those respondents who had not offset the climate impacts of their flight – or who reported being unwilling to use offsetting – were asked why not:

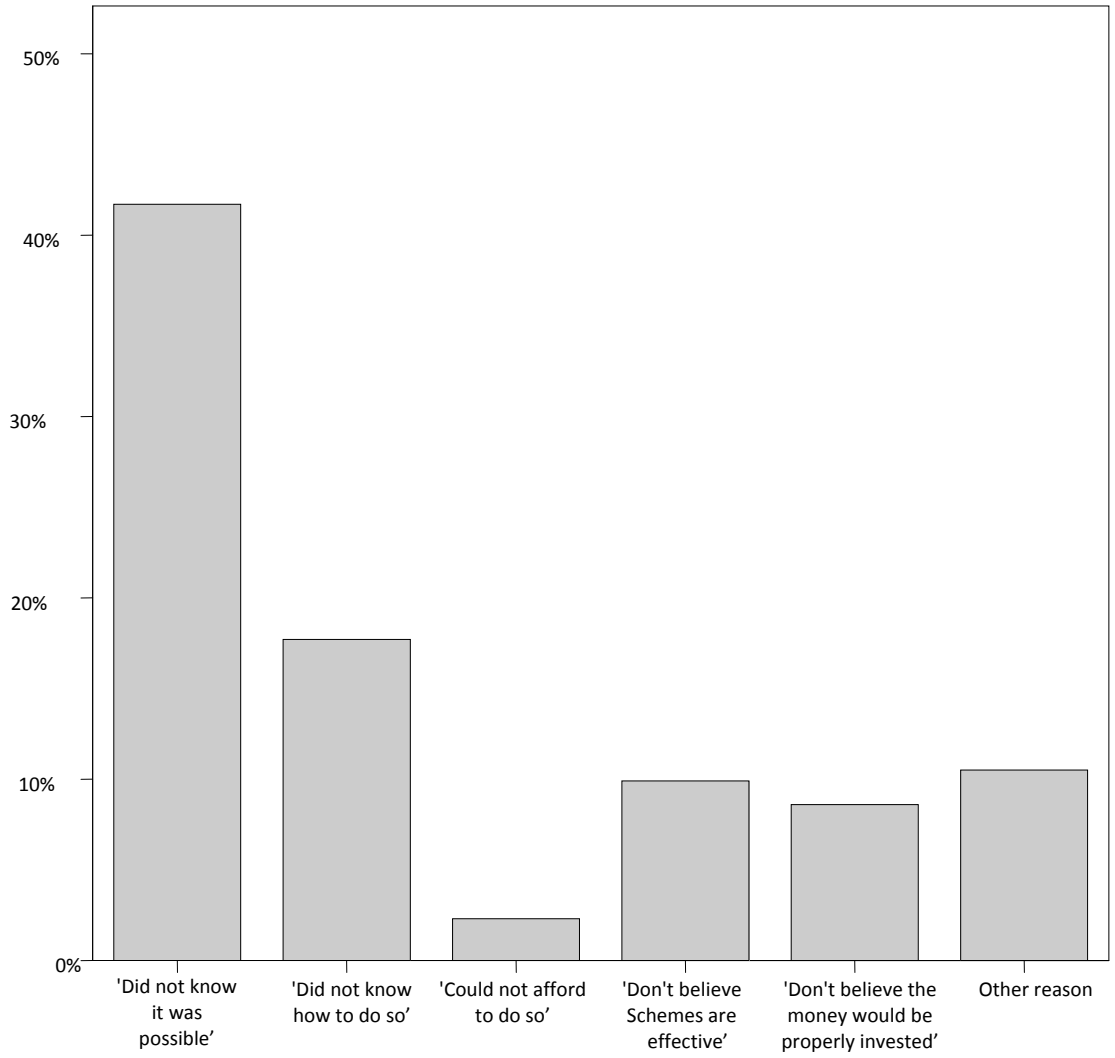

Figure 19: Reasons for not offsetting

Where respondents replied 'other' and provided further details, those responses were recorded and grouped into sub-categories. The sub-categories were: (a) don't believe climate science; (b) climate change needs more general action; (c) offsetting should be included in the ticket price; (d) offsetting wasn't offered, or wasn't asked to; (e) don't fly very often; (f) not my responsibility; (g) not enough information; (h) not enough time; (i) not bothered; (j) choose not to; (k) paid enough already; (l) Government propaganda; (m) don't understand; and (n) don't believe it works.

In Q9, therefore, many reasons for not offsetting were cited by respondents. These reasons were not mutually exclusive and there was considerable overlap between the sub-categories. Nonetheless, these sub-categories provided a useful means of grouping the most common responses. Furthermore, the responses to this question required broad interpretation: for example, 'offsetting wasn't offered' was interpreted broadly to include many aspects of passengers being unaware of, not thinking about, or not being presented with an explicit choice to, offset the climate impacts of their flights.

Questions Q10 and Q11 were directed at business travellers only. In Q10, business respondents were asked if their company had offset the climate impacts of their flight:

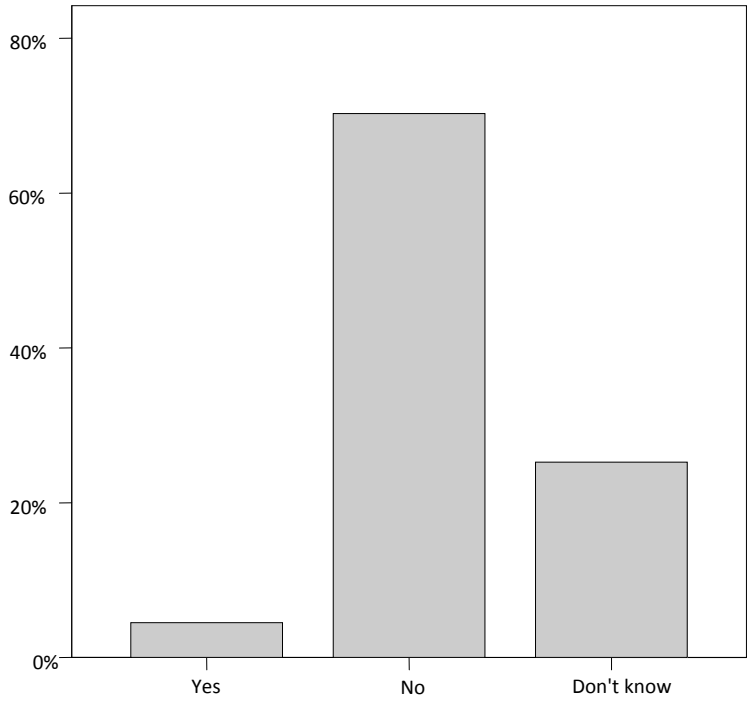

Figure 20: Has your company offset your flight today?

In Q11, business respondents were asked if they thought their company should offset the climate impacts of their flight:

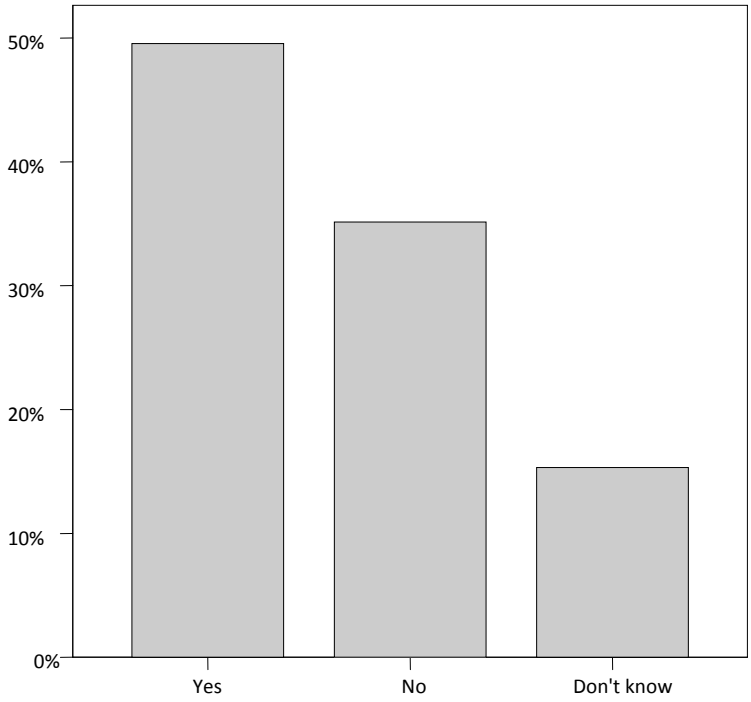

Figure 21: Do you think your company should offset your flight today?

In Questions Q12 and Q13, all passengers in the survey were presented with assumed costs to offset[17] the climate impacts of their flights. In Q12, respondents were asked what proportion of the assumed cost of offsetting they would be willing to pay:

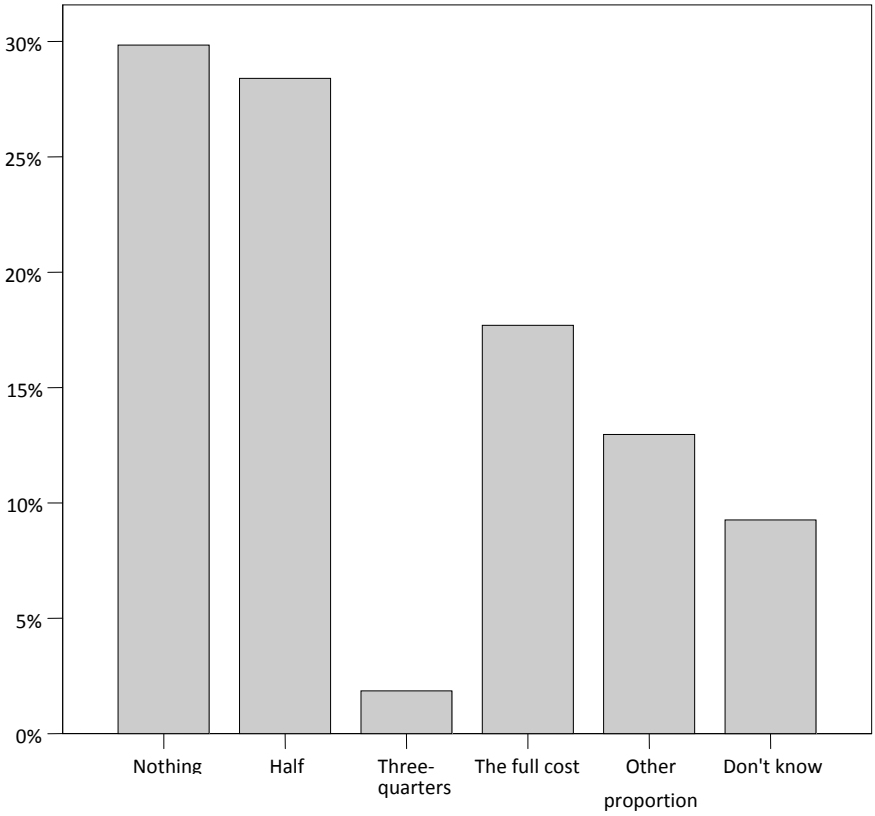

Figure 22: What proportion of the cost to offset your flight would you be willing to pay?

[17] Assuming the costs of compensating for the full climate change impacts of a return flight: Flights within the UK = £3 - £5; Flights within Europe = £3 (Paris) - £15 (Cyprus); Inter-continental = £30 (Dubai) - £150 (Sydney)

Of the subset of people who answered 'other proportion' and provided further details, their additional responses were:

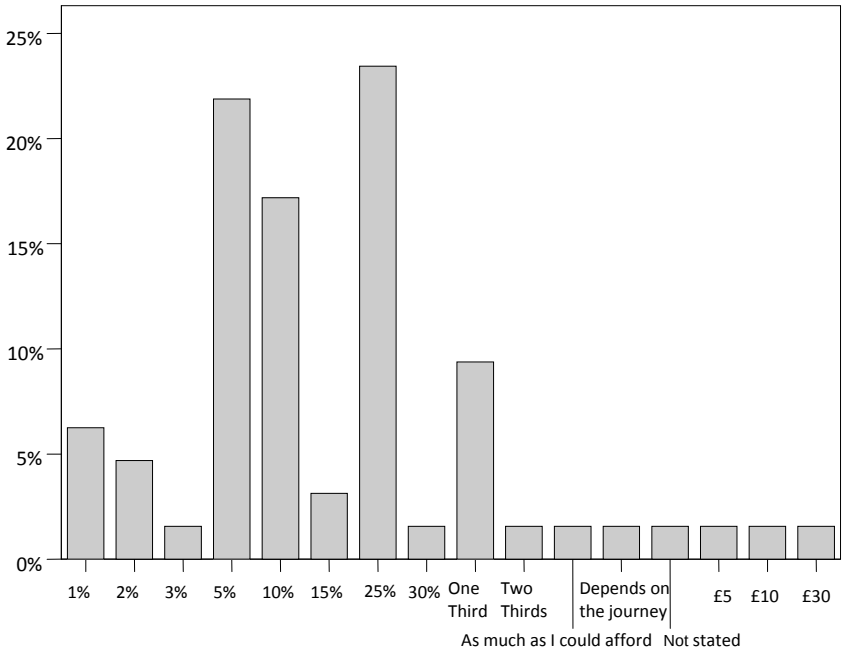

Figure 23: Other proportion of offset cost willing to pay

In Q13, respondents were asked if there was a maximum amount they would be willing to pay to offset the climate impacts of their flight:

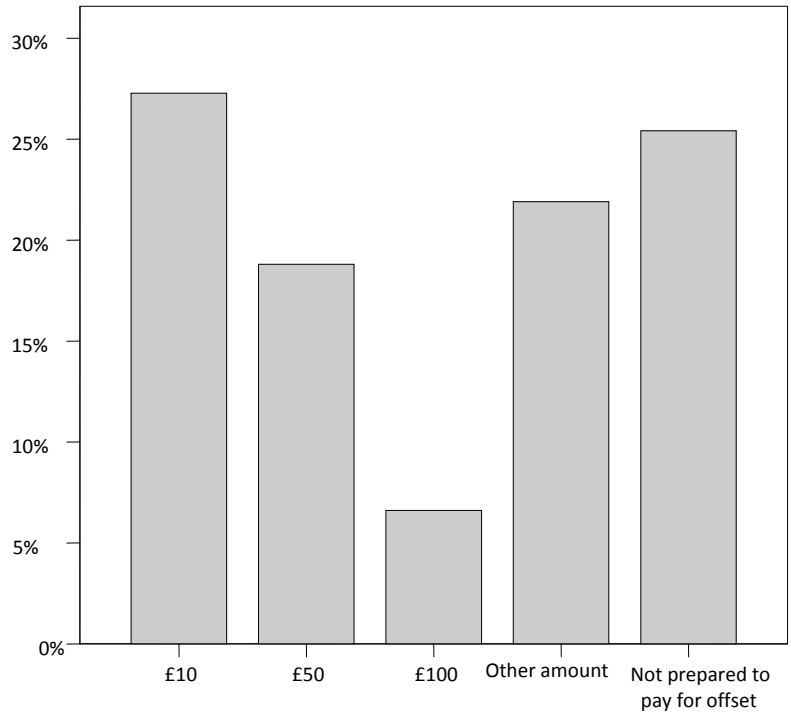

Figure 24: Is there a maximum amount you would be willing to pay to offset your flight?

Of the subset of people who answered 'other amount' and provided further details, their additional responses were:

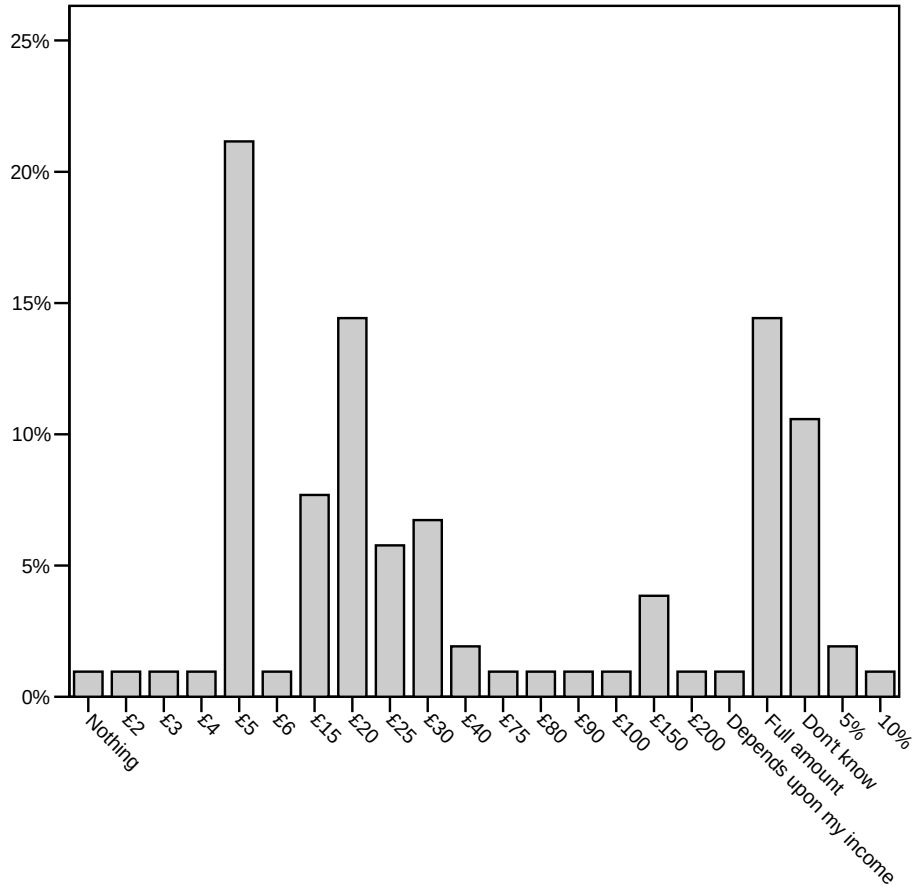

Figure 25: Other maximum amount willing to pay

In Q14, respondents who had answered 'nothing' or 'not willing to pay' in the previous two questions were asked to explain why they felt that way. The reasons given by respondents were diverse and the sub-categories overlapped considerably; nevertheless, the sub-categories represented useful ways of grouping the most common responses given by this subset of passengers. Not all of the responses were strictly related to the question, however, and they reflected considerable confusion amongst many respondents about the nature, purpose and methods of offsetting.

The reasons for not offsetting stated by that subset of informants (just over a quarter of respondents) are shown below:

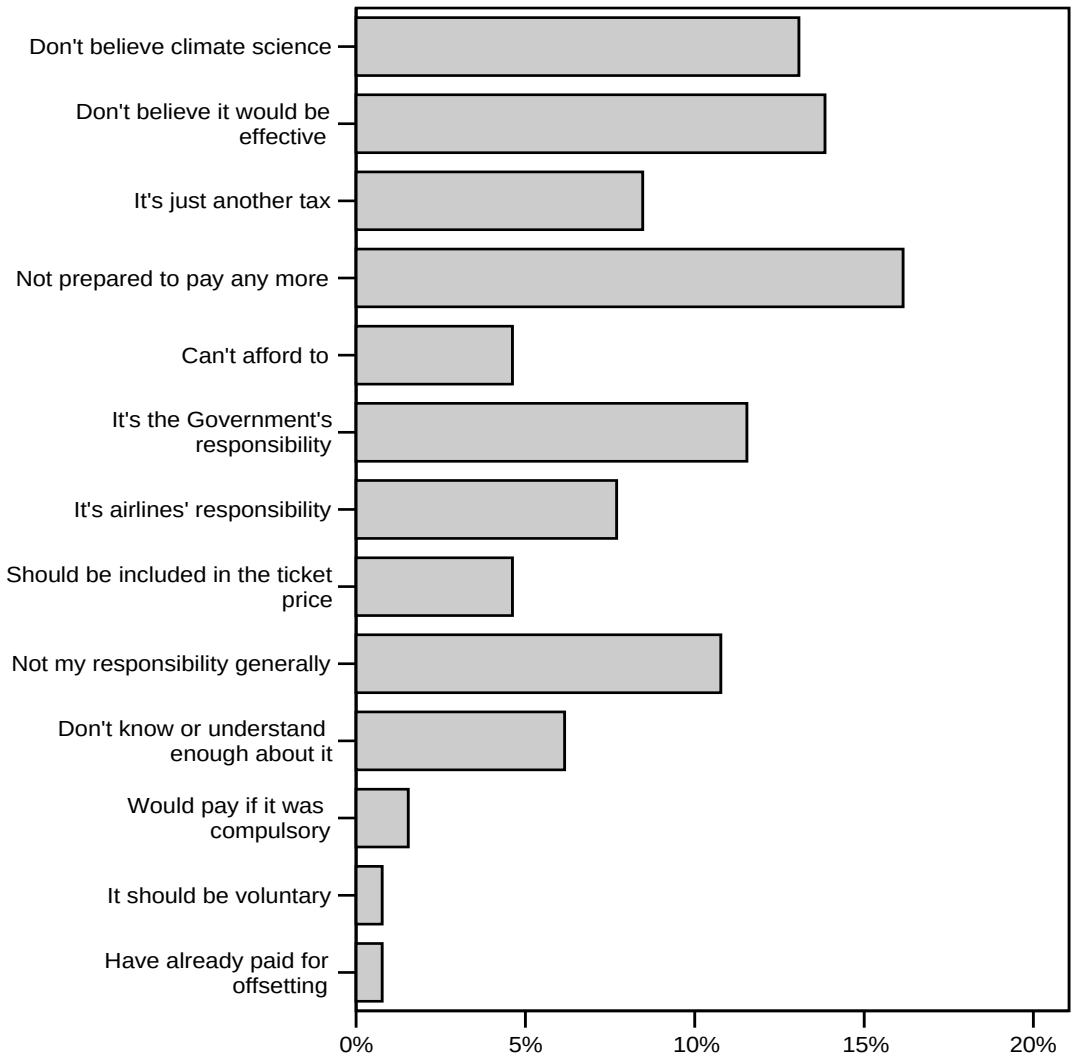

Figure 26: Reasons for not offsetting by respondents who were not willing to pay offset or answered 'nothing'

In Q15, respondents were asked whether they thought offsetting schemes for air passengers should be voluntary or compulsory:

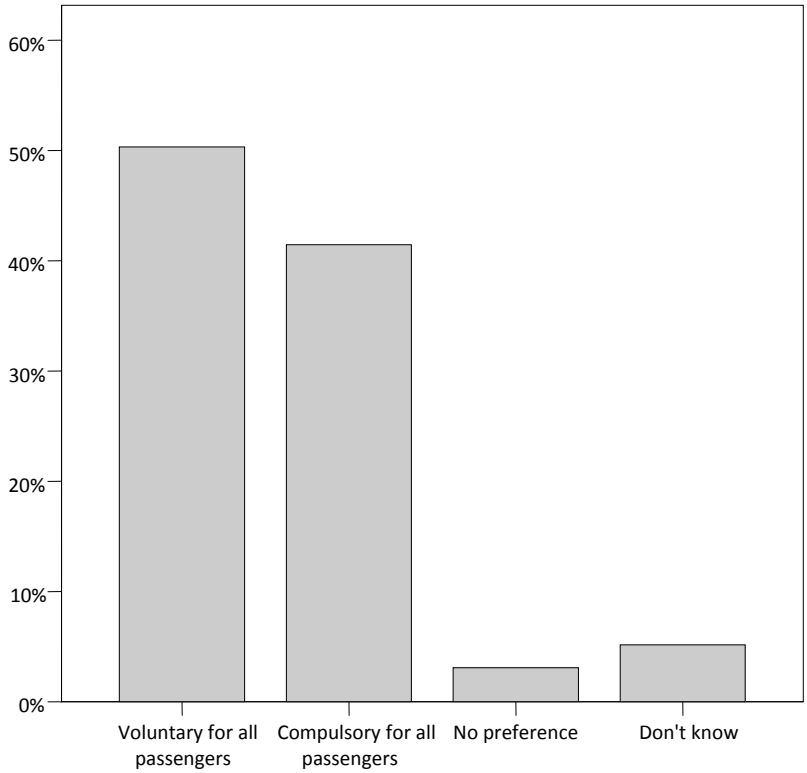

Figure 27: Should offset schemes be voluntary or compulsory?

In Q16, respondents were asked whether airlines should legally be required to include the cost of offsetting in the ticket price:

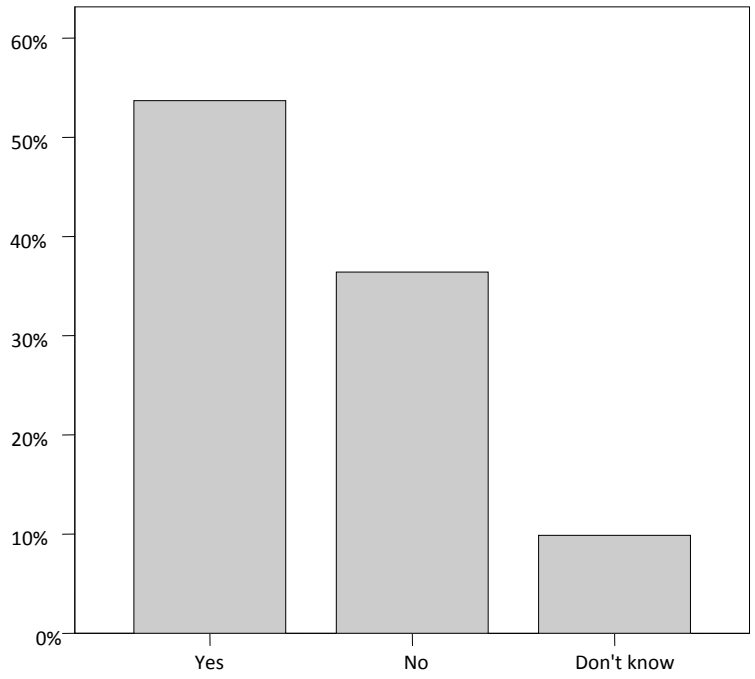

Figure 28: Should airlines be legally required to include offsetting in the ticket price?

In Q17, respondents were asked how they would prefer to pay for offsetting:

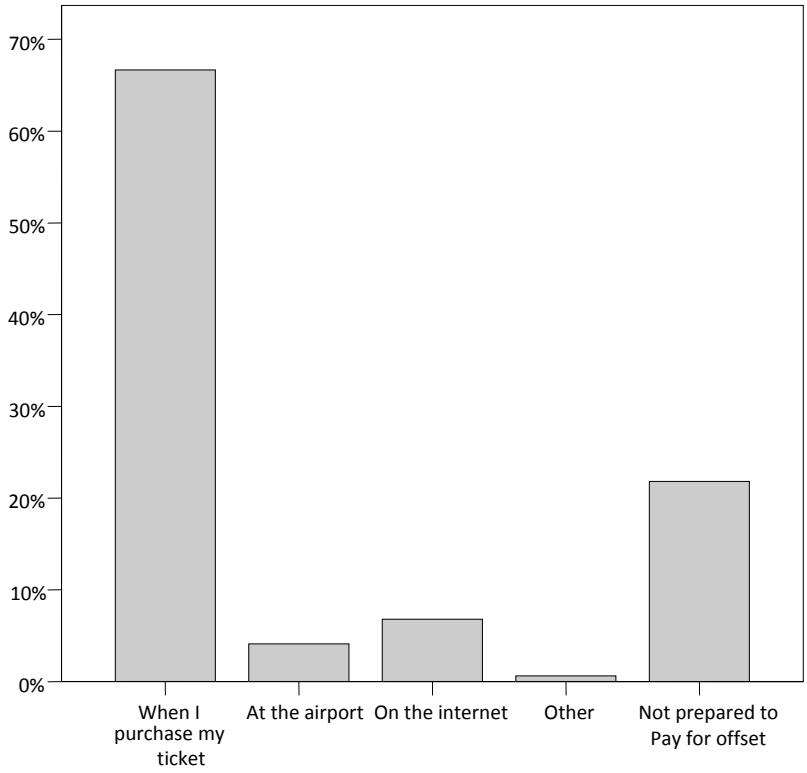

Figure 29: How would you prefer to pay for offsetting?

In Q18, respondents were asked whether they would prefer to pay the actual costs of offsetting the climate impacts of their flight, or simply to pay a fixed rate charge:

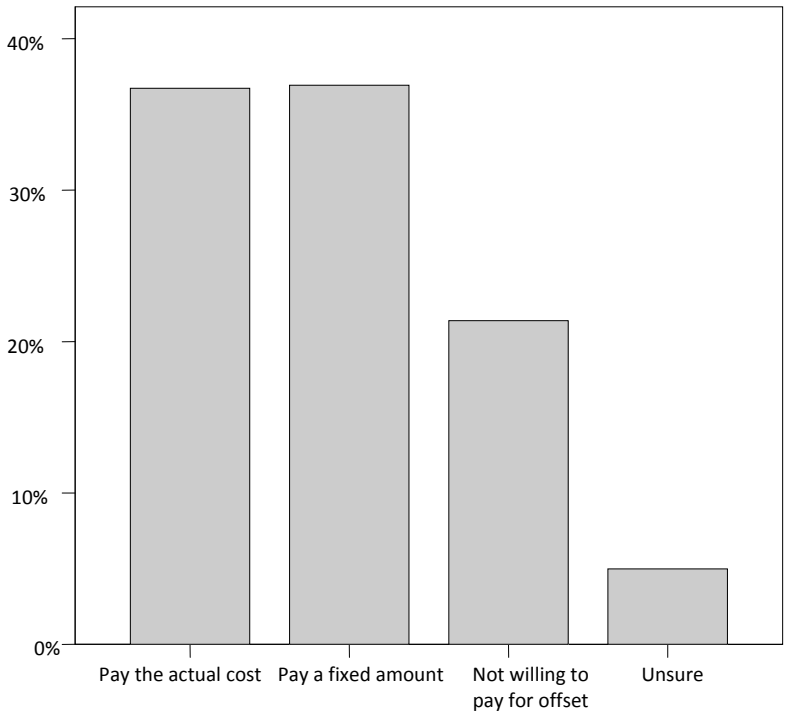

Figure 30: would you prefer to pay for the actual cost of offsetting your flight, or simply to pay a fixed amount?

In Q19, respondents were asked which factors would make them more likely to offset the climate impacts of their flight (multiple responses were possible):

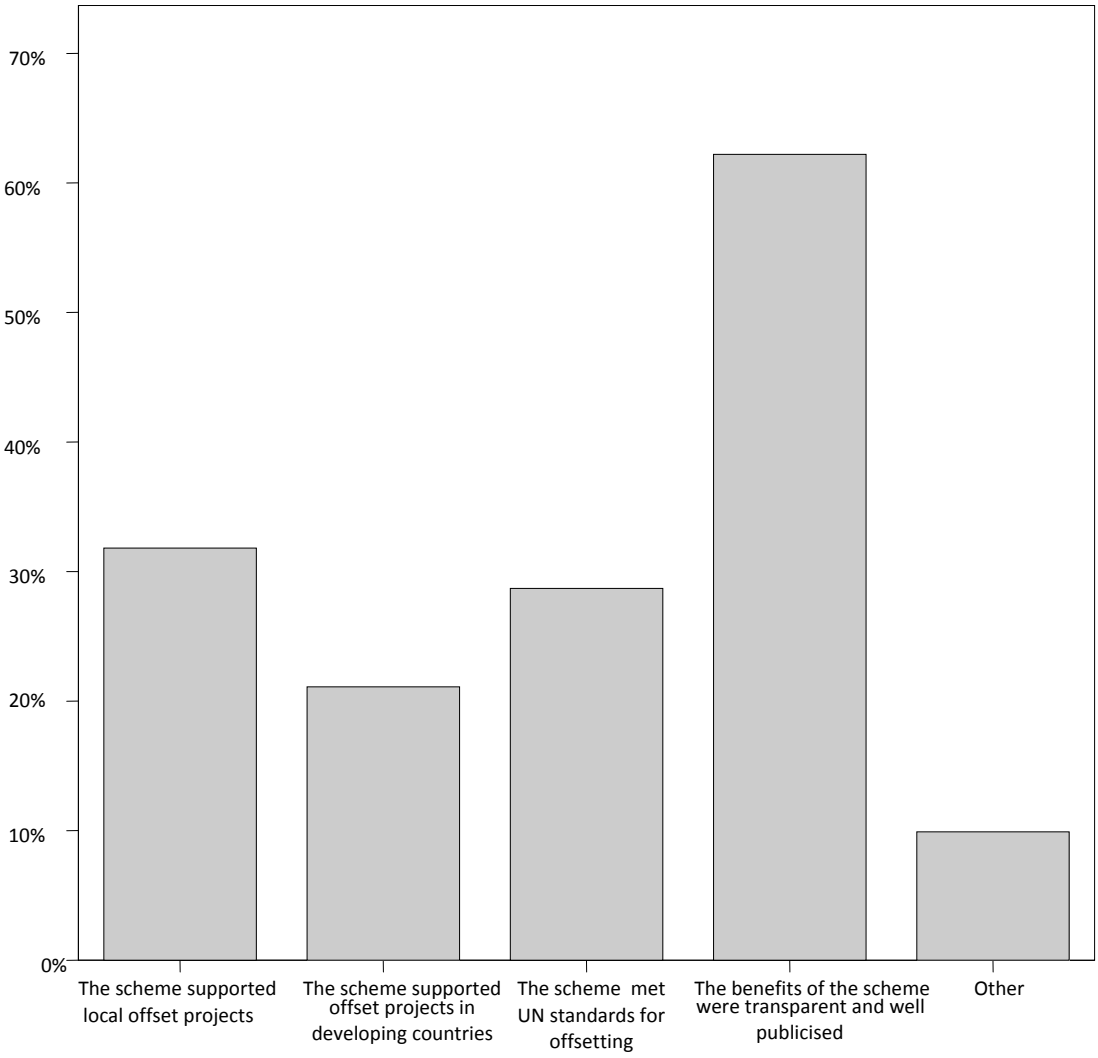

Figure 31: Factors increasing willingness to pay for offset

The responses given by the subset of respondents who answered 'other' are shown below:

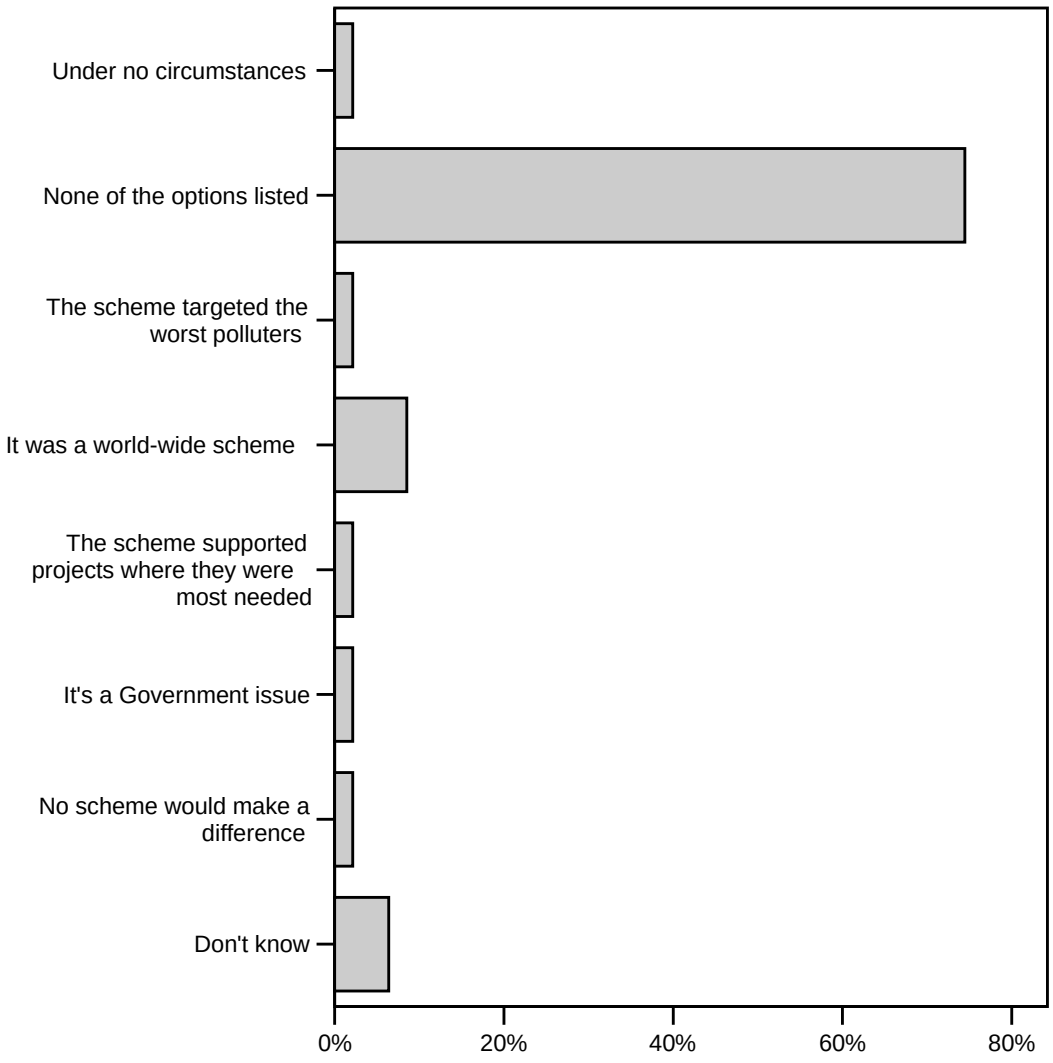

Figure 32: Other factors increasing willingness to pay for offset

The remaining questions were designed to collect demographic and socio-economic data, and details of the respondents' flights.

In Q20, respondents were asked to state their gender:

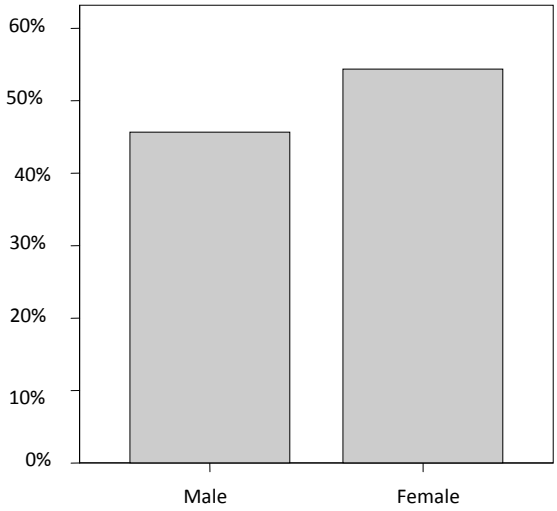

Figure 33: Gender

In Q21, respondents were asked which age group they belonged to:

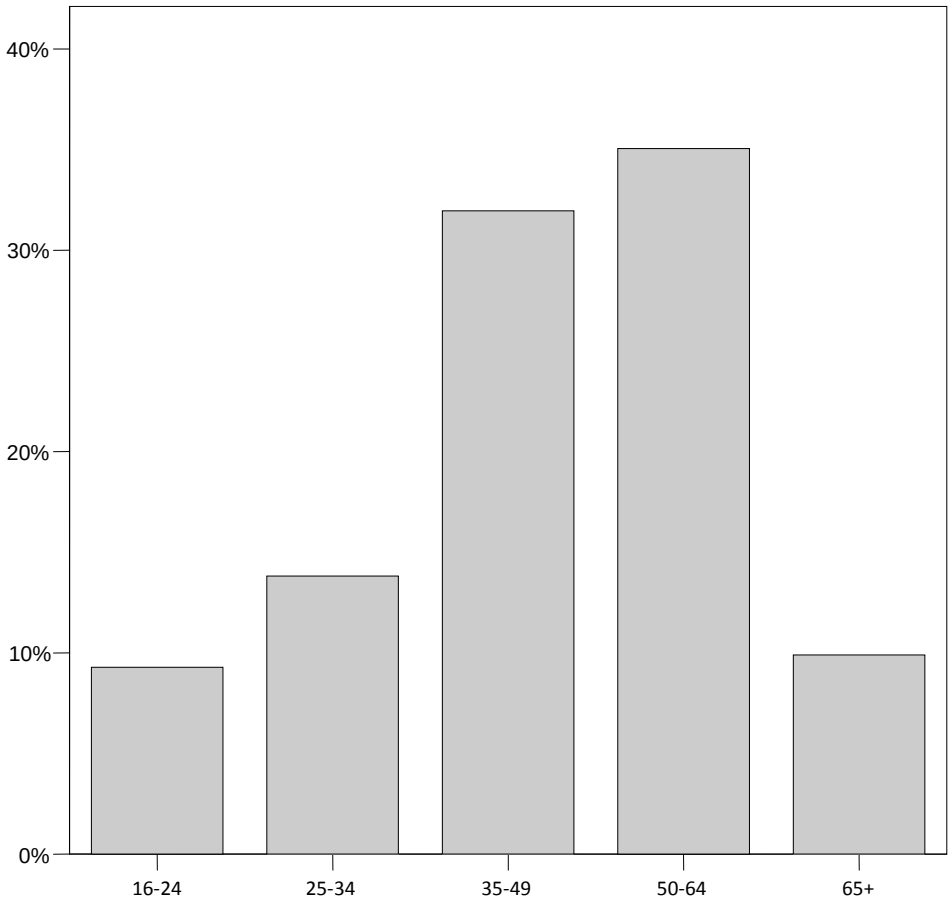

Figure 34: Age group

In Q22, respondents were asked whether they were resident in the UK or elsewhere:

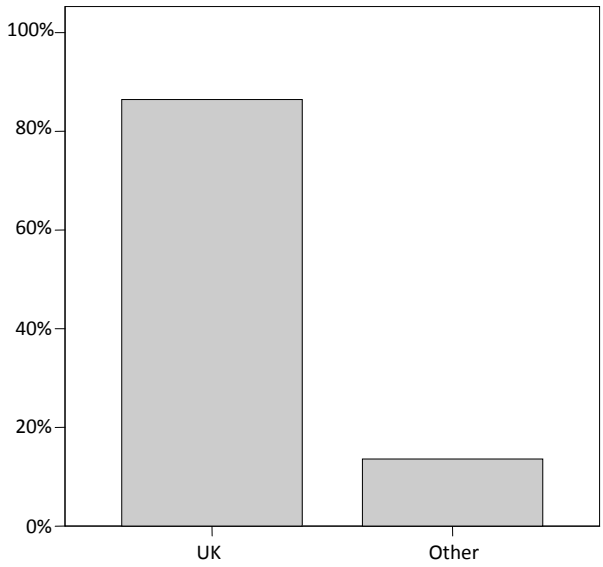

Figure 35: In which country do you live?

In Q23, respondents were asked which city or town they had travelled from to reach the airport. The approximate straight-line distances were calculated. Of the 472 respondents to this question, the approximate straight-line distances travelled to the airport ranged from 5 kilometres to 460 kilometres, with a mean of 51.78 kilometres (standard deviation = 47.31).

In Q24, respondents were asked to state their final (airport) destination. Those responses were categorised by region:

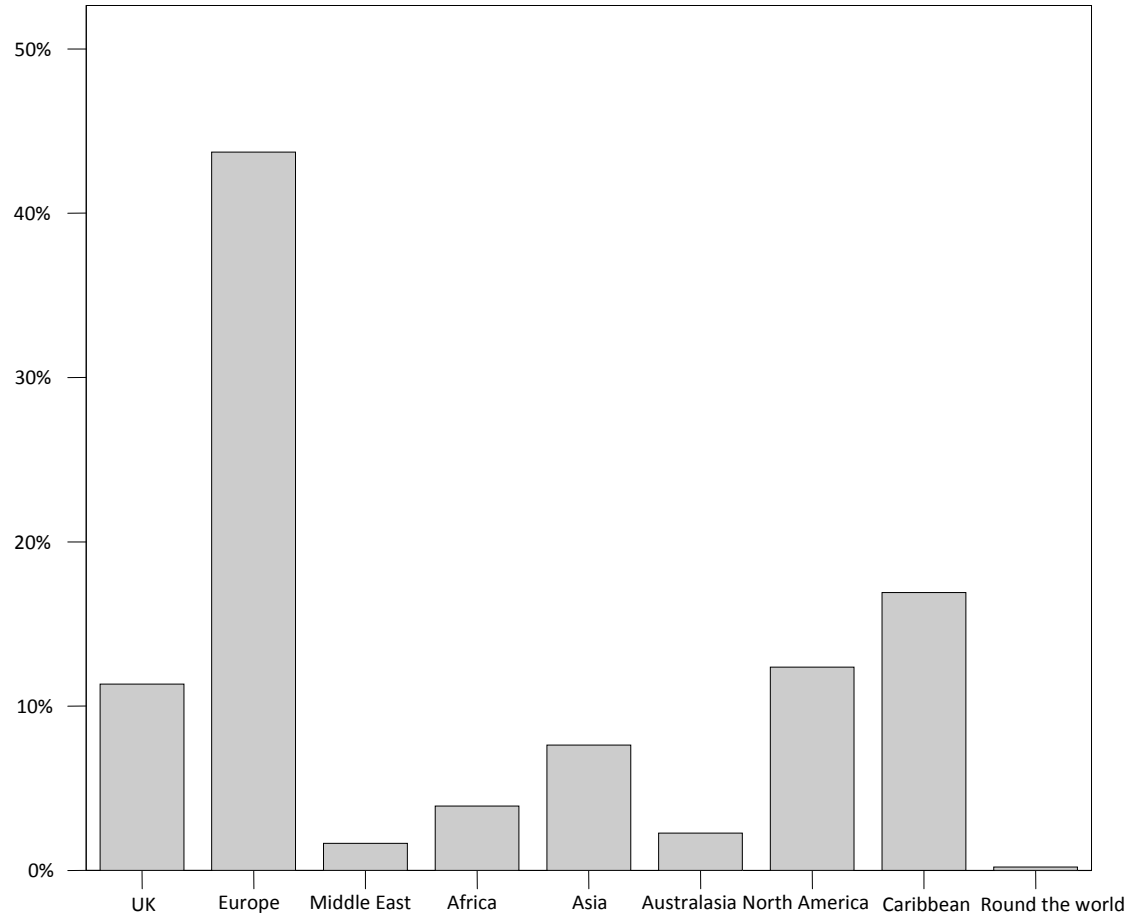

Figure 36: Final destination

Approximate great circle distances were calculated for each destination in order to estimate the distances flown. Of the 477 respondents to this question, the approximate distances flown ranged from 174 kilometres to 18,847 kilometres, with a mean of 4,118 kilometres (standard deviation = 3,655).

In Q25, respondents who were landing at an intermediate airport for transit were asked to identify that airport. Of the total sample, 125 passengers (25.6 per cent) identified a transit airport. Their responses were categorised by region:

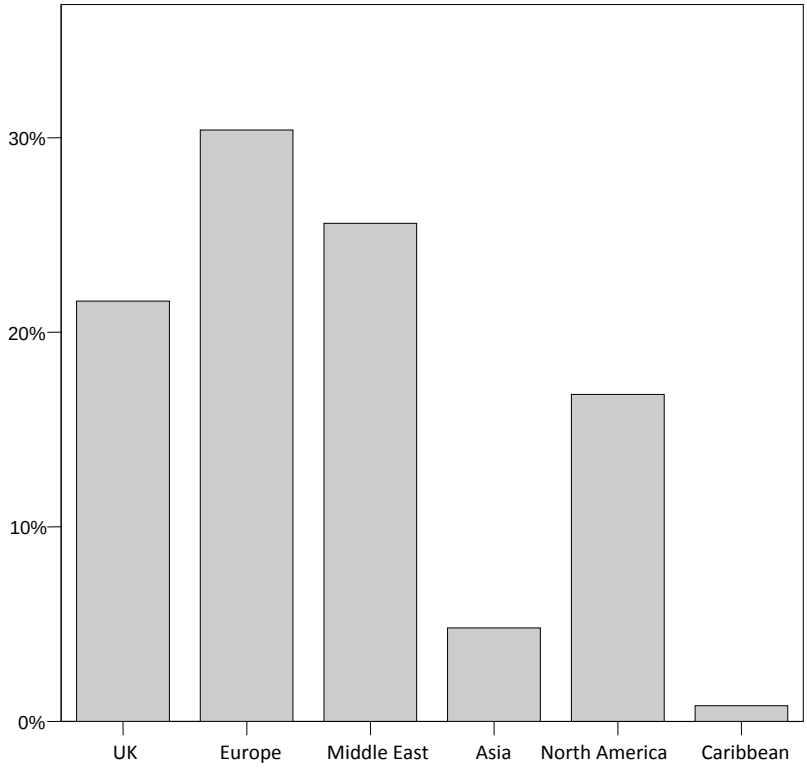

Figure 37: Transit airport region

In Q26, respondents were asked to state the type of ticket they were using for their flight:

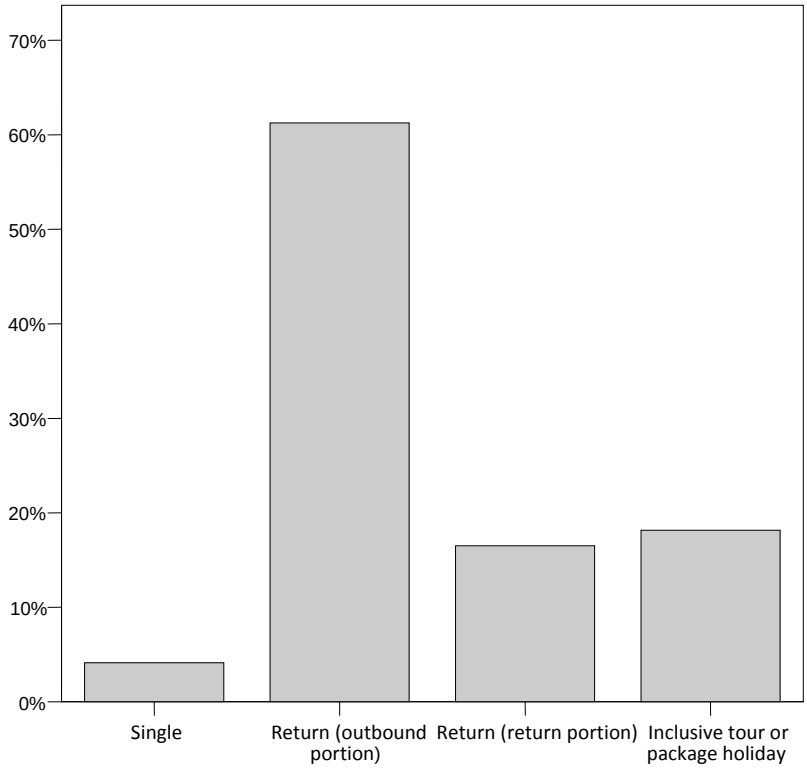

Figure 38: Ticket type

In Q27, respondents were asked how many people were travelling in their party:

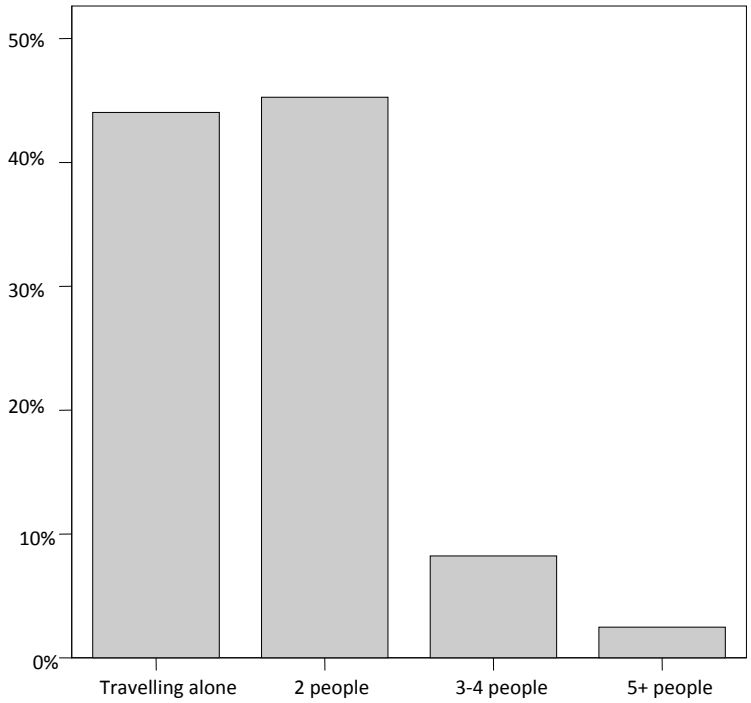

Figure 39: Number of people in party

In Q28, respondents were asked how many return flights they had taken in the past year (excluding their current flight):

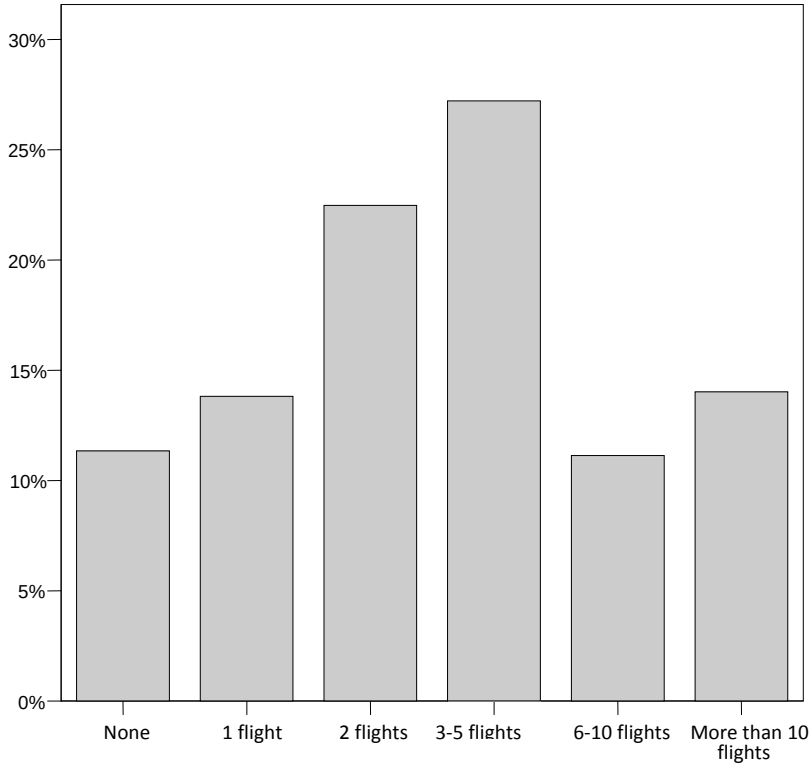

Figure 40: Number of return flights taken in the last year

In Q29, respondents were asked to state their current (or previous) occupation, and to indicate which standard category it belonged to:

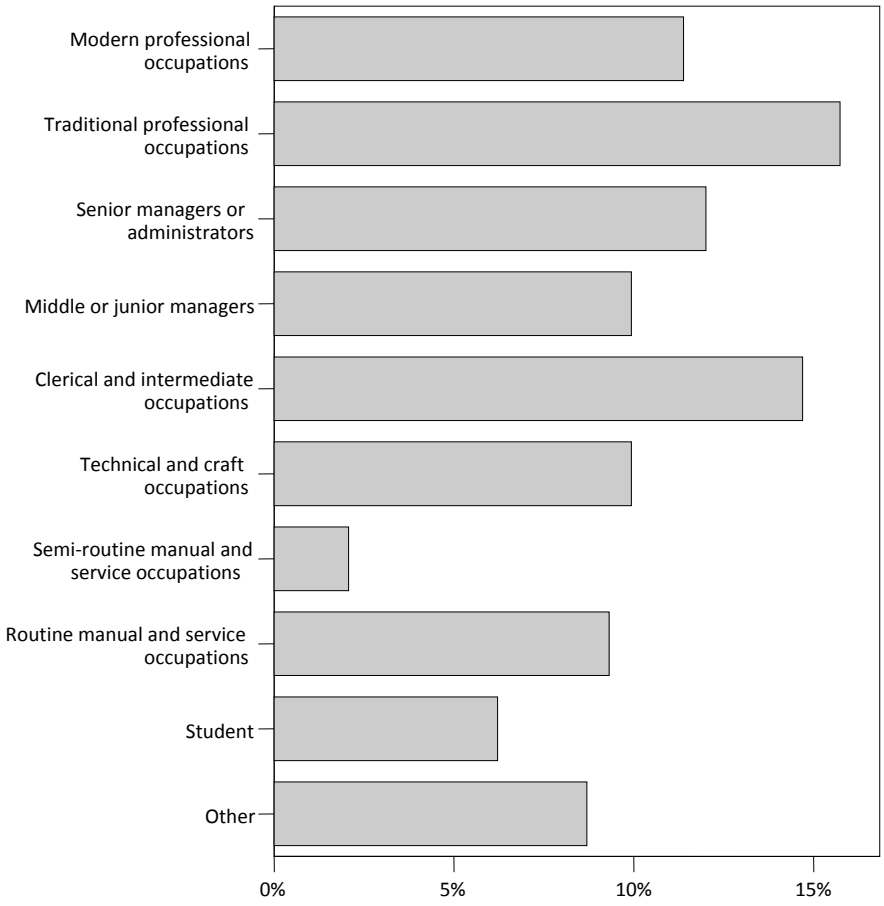

Figure 41: Participant occupation

In Q30, respondents were asked to indicate their total household income:

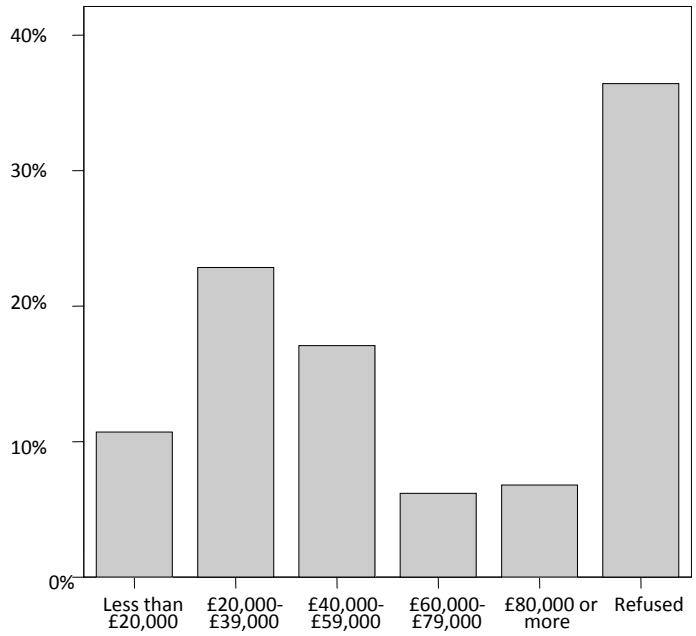

Figure 42: Total household income

In Q31, respondents were asked to state their flight number. These were used to determine the airlines used by passengers (although this did not take account for the possibility of code-sharing by airlines):

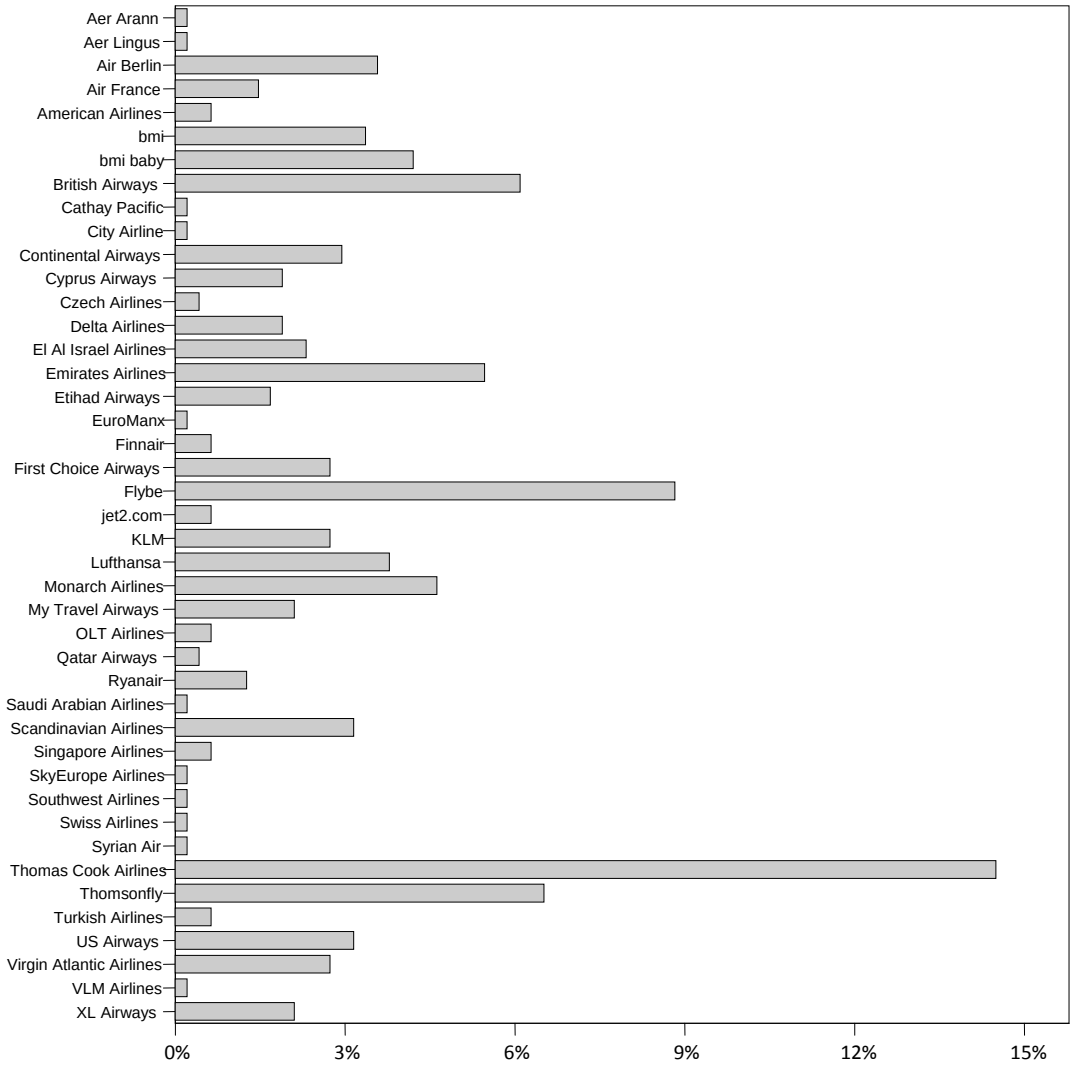

Figure 43: Airlines used by passengers

In Q32, respondents were asked to state the approximate cost of their flight. Of the 297 respondents to this question, the costs ranged from £0 (a passenger travelling for free) to £1,500, with a mean cost of £281.82 (standard deviation = 237.72).

The questionnaire results were next interpreted in terms of the strength of the associations between variables. All of the independent variables were cross-tabulated with all of the dependent variables; the values that were not significant at the $p<0.05$ level were excluded from consideration. Many results remained significant at much smaller levels, indicating that they are extremely unlikely to have occurred by chance; key emerging issues are discussed below.

4.5 Discussion

This survey represents a detailed investigation into the attitudes of air passengers at a major UK airport towards offsetting the climate impacts of their flights. Whilst the questions presented complex issues to passengers, using difficult terminology, the number and variety of responses to

questions – and the quality of the comments made by some respondents – indicated that passengers were generally able to engage with the survey questions. However, analysis of the results also suggests that a considerable degree of confusion exists amongst air passengers about the nature, purpose and methods of offsetting. The main issues emerging from our analysis of the results – and some common themes – are presented below.

4.5.1 Attitudes towards climate change and air transport

In terms of attitudes towards climate change and air transport generally, the large majority of respondents (87.5 per cent) believed that climate change is a genuine threat (stating that they 'agreed' or 'strongly agreed' with the statement). A large majority (77.8 per cent) believed that air transport has an influence on climate, and a smaller majority (54.7 per cent) believed that they could help to limit the effect of air transport on climate through their actions.

However, this general acceptance by passengers of the connection between air travel and climate change – and their broadly positive view of the ability of individual passengers to limit the climate effects of their flights – apparently did not translate into behavioural change: the very large majority of respondents (90.1 per cent) reported that their view of air travel and climate change did not affect their choices about flying.

One reason for this lack of conversion between attitudes and behaviour may be the perceptions held by passengers about who is (or should be) responsible for the climate impacts of flying. Although a majority of respondents believed that individual passengers could limit the climate effects of air travel, only 14.8 per cent believed that individual passengers are primarily responsible for aviation's climate impacts. Much higher proportions of respondents believed instead that the Government (40.7 per cent) or airlines (35.5 per cent) are primarily responsible for offsetting the climate impacts of flying.

In contrast, almost nobody (only 1.8 per cent of respondents) regarded airports as being primarily responsible for offsetting the climate impacts of flying.

4.5.2 Awareness of offsetting schemes

The large majority of respondents (78.0 per cent) had previously heard of offsetting schemes generally. A smaller proportion (44.9 per cent) had previously heard of offsetting schemes for flights. This suggests that many passengers may have encountered offsetting schemes elsewhere but are unaware that those schemes can also be used to offset the climate impacts of flying.

The idea that many passengers are not aware of aviation offsetting is further supported by the fact that the majority of respondents (57.2 per cent) reported that they did not know whether the airline they were flying with offered offsetting.

4.5.3 Use of offsetting schemes

A very large majority of respondents (93.0 per cent) reported that they had not – and did not intend to – offset the climate impacts of the flight that they were in the process of undertaking. A large majority (83.3 per cent) stated that they had never used an offsetting scheme.

Of the respondents who stated that they had not – and did not intend to – offset the emissions of their flight, many (41.7 per cent) reported that they did not know it was possible, and a smaller proportion (17.7 per cent) reported that they did not know how to do so. These responses support

the idea that many air passengers are unaware of, or confused about, the nature, purpose and methods of offsetting. In contrast, only very few respondents (20.3 per cent) stated that their reasons for not offsetting were that they did not believe existing schemes are effective (9.9 per cent), they did not believe the money would be invested properly (8.6 per cent) or that they could not afford to do so.

The reported behaviour of business travellers with respect to offsetting did not differ significantly from that of other passengers; only a small minority (4.5 per cent) reported that their companies had offset the climate impacts of their flight. The large majority of business travellers (70.3 per cent) reported that their companies had not purchased offsetting, and a significant proportion (25.2 per cent) did not know whether their companies had or not.

In terms of their attitudes, approximately half of the business respondents (49.5 percent) believed that their companies should offset the climate impacts of their flights.

4.5.4 Willingness to pay

A key feature of this study was the attempt to investigate the willingness of air passengers to pay to offset the climate impacts of their flights. We adopted a strategy of asking questions about willingness to pay both in terms of the proportion of the assumed costs of offsetting, and in terms of actual amounts. This strategy allowed us to compare responses for internal consistency and to explore whether the use of different terminology prompted different answers.

Using this approach, similar proportions of respondents reported that they were unwilling to pay for offsetting whether the question was presented in terms of a percentage of the cost (29.8 per cent of respondents being unwilling to pay) or in terms of an actual cost (25.4 per cent of respondents being unwilling to pay).

A small but notable proportion of respondents (17.7 per cent) were willing to pay the full cost of offsetting when the question was presented in terms of percentage of the cost. In contrast, when the same option was presented in terms of an actual cost, only 3.1 per cent of respondents were willing to pay the full cost of offsetting. This may reflect the fact that the use of the terminology of 'percentages' and 'proportions' can obscure the true cost of offsetting to a passenger, and that presenting the same individuals with the actual costs may make the decision to offset less appealing.

Thus the study revealed an interesting discrepancy when passengers were presented with the option to pay either nothing or the full amount to offset the climate impacts of their flights. However, between those two extremes, many passengers expressed willingness to pay part of the cost of offsetting. A significant proportion of respondents (28.4 per cent) stated that they would be prepared to pay half the cost of offsetting: after 'nothing', this represented the most popular response. The next most common response was £10 (27.3 per cent of respondents). A smaller proportion of respondents (18.8 per cent) reported being willing to pay £50. Overall, the fact that more respondents reported being willing to pay for offsetting when the question was presented in terms of actual costs rather than proportions or percentages suggests that passengers may better understand, and respond more positively to, that terminology.

4.5.5 Potential mechanisms of an aviation offsetting scheme

A number of issues relating to how a dedicated aviation offsetting scheme might work were investigated. A slightly larger proportion of respondents considered that any such scheme should be

voluntary (50.3 per cent) rather than compulsory (41.4 per cent) for all passengers, although the difference between these groups was not particularly large.

When asked whether airlines should legally be required to include the cost of offsetting in the ticket price, a majority of respondents (53.7 per cent) agreed that they should – although a significant minority (36.4 per cent) disagreed.

An even larger majority of respondents (66.7 per cent) reported that their preferred time and location of payment was at the point when they purchased their tickets. Only very small minorities reported preferences for paying on the Internet (6.8 per cent) or at the airport (4.1 per cent).

The issue of whether passengers would prefer to pay the actual cost of offsetting the climate impacts of their flights, or simply to pay a fixed rate charge, was a central research question in this study. The results indicate no clear preference amongst passengers, with 36.7 per cent of respondents preferring to pay for the actual offset costs and 36.9 per cent reporting a preference to pay a fixed rate charge. Again, a sizeable minority (21.4 per cent of respondents) maintained that they were unwilling to pay at all for offsetting.

Another key research area in this study was whether passengers would be more willing to pay for offsetting if certain aspects of the schemes were assured. The most important factor that could increase uptake of offsetting schemes, as 62.2 per cent of respondents reported, was that their benefits should be transparent and well publicised. The next most important factor was that they should support local projects (31.8 per cent of respondents). Smaller proportions of respondents stated that they would be more willing to pay for offsetting if schemes met UN standards (28.7 per cent) or if they supported projects in developing countries (21.1 per cent).

4.5.6 Associations between variables

The use of cross-tabulation revealed a range of associations between many of the variables in our study, allowing the responses of sub-groups of respondents to be explored in greater detail. However, it is important to emphasise that statistical evidence of an association between variables does not imply that a causal relationship exists.

The main associations are outlined below.

- **Patterns related to reason for flight -** Significantly more business travellers than expected (by statistical chance) reported that they were willing to use offsetting, and significantly more business travellers than expected were willing to pay the full cost of offsetting. In contrast, fewer leisure travellers than expected were willing to offset, and significantly fewer leisure travellers than expected were willing to pay the full cost of offsetting. Significantly more business travellers than expected reported that they would prefer to pay the actual cost of offsetting than to pay a fixed rate charge. In contrast, more leisure travellers than expected reported that they would prefer to pay a fixed rate charge than to pay the actual cost of offsetting.

- **Patterns related to passengers' attitudes to climate change generally -** The large majority of passengers agreed – or strongly agreed – that climate change is a genuine threat. There was a greater willingness to pay for offsetting than expected amongst passengers who strongly believed that climate change is a genuine threat. Those passengers were also much more willing than expected to pay a maximum £50 towards offsetting, and a smaller group

of those passengers were more willing than expected to pay a maximum of £100 towards offsetting.

Passengers who strongly believed that climate change is a genuine threat were much more likely than expected to believe that offsetting should be compulsory for all passengers. In contrast, passengers who agreed (but not strongly) that climate change is a genuine threat were much more likely than expected to believe that offsetting should be voluntary for all passengers.

Passengers who strongly believed that climate change is a genuine threat were also much more likely than expected to believe that airlines should legally be required to include the cost of offsetting in the ticket price. Conversely, passengers who disagreed that climate change is a genuine threat were more likely than expected to believe that airlines should *not* legally be required to include the cost of offsetting in the ticket price (although the latter group was much smaller than the former).

Passengers who strongly believed that climate change is a genuine threat were much more likely than expected to prefer to pay for offsetting when they purchase their tickets and were also much more likely than expected to pay the actual cost of offsetting the climate change impacts of their flight (as opposed to paying a fixed rate charge). In contrast, passengers who agreed (but not strongly) that climate change is a genuine threat were much more likely than expected to prefer to pay a fixed rate charge for offsetting (as opposed to paying the actual cost).

Overall, passengers who strongly believed that climate change is a genuine threat were much more likely than expected to prefer regulatory instruments to voluntary measures. Unsurprisingly, passengers who did not believe that climate change is a genuine threat were generally unwilling to pay for offsetting in any shape or form (although their numbers were relatively small).

- **Patterns related to passengers' attitudes to the influence of air transport on climate -** Those passengers who strongly agreed that air transport has an influence on climate were much more likely than expected to have offset the climate impacts of their flight, and to have previously used an offsetting scheme. The same effect was not apparent amongst the group of passengers who agreed (but not strongly) that air transport has an influence on climate.

  Passengers who strongly agreed that air transport has an influence on climate were much more likely than expected to be willing to offset the climate impacts of their flights, with many more of those passengers than expected being willing to pay half of the cost of offsetting. They were also much more likely than expected to be willing to pay a maximum of £50 to offset the climate impacts of a flight; they were much more likely than expected to believe that offset schemes should be compulsory for all passengers; and they were also much more likely to believe that airlines should legally be required to include offsetting in the ticket price.

  Those passengers who agreed (but not strongly) that air transport has an influence on climate were much more likely than expected to pay a maximum of £10 for offsetting, and a smaller number of those passengers were more likely than expected to pay a maximum of £50 for offsetting.

Unsurprisingly, those who disagreed that air transport has an influence on climate were much more likely than expected to be unwilling to pay anything for offsetting (although they represented a much smaller group than those who agreed with the statement). Those passengers were also more likely than expected to believe that airlines should *not* legally be required to include the cost of offsetting in the ticket price.

Passengers who agreed that air transport has an influence on climate were much more likely than expected to prefer to pay for offsetting when they purchased their tickets. Passengers who strongly agreed that air transport has an influence on climate were much more likely to be willing to pay the actual cost of offsetting (rather than a fixed rate charge), whilst passengers who agreed (but not strongly) with the statement were more likely to prefer to pay a fixed rate charge.

- **Patterns related to passengers' attitudes towards their capacity to limit the effect of air transport on climate by their actions -** The strongest associations found in the survey involved those passengers who believed that they can limit the effect of air transport on climate by their actions. Passengers who agreed – or strongly agreed – with the statement were very much more likely than expected to be willing to offset the climate impacts of their flights. They were also very much more likely to be willing to pay the full cost of offsetting. Those passengers were also very much more likely than expected to be willing to pay a maximum amount of £50 – or even of £100 – for offsetting. Those passengers were also very much more likely than expected to believe that offset schemes should be compulsory for all passengers. Passengers who agreed – or strongly agreed – with the statement were much more likely than expected to believe that airlines should legally be required to include the cost of offsetting in the ticket price, and to prefer to pay for offsetting when they purchased their tickets. They were also much more likely than expected to be willing to pay the actual cost of offsetting, although those who agreed (but not strongly) with the statement were also more willing to pay a fixed rate charge.

  In contrast, passengers who disagreed with the statement were highly unlikely to be willing to pay anything for offsetting, and those passengers were also more likely than expected to believe that offset schemes should be voluntary for all passengers.

- **Patterns related to passengers' choices about flying -** The large majority of passengers reported that their view of air travel and climate did not influence their choices about flying. This is not particularly surprising, given that the survey focused on individuals who had chosen to fly – and did not include those people who (for whatever reason) may have chosen not to fly during the survey period. Nevertheless, the survey revealed that a small but notable proportion of passengers reported that their view of air travel and climate *did* influence their choices about flying, and that those passengers were much more likely than expected to have offset the climate impacts of their flights. That minority of passengers were also much more likely than expected to be willing to pay the full cost of offsetting, and they were much more likely to pay a maximum cost of £50 for offsetting. Those passengers were much more likely than expected to believe that airlines should legally be required to include the cost of offsetting in the ticket price, and to prefer to pay for offsetting when they purchased their tickets.

- **Patterns related to passengers' views about responsibility for offsetting -** Unsurprisingly, passengers who believed that individual passengers should be primarily responsible for offsetting the climate impacts of flying were much more likely than expected to have offset the climate impacts of their flights – and to have previously used an offsetting scheme –

although they comprised a relatively small group of passengers. Those passengers were also very much more likely than expected to be willing to pay the full cost of offsetting, and to pay a maximum of £100 for offsetting. They were also much more likely to believe that offsetting should be compulsory for all passengers, and that airlines should legally be required to include the cost of offsetting in the ticket price. Those passengers were significantly more likely than expected to prefer to pay for offsetting when they purchased their tickets, and to prefer to pay either the actual cost of offsetting or a fixed amount, with little preference between those two options being apparent for this group of passengers.

Those who regarded the Government as being primarily responsible for offsetting the climate impacts of flying were much less likely than expected to have ever used an offsetting scheme, or to be willing to pay anything for offsetting. They were also much less likely than expected to prefer to pay the actual cost of offsetting over a fixed rate charge.

Those who believed that airlines are primarily responsible for offsetting the climate impacts of flying were much more likely than expected to be willing to pay half of the cost of offsetting; they were also more likely than expected to pay a maximum of £50 for offsetting.

- **Patterns related to previous experience of offsetting schemes -** Passengers who had previously heard of offsetting schemes – either in general, or specifically for aviation – were much more likely than expected to have ever used a scheme, and to have offset the climate impacts of their flights. They were also much more likely to be willing to pay either half of the cost of offsetting or the full cost. Those passengers were also much more likely to believe that offsetting should be compulsory for all passengers. They were more likely than expected to be willing to pay the actual cost of offsetting.

  In contrast, those who had not previously heard of offsetting were more likely to believe the schemes should be voluntary, and that airlines should not legally be required to include the cost of offsetting in the ticket price. They were also more willing to prefer to pay a fixed rate charge than to pay the actual cost of offsetting.

  Passengers who had previously heard of offsetting schemes for aviation were much more likely than expected to be willing to pay a maximum of £50 for offsetting, and to believe that airlines should legally be required to include the cost of offsetting in the ticket price.

  Passengers who had not previously heard of offsetting schemes for aviation were much more likely to be unwilling to pay for offsetting at all.

  Very few passengers reported that their airline offered offsetting, but those who did were very much more likely than expected to have ever used an offset scheme, and to have offset the climate impacts of their flights.

- **Patterns related to demographic and social factors -** Male passengers were more likely than expected to believe that airlines should legally be required to include offsetting in the ticket price.

  Passengers aged 16-34 were more likely than expected to be willing to pay for offsetting, and to pay the actual cost of offsetting rather than a fixed rate charge. Passengers aged 16-49 (especially those aged 25-34) were more likely than expected to be willing to pay the full cost of offsetting. Passengers aged 35-49 were slightly more likely than expected to prefer to pay a fixed rate charge than the actual cost of offsetting. Passengers aged 65+ were much

more likely than expected to be unwilling to pay anything for offsetting. Overall, older passengers were much less likely to be willing to offset than younger passengers.

- **Patterns related to ticket type and travel behaviour -** Passengers travelling as part of an inclusive tour or package holiday were very much more likely than expected to be unwilling to pay anything for offsetting.

  Passengers travelling alone were very much more likely than expected to be willing to pay the full cost of offsetting – and to pay the actual cost of offsetting rather than a fixed rate charge.

  In contrast, passengers travelling in parties of 2-4 people were much less likely to pay the full cost of offsetting – and were much more likely to be unwilling to pay anything at all for offsetting. Passengers travelling in parties of 2 people were more likely to prefer to pay a fixed rate charge than to pay the actual cost of offsetting.

  Passengers who had travelled on more than 10 flights in the previous year were much more likely than expected to have previously used an offsetting scheme.

- **Patterns related to occupational category -** Passengers in modern professional occupations were much more likely than expected to be willing to pay half the cost of offsetting – and were also much more likely to be willing to pay the full cost. Passengers in traditional professional occupations, and senior managers or administrators, were much more likely than expected to be willing to pay the full cost of offsetting. Passengers in modern or traditional professional occupations, and senior managers or administrators, were much more likely than expected to be willing to pay a maximum amount of either £50 or even £100 for offsetting. They were also more likely to believe that offsetting should be compulsory for all passengers, and that airlines should legally be required to include the cost of offsetting in the ticket price. Those passengers were much more likely to prefer to pay for offsetting when they purchased their tickets, and to pay the actual cost of offsetting (rather than a fixed rate charge).

  Middle or junior managers were much more likely to be willing to pay a maximum amount of £10 for offsetting; they were more likely than expected to believe that airlines should legally be required to include the cost of offsetting in the ticket price.

  Passengers in clerical and intermediate occupations were more likely than expected to prefer to pay a fixed rate charge than to pay the actual costs of offsetting.

  Passengers in technical or craft occupations, semi-routine manual and service occupations, or routine manual or service occupations, were much more likely to be unwilling to pay anything for offsetting. They were also much more likely to believe that airlines should *not* legally be required to include the cost of offsetting in the ticket price.

- **Patterns related to household income -** Passengers with a total household income of £80,000 or more were much more likely to have ever used an offsetting scheme.

  Passengers with a total household income of less than £20,000 were more likely than expected to prefer to pay the actual cost of offsetting (rather than a fixed rate charge) and were also much less likely to be unwilling to pay anything for offsetting.

Passengers with a total household income of £20,000-£39,000 were more likely than expected to prefer to pay a fixed rate charge rather than the actual costs of offsetting.

Passengers who refused to state their total household income were very much more likely than expected to be unwilling to pay anything for offsetting.

- **Areas where associations were expected but not found -** There were several areas in which associations between variables were expected, but no evidence of those associations was apparent from the cross-tabulation results (This is not to claim that no relationship exists, but simply that no evidence of any significant association was found in our study). Those areas are summarised below.

  In our results, there was no apparent relationship between attitudes towards offsetting (or offsetting behaviour) and destination region. Nor was there any apparent relationship between offsetting preferences and distance flown. This was unexpected, as passengers flying longer distances might be expected to be more willing to offset the climate impacts of their flights.

  Little relationship was apparent between offsetting preferences and the number of flights taken by passengers in the last year. Again, passengers flying relatively frequently might be expected to report a greater willingness to use offsetting.

  No clear relationship was apparent between offsetting preferences and total household income (although, since many passengers refused to state their income, any such relationship may have been obscured by a relatively low response rate for this question). This was unexpected as passengers with a higher total household income might be expected to be more willing to pay for offsetting.

  No relationship was apparent between passengers' offsetting preferences and the airlines used (although a large number of airlines operate at the study airport, and any such relationship may have been obscured by the small numbers of respondents for many of those airlines in this study). A relationship of some sort was expected, given that offsetting is a rapidly emerging market and some airlines are likely to have positioned themselves as lead-edge with respect to offsetting much more successfully than others.

  No relationship was apparent between offsetting preferences and cost of flight. Again, this was unexpected: passengers paying more for their flights might be expected to be more willing to use offsetting, perhaps because of greater ability to pay, or because the cost of offsetting would probably represent a smaller proportion of the cost of their flights.

4.5.7 A profile of 'lead-edge' aviation offsetting consumers

Following suggestions from stakeholders, the results of the questionnaire were used to derive a profile of 'lead-edge' aviation offsetting consumers: those passengers who were regarded as most willing to engage with offsetting the climate impacts of their flights. Analysis of our data indicates that the main features of this group of people are:

- They strongly agree that climate change is a genuine threat
- They strongly agree that air transport has an influence on climate
- They strongly agree that they can limit the impact of air transport on climate through their actions

- They report that their views towards the relationship between climate change and aviation affect their decisions about flying
- They have probably used an offsetting scheme before
- They believe that individual passengers are primarily responsible for offsetting the climate impacts of flying
- They are likely to believe that stronger regulation of human activity is required in relation to the climate impacts of flight
- They would prefer offsetting to be compulsory for all passengers
- They would prefer airlines to be legally required to include the cost of offsetting in the ticket price
- They would prefer to pay for offsetting when they purchase their tickets
- They would prefer to pay the actual cost of offsetting rather than to pay a fixed rate charge
- Whilst they would prefer to pay the actual cost of offsetting, they report being willing to pay up to £50 – or even £100 – for offsetting
- They are likely to be younger than 65 years old, and may be particularly likely to be in the 25-34 year age group
- They are very unlikely to be travelling on an inclusive tour or package holiday
- They are likely to be travelling alone
- They are likely to be working in modern or traditional professional occupations, or to be senior managers or administrators

It is important to emphasise that these characteristics relate only to what might be regarded as 'lead-edge' offsetting consumers: this list does not characterise all likely offsetting consumers. Furthermore, not all of the characteristics listed here will be found even in the most 'willing' offset-purchasers. However, this list provides an indication of the likely characteristics that might identify lead-edge consumers on a probabilistic basis.

Other profiles could potentially be derived from our data: for instance, a profile of passengers who do not represent lead-edge offsetting consumers, but who might nonetheless be willing to contribute something to offset the climate impacts of their flights – and who might represent much more of a 'typical' passenger in terms of their attitudes towards climate change, aviation and offsetting.

4.5.8 Indications of a greater willingness to engage with offset

A number of different responses to the questions indicated the considerable proportion of the passengers surveyed may be willing to contribute to some form of climate compensation scheme in the future. In summary:

- Nearly 70% of passengers acknowledged that air transport contributes to climate change and over 50% agreed, or strongly agreed, that they could limit the environmental impacts of air travel by their actions
- For 60% of respondents, the primary reason for not offsetting were that passengers 'did not know it was possible' or 'did not know how to' offset; rather than an inability or unwillingness to engage in the process
- Nearly 50% of business passengers thought that their companies should offset the climate impact if their flight
- When presented with an assumed cost to offset, over 45% of passengers indicated that they would be willing to pay at least half of the costs
- Over half of the sample indicated a maximum willingness to pay figure of between £10 and £100

- Over 40% of passengers felt that offsetting should be compulsory for all passengers and more than 50% thought airlines should be legally required to include the cost of offsetting within the ticket price
- Approximately a third of the respondents indicated a preference to pay the actual cost of offset, with a further third preferring to pay a fixed rate

Given these findings, and the strong association between those who believed that they can limit the effect of air transport on climate change by their actions and a willingness to pay the full cost to offset and the higher maximum values of £50 - £100, it would appear that a substantial minority of between 30 – 40% (excluding those already offsetting), would be willing to contribute to a climate change mitigation fund. If providers are to tap into this potential market then much needs to be done to raise awareness of the opportunities to offset and/or make the offset process much simpler (a simpler fixed fee may be most appropriate here) and a more attractive (by addressing some of the issues highlighted in Q19 – see Figure 31).

4.5.9 Implications for environmental education and awareness-raising

Our results have several implications for environmental education and awareness-raising in relation to offsetting; those implications are discussed below.

First, our results are consistent with other analyses of offsetting which indicate that consumer confidence in the activity may be seriously undermined by the wide variety in projects, cost of carbon, transparency, accountability, verification, additionality and robustness of offsetting schemes. Passengers' responses to questions – particularly their qualitative answers – indicate that considerable confusion exists among many passengers about the value, purpose and methods of offsetting. Many passengers expressed their confusion directly. Many others provided responses that suggested they did not sufficiently understand the principles underlying offsetting. Therefore, we argue that much more attention could be paid to communicating the purpose, principles and methods of offsetting to potential consumers.

Second, a large discrepancy exists between the attitudes held by passengers about the climate impacts of flying and their reported willingness to act to mitigate those impacts. One important factor in this lack of conversion between attitudes and behaviour may be that many passengers do not believe that they are primarily responsible for mitigating the climate impacts of their flights: instead, many passengers believe that the Government or airlines should play this role. Therefore, we propose that further debate could usefully occur in the public arena to clarify issues of responsibility and influence in relation to offsetting the climate impacts of flights. In addition, more work could be undertaken to highlight the links between individual choices about flying and the impacts on climate, and to emphasise the opportunities that offsetting offers to consumers who are concerned about the climate impacts of aviation.

Third, we suggest that dramatically improved consumer confidence is required if passenger uptake of offsetting schemes is to be increased. Such confidence could be improved by far greater transparency and accountability of the schemes. We argue that the passengers currently most likely to use offsetting providers are already aware of climate change issues and are strongly supportive of the need to support climate change mitigation initiatives. Those passengers are likely to be highly discriminating in terms of the benefits offered by offsetting schemes. Therefore, we argue that offsetting schemes could provide much more information to customers about the operation of their schemes and projects. This additional information should include technical details of the calculation of costs, as well as far more information about project benefits, carbon accountancy, additionality, verification, and even the sustainability performance of the offsetting companies themselves.

Fourth, we argue that greater standardisation between offsetting providers – and much clearer methods of communication of common standards and good practice to consumers – could be developed within the voluntary carbon market. Our results indicate that many passengers are concerned at the lack of standardisation in carbon markets and in institutional responses to climate change – including between countries – and that offsetting may be regarded by many as a relatively futile activity unless it occurs in a context of much more robust, standardised and widespread climate change mitigation activity. Such a view is consistent with the view that offsetting is not in itself a sufficient response to the challenge of climate change, but that it can nevertheless offer an immediate, pragmatic way in which individuals and organisations can begin to engage with that challenge.

4.6 Passenger survey conclusions

Our research explored a range of issues relating to climate change, aviation and offsetting, based on a questionnaire survey of passengers at a major UK airport. A key feature of the study was to investigate passengers' willingness to offset the climate impacts of their flights; we found evidence of a range of characteristics of passengers' attitudes towards – and behaviour in relation to – offsetting.

Most passengers agree that climate change is a genuine threat, and many accept the fact that air transport influences climate change. However, in general, this view did not translate into behavioural change – or even into positive attitudes towards offsetting. The very large majority of passengers (over 90 per cent) reported that their views towards air travel and climate change do not affect their choices about flying.

One reason for this lack of conversion between attitudes and behaviour may be the perceptions held by passengers about who is (or should be) responsible for the climate impacts of flying. Although many people believe that individual passengers can limit the climate effects of flying, only a minority believe that individual passengers are primarily responsible for those impacts. Instead, passengers look to either the Government or airlines to address the climate impacts of flying (although many accept that airlines should include the cost of offsetting in the ticket price). Almost nobody regarded airports as being primarily responsible for offsetting the climate impacts of flying.

A wide range of reasons for *not* offsetting were reported by passengers. Whilst those reasons generally reflected the view that individual passengers are not primarily responsible for the climate impacts of flying, they also suggest that considerable confusion exists about the nature, purpose and methods of offsetting. Whilst the majority of passengers had previously heard of offsetting schemes, a smaller proportion was aware that schemes could also be used to offset the climate impacts of flying, and some passengers reported that they did not know how to offset the impacts of their flights. Many passengers expressed doubts that offsetting is effective, that it is a suitable response to the challenge of climate change, or that the funds are used effectively. Consequently, a very large majority of respondents (93 per cent) had not – and did not intend to – offset the climate impacts of the flights that they were undertaking.

We found evidence of strong resistance to offsetting by a significant minority of passengers. This resistance was linked to some passengers' scepticism about climate science, about the role of air transport in driving climate change, about the responsibility of individual passengers to limit the climate impacts of their flights, and about the effectiveness of offsetting as a potential solution to the challenge of climate change. We found no evidence that passengers believed that they could

not afford to pay for offsetting: instead, their objections were related to the principles – rather than to the practicalities – of offsetting.

On the other hand, we found considerable evidence that those passengers who *are* willing to pay for offsetting may be much *more* willing – or willing to pay more – than might have been expected. This suggests that, if passengers generally understand the benefits of offsetting, they could lend strong support to the activity. However, it is worth emphasising that these findings relate to the *reported* willingness of passengers to pay – and that further investigation would be worthwhile in order to determine whether that reported willingness would translate into *actual* willingness to pay. This is particularly the case given that the offsetting market (and climate science in general) is rapidly evolving and that media messages about offsetting may be highly unstable.

We found that a large potential 'swinging vote' exists amongst air passengers (approximately one third of the respondents - see section 4.5.8): many passengers are unsure about the value and implications of offsetting, and they could perhaps be persuaded either way on the basis of appropriate information and evidence. Nearly half the passengers surveyed expressed a willingness to pay half or more of the cost of offsetting (see Figure 22).

Passenger uptake of offsetting could potentially be increased by a variety of means. One key finding in this respect is that passengers would be more willing to pay for offsetting if they could be provided with assurances about certain aspects of the schemes. Above all, many passengers (62 per cent) would be more likely to use offsetting if the benefits of the schemes were transparent and well publicised. Other ways in which uptake could potentially be increased include ensuring that schemes support local projects, that they meet UN standards, and that they support projects in developing countries.

One innovative feature of this study is that it explored issues relating to the terminology used in presenting options about offsetting to passengers. Our evidence suggests that the language of offsetting is complex and presents considerable challenges to offsetting providers in presenting choices to potential consumers in an optimal way. Overall, passengers could probably make more informed choices about offsetting if those choices were presented in terms of actual costs rather than proportions or percentages. Use of the terminology of 'percentages' and 'proportions' may obscure the true costs of offsetting to passengers; ideally, actual costs should be presented to potential consumers, to the extent possible.

A profile of lead-edge aviation offsetting consumers was developed in our study. That profile includes key indicators that might be used to identify the most 'willing' offsetting consumers. The strength of passengers' beliefs about the relationship between air transport, climate change and offsetting – and about the ability of individuals to limit the impacts of their flying behaviour – emerged as a key indicator of willingness to pay. Passengers who *strongly* believe that they can limit the effect of air transport on climate through their actions are very much more likely to use offsetting than any other group of passengers.

The study has identified several areas where relationships between offsetting preferences and other factors were expected, but not found. We found no evidence that flight distance, number of flights taken per year, household income, airline used or cost of flight influenced passengers' offsetting preferences to any significant extent. These effects may have been obscured by small response rates in certain sub-categories, or they may reflect the fact that a large group of potential offsetting consumers is currently not participating in the carbon market because of confusion or doubts about the value of offsetting.

Above all, our results indicate that considerable potential exists for the issues relating to climate change, air transport and offsetting to be communicated to passengers much more effectively. In particular, based on this research, we suggest that public messages about offsetting could be made significantly clearer and more consistent if greater uptake of offsetting is to be promoted.

5. Overall Project Conclusions

The previous sections have revealed that offsetting is a diverse and rapidly-growing voluntary carbon market, but that it is not a straightforward solution to the challenge of climate change. This is in part because offsetting is seen by some as a palliative, allowing 'unsustainable ' practices to continue, and in part due to doubts about the accountability, credibility, effectiveness and transparency of the schemes. However, offsetting does provide many stakeholders with the opportunity to make an immediate, practical response to concerns about the climate impacts of air travel when they choose to fly. As a means of raising awareness of climate change – and potentially of prompting more fundamental changes in attitudes and behaviour – it may therefore have considerable value. However, if this potential is to be realised, our study suggests that some key issues need to be addressed, most importantly these relate to:

- **Inconsistencies in service provision** – these were particularly evident in respect of the use of emissions calculators, the unit cost of emission reductions and therefore the price to offset a given flight. Furthermore, the range of factors influencing the quality of the offsets being sold was demonstrably extensive and complex; indeed the burgeoning number of verification schemes appears to confuse rather than simplify this situation.

- **Awareness and transparency** – the passenger survey suggests that a lack of awareness of offsetting services for aviation and/or understanding of how to utilise the services available, are major obstacles to uptake. This is compounded by a lack of transparency in schemes that inhibits potential customers who have got as far as investigating the options available.

On a more positive note, the passenger survey suggests that over a third of passengers would be willing to contribute to mitigate the climate change effects arising from their flights; but they are less concerned about the 'perfect' offset (i.e. the accurate calculation of carbon liability linked to the purchase of the verified equivalent of emissions reductions). This is not to suggest that mitigating actions need not be effective; rather that passengers seem to be motivated by a desire to simply contribute to climate change reduction (See willingness to contribute a proportion of the full offset cost in the passenger survey) and are not necessarily concerned about full compensation.

This raises an important question about the purpose of offset; if the intention is to raise as much money as possible to fund emissions reductions that compensate for behaviour that passengers seem reluctant to change, then simply offering an opportunity to contribute a fixed sum to climate compensation would appear to be very attractive. Certainly, the evidence presented here suggests that, assuming the effectiveness of actions can be demonstrated to potential customers (independent verification of tangible benefits is key here – see Figure 31) then the uptake of offset services could be increased substantially.

If, on the other hand, the aim of the voluntary offset sector is to pave the way for a comprehensive carbon market, then not only is a standard price for carbon imperative; but so is a rigorous and consistently applied mechanism for calculating the emissions arising from a given activity. Only in this way can the price to offset be compared with the marginal cost of behavioural change (to reduce inherent carbon intensity, avoid carbon emitting action, etc.) and thereby stimulate

economically efficient decision-making. In this instance, a common calculator needs to be agreed upon with sufficient resolution to capture those changes that should occur in the drive to reduce carbon intensities; this could involve agreement over the core variables and independent auditing of how they are manipulated to reflect the carbon efficiencies prevalent in a specific case (e.g. specific to an airline, airport, country, region, etc).

What appears to be emerging is an issue of choice: where customers simply want to make a contribution to climate change compensation, then a simple range of financial contributions linked to clear evidence of investment in effective and verified emissions reductions activity would seem to suffice. Where customers (through personal conviction or corporate desire to demonstrate carbon neutrality) wish to fully compensate for the carbon emissions resulting from their flights; then a rigorous and consistently applied carbon calculator needs to be used to establish full offset costs. It should be stressed that these are short-term options only as, ultimately, a comprehensive carbon market in which the price of carbon fully reflects its environmental and social costs should serve to stimulate investment in reducing the carbon intensity of all economic activities and, where this does not occur to a sufficient degree, to shift consumption away from carbon intensive actions.

5.1 Implications for the offset industry

In order to tap into the potential market of customers who desire simply to make a contribution to the climate change effects of flights, offset providers need to:

- Simplify and communicate the offset service – demonstrating clear links between financial contributions and concrete emissions reductions achieved
- Offer opportunities to make fixed financial contributions[18], as well as full compensation

More generally there is a need to:

- Remove unnecessary inconsistencies (that reduce confidence in the market) – for example in respect of the use of carbon calculators, or the price of carbon reduction.
- Clarify the nature of the offset product – thereby providing full explanation of the quality issues that affect the unit price for carbon emission reductions. Allowing customers to choose between different offset products appears a positive move.

5.2 Implications for Regulators

There are numerous agents acting for the standardisation of the voluntary offset market. The vast majority of these focus on verification of the product itself (i.e. establishing the emission reductions made by particular initiatives), through monitoring and accounting. Unfortunately, the number of verification bodies has increased dramatically and this further serves to complicate the market and confuse potential customers. In addition, the particular intermediary function played by the offset providers reviewed here in making a link between air passengers and offset products has been largely ignored by assurance agents. One notable exception is DEFRA's Draft Code of Best Practice

[18] First Choice has such an initiative with the World Care Fund (whereby customers donate £1 per adult and £0.50 per child in an 'opt-out' scheme matched by First Choice). To date, its customers have donated over £1 million since it launched the scheme in March 2007. The contributions are split between ClimateCare (80%) and The Travel Foundation (20%). The World Care Fund initiative has seen an overall uptake of 35% from customers to date - this year, enough money will have been raised to offset 250,000 tonnes of carbon dioxide [CO2], equivalent to 20% of First Choice Airways annual CO2 emissions. Carbon offsets are secured from ClimateCare by developing projects which are accredited to the Voluntary Gold Standard (Ashton, 2008).

for Carbon Offset Providers, which covers the whole of the offset process from the calculation of carbon liability, through internal financial procedures, to the utilisation of particular offset products. Significantly, however, the flight emissions calculator advocated by DEFRA differs in its output to the recently published ICAO calculator developed specifically for use by offset providers. International action is therefore required to:

- **Harmonise the approach to emissions calculation** – DEFRA and ICAO use the same core engine data and only differ slightly its manipulation to arrive at emissions totals for given flight. Whilst the rational for these differences may be entirely sound the impression is one of inconsistency. Agreement is needed over the core variables and how these should be adjusted to reflect the relative efficiencies of different system components depending upon city pairs, airline, etc.
- **Simplify verification systems** – the plethora of offset verification bodies and the range of auditing standards they apply threatens the very thing they seek to enhance; namely confidence in the voluntary offset market. Some rationalisation is needed here, or at the very least an internationally endorsed guide to verification standards and their relative strengths and weaknesses. The emerging DEFRA template offers one potential model for standardisation.

More broadly, given the low levels of awareness about the nature and role of voluntary offset service, there is a clear need for increased efforts to inform consumers about climate change and the range of actions individuals can take to influence the carbon emissions arising from their patterns of consumption.

5.3 Implications for Offset users

Given the market inconsistencies highlighted above, passengers wishing to use offset services should first decide whether they want to fully compensate for their flight emissions or whether they simply want to make a contribution to mitigate climate change. In the latter case, users of offset services should assure themselves of value for money by reference to the description of the offset actions and associated verification procedures. In the former case, users need to satisfy themselves that the emissions calculated for their flight are based on good practice and represent a their circumstances accurately (i.e. can the specific flight destination be catered for in the calculator, is seating class appropriate, etc.), as well as convinced that the offsets purchased are of good quality. In both cases, only offset providers with transparent and comprehensive service descriptions will provide access to the information needed.

5.4 Limitations to the study and future research

It should be recognised that this study only provides a snap-shot of the attitudes towards offsetting and the service provision itself in a fast changing market. Indeed, some of the key positive developments in the market such as DEFRA's draft good practice guide and ICAO's flight emissions calculator have emerged since core empirical work for this study was undertaken. Nevertheless, the study reveals some core foci for future developments and some significant choices in terms of the role of the voluntary market.

More work is needed to establish the potential market expansion that the suggested fixed rate offset contribution could deliver. Our results imply that potentially, in addition to the small proportion of current offsetters, a further one third of all passengers could reasonably be expected

to contribute to climate compensation; although, it is one thing to express a willingness to contribute and quite another to 'put your hand in your pocket'. A trial is needed to establish genuine capacity of passengers to fund offset at different rates when purchasing tickets (the most preferred option for paying offset).

Agreement on the core functionality of the emissions calculator is also needed. This requires an assessment of all stakeholder needs from individual passengers, to airlines, to businesses choosing between air services and offset providers, to organisations wanting to establish accurate emissions inventories.

The passenger survey also revealed a marked reluctance to change flying behaviour as a result of increasing concerns about climate change. However, this may not be representative of the population as a whole. A wider survey of the general public's attitudes towards climate change and the consumption of air services are required to provide further resolution on this issue.

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Glossary

Additionality:
Offset projects must demonstrate that emissions savings would not have happened as a result of 'business-as-usual'. Often this is achieved by restricting projects to non-Kyoto signatory countries as 'business-as-usual' does not include commitments to GHG reductions in these nation states.

Clean Development Mechanism (CDM):
As defined under Article 12 of the Kyoto Protocol, CDM allows countries with an emissions reduction or limitation commitment to implement projects in developing countries (non-Annex 1). Such projects can be used to earn saleable CERs credits and must be additional, subjected to rigorous public registration and assurance processes.

Certified Emissions Reductions (CERs):
Certified emissions reductions generated under the CDM, in developing countries (non-Annex 1 parties).

Carbon Dioxide Equivalent (CO_2e):
Carbon dioxide equivalent is a measure of the contribution of non-CO_2 GHGs and other contributors to global warming expressed as an equivalent of CO_2 emissions.

Carbon Offsetting:
Carbon offsetting is a mechanism for compensating for greenhouse gas emissions generated by a particular activity by paying for equivalent emissions savings or reductions to be made elsewhere in the economy.

Double-Counting:
Double-counting describes circumstances where emissions reductions are claimed/sold more than once e.g. a voluntary offset provider claims emissions reductions (possibly through renewable energy or energy efficiency), which are also being claimed by an energy provider as part of meeting their obligations.

European Union Emissions Trading Scheme (EU ETS):
The Phase 1 of the scheme began in January 2005 and ran until December 2007; it was the largest multi-sector, multi-country Greenhouse gas emission trading scheme (a 'cap-and-trade' system) at that time. It had two main elements:

1. Carbon dioxide limits applying to sectors
2. A system of trading allowances

The trading registry was overseen by a Central Administrator at the EU level through the Community independent transaction log. The scheme also allowed companies to use credits from Kyoto based projects (i.e. CDM) to help them to comply with their obligations/limits under the scheme. Phase 2 will run from 2008 to 2012.

Great Circle Distance (GCD):
The great circle distance is the distance between the origin and destination of two points on the Earth's surface, for example two airports, derived from the latitude and longitude co-ordinates.

Gold Standard (GS):
The Gold Standard is a quality assurance label applying to CDM/JI and voluntary offset projects.

Radiative Forcing (RF):
Radiative forcing is calculated in Watts per m^2 and represents the change in energy received at the surface of the earth as a result of the emission of GHGs. A positive radiative forcing tends on average to warm the surface of the Earth, and negative forcing tends on average to cool the surface.

Radiative Forcing Index (RFI):
The radiative forcing index is the total radiative forcing from emissions generated by a particular activity - e.g. emissions from flights - compared to that of CO_2 emissions alone from the same activity (i.e. a RFI of 1.9 implies that the total radiative forcing from aircraft emissions over a given time is 1.9 times that resulting from CO_2 emissions alone).

Sequestration:
The uptake and storage of carbon. Sequestration projects include land use projects (forestry and no-till farming) and geological sequestration projects

Appendix A: List of stakeholder organisations consulted

Airport Operators Association (AOA)
Aviation Environment Federation (AEF)
British Air Transport Association (BATA)
Councillor Neil Swannick
Department for Environment, Food and Rural Affairs (DEFRA)
Department for Transport (DfT)
KGS Limited
Lord Peter Smith of Wigan
Manchester Airports Group
Manchester City Council
Manchester Knowledge Capital
Manchester Metropolitan University
Northwest Regional Development Agency (NWDA)
Omega Partners

Appendix B: List of offset providers used in provider review.

Offset provider	Website address
Air Canada with Zerofootprint	http://www.aircanada.com/en/travelinfo/traveller/zfp.html
Air France with Action Carbone	http://development-durable.airfrance.com/FR/en/local/calculateurCO2/calculateurAccueil.htm
Atmosfair	http://www.atmosfair.de
Better World Club with LiveNeutral	http://www.betterworldclub.com
Carbon Balanced (World Land Trust)	http://www.carbonbalanced.org
Carbon Clear	http://www.carbon-clear.com
CarbonCounter.org for The Climate Trust	http://www.carboncounter.org
Carbon Footprint	http://www.carbonfootprint.com
Carbonfund.org	http://www.carbonfund.org
CarbonNeutral Newcastle	http://www.carbonneutralnewcastle.com
Carbon Passport	http://www.carbonpassport.com
Carbon Planet	http://www.carbonplanet.com
Carbon Reduction Institute	http://www.noco2.com.au
CarbonZero	http://www.carbonzero.ca
carboNZero with EBEX21	http://www.carbonzero.co.nz/
Clear	http://www.clear-offset.com
Climat Mundi	http://www.climatmundi.fr
Climate Care	http://www.climatecare.org
Climate Friendly	http://www.climatefriendly.com
Climate Neutral Group with GreenSeat	http://www.climateneutralgroup.com
co2balance	http://www.co2balance.com
Conservation Fund: Go Zero	http://www.conservationfund.org
Conservation International	http://www.conservation.org
Driving Green	http://www.drivinggreen.com

Envirotrade	http://www.envirotrade.co.uk
Friends of Conservation	http://www.foc-uk.com
Green My Flight	http://www.greenmyflight.com
Growaforest	http://www.growaforest.com
Moor Trees	http://www.moortrees.org
*Native*Energy	http://www.nativeenergy.com
Offsetters	http://www.offsetters.ca
PRIMAKLIMA-weltweit	http://www.prima-klima-weltwiet.de
Pure – The Clean Planet Trust	http://www.puretrust.org.uk
Scandinavian Airlines with The CarbonNeutral Company	http://sasems.port.se/EmissionCalc.cfm?lang=1&utbryt=0&sid=geninfo&left=geninfo?WT.ac=CO2&ID=60091
Sustainable Travel International	http://www.sustainabletravelinternational.org
Swiss International Airlines with myclimate	http://www.swiss.com/web/EN/services/additional_services/Pages/co2_compensation.aspx
TerraPass	http://www.terrapass.com
the c-change Trust	http://www.thec-changetrust.org/
Tree Canada	http://www.treecanada.ca
Trees for Travel	http://www.treesfortravel.nl
Uncook the Planet	http://www.uncook.com
Virgin Blue	http://www.virginblue.com.au/carbonoffset/

Appendix C: Climate Compensation Questionnaire

KGS LTD
RESEARCH HOUSE, ROLSTON ROAD, HORNSEA, HU18 1UR. TEL (01964) 535181

Interviewer: _____ Job No: 4917

Date of interview: _____ Q're No. _____

Date of Design: 21/11/07 - CC/EC–V2 - CH260

Start time of interview	:	End time of interview	:	Please use 24hr clock

T1	1	T2	2	T3	3

CLIMATE CHANGE COMPENSATION QUESTIONNAIRE

Introduction: This questionnaire is being conducted on behalf of the Centre for Air Transport and the Environment at Manchester Metropolitan University. We are carrying out research into climate change compensation schemes. Would you be willing to take part in the research? It involves completing a questionnaire, which will take about 5 minutes. This survey is completely anonymous and your response will be treated in confidence.

QA. What is the reason for your flight today?

A. Business	1
B. Leisure	2
C. Visiting friends and relatives	3
D. Other (state)	4

(1.) READ TO INTERVIEWEE:
In this questionnaire, we would like to ask you about schemes to compensate for the climate impacts of flying. There are some schemes that allow air travellers to pay a certain amount to offset the carbon dioxide emissions of their flight. This questionnaire aims to find out how aware people are of these schemes, whether people are willing to take part in them, and how they could be improved.

This first section asks what you think about air travel and climate change

Q1. To what extent do you agree with the following statements? SHOW CARD A

ROTATE START:	Strongly agree	Agree	Neither / nor	Disagree	Strongly disagree
A. Climate change is a genuine threat	1	2	3	4	5
B. Air travel has an influence upon the world's climate	1	2	3	4	5
C. I can help to limit the effects that air travel has on climate through my actions	1	2	3	4	5

Q2. Does your view on the relationship between air travel and climate change influence the number of flights you take or the distance you fly?

A. Yes	1
B. No	2
C. Don't know	3

(2.) READ TO INTERVIEWEE:
There is agreement among leading scientists that human activities are causing climate change. Many of our activities – such as travelling and heating our homes – produce greenhouse gases (including carbon dioxide), which cause global warming. The impacts of air travel on climate have received considerable attention recently, because air travel is expected to grow rapidly over the next 20 years. The impacts of air travel on climate are also expected to increase.

Q3. Which of the parties shown on (SHOW CARD B) should primarily be responsible for compensating for the impacts of flying on climate? PLEASE SELECT ONE ONLY

A. Individual passenger	1
B. Airlines	2
C. Airports	3
D. The government	4
E. Other (state)	5

NOTE TO INTERVIEWER: In this section, we are investigating the opinions of all travellers, regardless of whether or not they are travelling on business. Please emphasise to the respondent that, in this section, they are asked to respond from a personal perspective.

(3.) READ TO INTERVIEWEE:
There are schemes that allow people to compensate for the climate impacts of their activities. These schemes invest in projects that prevent or reduce greenhouse gas emissions in this country or in other parts of the world. Projects include building wind farms, installing low electricity light bulbs, and protecting or planting forests.

Q4. Before today, had you heard of carbon offset schemes in general?

A. Yes	1
B. No	2

Q5. Before today, had you heard of schemes offering to compensate for the climate change impacts of flying?

A. Yes	1
B. No	2

Q6. Does the airline you are flying with today offer you the option to compensate for the climate change impacts of your flights?

A. Yes	1
B. No	2
C. Don't know	3

Q7. Did you / or do you intend to compensate for the climate change impacts of your current flight?

A. Yes	1
B. No	2

Q8. Have you ever used a scheme to compensate for climate change?

A. Yes	1	SKIP TO Q10 IF TRAVELLING ON BUSINESS, Q12 IF NOT
B. No	2	CONTINUE

Q9. If you have never paid to compensate for the climate change impacts of a flight, why not? PROBE BUT DO NOT PROMPT – MULTIPLE ANSWERS ALLOWED – PLEASE TICK ALL THAT APPLY

	TICK(✓)
A. Did not know it was possible	
B. Did not know how to do so	
C. Could not afford to do so	
D. Don't believe existing schemes would actually compensate for the real climate change impacts of my flight	
E. Don't believe the money would be invested properly	
F. Other (state)	
G. Don't know	

ASK BUSINESS TRAVELLERS ONLY (FROM QA. others go to Q12.)
Q10. Has your company compensated for the climate change impacts of your flight today?

A. Yes	1
B. No	2
C. Don't know	3

Q11. Do you think your company <u>should</u> compensate for the climate change impacts of your flight today?

A. Yes	1
B. No	2
C. Don't know	3

This section makes some assumptions about the costs of climate compensation.

NOTE TO INTERVIEWER: In the following questions, we are using some illustrative figures to explore the idea of compensating for the climate impacts of flying, based on ICAO estimates. There is a lot of uncertainty about the climate impacts associated with flight.

(4.) READ TO INTERVIEWEE:
Assuming the costs of compensating for the full climate change impacts of a return flight are: **(SHOW CARD C)**

Flights within the UK: £3 - £5
Flights within Europe: £3 (Paris) - £15 (Cyprus)
Intercontinental: £30 (Dubai) - £150 (Sydney)

Q12. Given these estimated costs, what proportion of the total cost of compensating for the climate change impacts of your current flight would you be willing to pay? ASK BUSINESS TRAVELLERS TO ASSUME THAT THEY PAID FOR THEIR OWN FLIGHT.

A. Nothing	1
B. Half	2
C. Three-quarters	3
D. All	4
E. Other proportion (state)	5
F. Don't know	6

Q13. Is there a <u>maximum</u> amount you would be willing to pay – regardless of your destination – for compensating for the climate change impacts of your flight?

A. £10	1
B. £50	2
C. £100	3
D. Other amount (state) £	4
E. Not prepared to pay for climate change	5

Q14. ASK IF ANSWERED 'Nothing' at Q12., and/or 'Not prepared to pay' at Q13., why do you feel this way?

_____

_____

_____

_____

_____

This section asks about how climate compensation schemes might work.

Q15. Should schemes to compensate for climate change be voluntary or compulsory?

A. Voluntary for all air travellers	1
B. Compulsory for all air travellers	2
C. No preference	3
D. Don't know	4

Q16. Do you think airlines should be legally required to include the cost of compensating for climate change in the ticket price?

A. Yes	1
B. No	2
C. Don't know	3

Q17. In which of the ways shown on (SHOW CARD D) would you prefer to pay to compensate for the climate impacts of your flight? ONE ANSWER ONLY PLEASE

A. When I purchase my ticket	1
B. At the airport	2
C. On the internet at a time of my choice	3
D. Other (state)	4
E. Not willing to pay for climate compensation	5

Q18. Would you prefer to pay for the actual climate change impacts of your flight, or to pay a fixed amount regardless of how far you were flying?

A. Pay for the actual climate change impacts of my flight	1
B. Pay a fixed amount	2
C. Not willing to pay for climate compensation	3
D. Unsure	4

Q19. Which, if any, of the following considerations shown on (SHOW CARD E) make you more willing to pay to compensate for the climate change impacts of your flight? MULTIPLE ANSWERS POSSIBLE – PLEASE TICK ALL THAT APPLY

	TICK(✓)
A. The scheme supported local climate change compensation projects	
B. The scheme supported climate change compensation projects in developing countries	
C. The scheme met UN standards for climate change compensation	
D. The benefits of the scheme were transparent and well published	
E. Other (state)	

This final section asks some facts about you

Q20. Gender:

A. Male	1
B. Female	2

Q21. Which of the following age groups do you fit into? (SHOW CARD F)

16 – 24	25 – 34	35 – 49	50 – 64	65+
1	2	3	4	5

Q22. In which country do you live?

A. UK	1
B. Other (state)	2

Q23. Which city/town have you travelled from today? _____

Q24. What is your final <u>airport</u> destination? _____

A. Within the UK	1
B. Europe	2
C. Middle East	3
D. Africa	4
E. Asia	5
F. Australasia	6
G. North America	7
H. Caribbean	8
I. South America	9
J. Round the World	t

Q25. Where will you land first today (if on more than one flight)? _____

A. Within the UK	1
B. Europe	2
C. Middle East	3
D. Africa	4
E. Asia	5
F. North America	6
G. Caribbean	7

Q26. What type of ticket are you using today?

A. Single ticket	1
B. Return ticket (outbound portion)	2
C. Return ticket (return portion)	3
D. Inclusive tour or package holiday	4
E. Other type of ticket (e.g. round the world)	5

Q27. How many people are flying in your party?

Travelling alone	2 people	3-4 people	5+ people
1	2	3	4

Q28. How many return flights have you taken in the past year (i.e. since January 2007) (excluding today)?

None	1 flight	2 flights	3-5 flights	6-10 flights	More than 10
1	2	3	4	5	6

Q29. What is your occupation? _____

Please indicate which of the following best describes the sort of work you do (SHOW CARD G). If you are not working now, please tick a box to show what you did in your last job.

A. Modern professional occupations	1
B. Traditional professional occupations	2
C. Senior managers or administrators	3
D. Middle or junior managers	4
E. Clerical and intermediate occupations	5
F. Technical and craft occupations	6
G. Semi-routine manual and service occupations	7
H. Routine manual and service occupations	8
I. Student	9
J. Other (state)	t

Q30. What is your total household income? SHOW CARD H

Less than £20,000	£20,000 - £39,999	£40,000 - £59,999	£60,000 - £79,999	£80,000 or more	Refused
1	2	3	4	5	6

Q31. What is your flight number for today's flight from Manchester? _____

Q32. What was the cost of your flight today (approximately)? _____

THANK YOU VERY MUCH FOR YOUR HELP

You will be able to find out more about the results of this study by visiting the Manchester is My Planet website at **www.manchesterismyplanet.com**

Appendix D: Hypothesis testing variables

The table below contains the variables used for hypothesis testing. Each independent variable was cross-tabulated with each dependent variable.

In the column labelled 'Dependent', two categories of indicator were defined. Five variables were used to indicate 'willingness to offset'; a further four variables were used as indicators of respondents' preferences about the nature of offsetting schemes.

Independent	**Dependent**
QA: Reason for flight (business/leisure/visiting) Q1A: Belief about threat of climate change Q1B: Belief about impacts of air travel on climate Q1C: Belief about significance of their actions Q2: Willingness to act on their beliefs Q3: Belief about which party is responsible Q4: Awareness of offsetting generally Q5: Awareness of offsetting for flights Q6: Awareness of airline offsetting services Q9A: Did not know it was possible Q9B: Did not know how to do so Q9C: Could not afford to do so Q9D: Don't believe schemes are effective Q9E: Don't believe money used properly Q9F: Other reasons not to offset Q11: Belief about company offsetting Q14: Reasons not prepared to pay Q19: Reasons more prepared to pay Q20: Gender Q21: Age group Q22: Country of residence Q23: Distance travelled to airport Q24: Distance flown Q26: Ticket type Q27: Number in party Q28: Number of flights in last year Q29: Occupation category Q30: Total household income Q31: Airline Q32: Cost of flight	WILLINGNESS TO OFFSET: Q7: Willingness to offset Q8: Previous use of offsetting Q10: Company use of offsetting Q12: Willingness to pay (proportion) Q13: Willingness to pay (amount) NATURE OF SCHEMES: Q15: Voluntary or compulsory Q16: Included in ticket price Q17: Payment preferences Q18: Actual cost or fixed amount