

From the Minister

'The earth is the Lord's and all that is in it', declares David in Psalm 24. 'Arise, LORD! Lift up your hand, O God. Do not forget the helpless', cries the Psalmist in Psalm 10. 'Blessed is he who has regard for the weak', teaches David in Psalm 41.

God owns our world; God helps the helpless; God wants his children to be blessed by showing his love for the weak. These three facts compel us to examine our stewardship of the environment that God made for humanity and to have regard for those among the poorest of our fellow-creatures whose lives will be most affected by even one degree of warming, or by a 1% increase in the incidence of malaria or a one metre rise of sea level.

So when the Deacons' Court had the opportunity to ask a group within the fellowship to study our congregational carbon footprint, we did.

We are well aware of the global irrelevance of our tiny carbon footprint; reducing it will make no noticeable effect on the global climate whatsoever. We emit about 104 tonnes of carbon dioxide a year from our activities at this building. Longannet Power Station in Fife produces around 10 *million* tonnes in the same time. 10 years of Longannet's output matches about one week's worth of China's current emissions. It would take Gilc nearly 1 million years to produce that much!

We're not trying to save a world which one day will be rolled up; nor are we trying to make a trendy political statement or a politically correct social one. We're Christians: we want to let the voice of the Psalmist shape what we do with what we have, because the Psalms speak for God whom we honour with responsible service. However small or great the outcomes, we listen to God's word.

The Audit group's report gives us a helpful snapshot of our developing congregation's hidden impact. It forms part of a more aware, thoughtful and responsible strategy for using the resources that the Lord has given us for his mission in this world, both here and wherever we spend the rest of our time. The group's suggestions for simple actions to reduce our carbon footprint are already being looked at by the Deacons' Court and we expect others to emerge from the Court's discussions.

I am glad to commend the report of the carbon footprint audit.

Dominic Smart

May 2009

**GILCOMSTON SOUTH CHURCH
ABERDEEN**

**Carbon Footprint Audit
January to March 2008**

Report to the Kirk Session and Deacons' Court

December 2008

Report of the Carbon Footprint Audit undertaken January to March 2008

CONTENTS

	Page
List of tables	2
Foreword	3
Congregational summary	5
Introduction	9
Audit Findings	
1. Use of gas	9
2. Use of electricity	12
3. Travel	15
4. Waste	19
5. Water	20
6. Purchasing	20
7. Summary	21
A summary of the scientific context	22
Gilcomston's response	24
Possible action	24
Appendix 1 : Temperatures 26 February to 24 March 2008	26
Appendix 2 : Greenhouse gases	28
References	29

Gilcomston South Church, Aberdeen
Report of the Carbon Footprint Audit undertaken January to March 2008

LIST OF TABLES

	Page
Gilcomston's approximate annual emissions of carbon dioxide	7
1. Gas consumption November 2006 to October 2007	10
2. Gas consumption week beginning 24 February 2008	11
3. Annual CO ₂ emissions from use of gas by activity	12
4. Electricity consumed November 2006 to October 2007	13
5. Electricity consumption week beginning 24 February 2008	14
6. Annual emissions of CO ₂ from use of electricity by activity	15
7. Average emissions of CO ₂ by public transport per passenger km	16
8. Travel survey sample size	16
9. Journeys during survey week	17
10. Return Mileage during survey week	17
11. Annual return mileage	18
12. CO ₂ emissions from use of cars to travel to and from Gilcomston	18
13. CO ₂ emissions from use of buses to travel to and from Gilcomston	19
14. Weight of waste disposed of by Gilcomston	19
15. Gilcomston's approximate annual emissions of CO ₂	22

Gilcomston South Church, Aberdeen
Report of the Carbon Footprint Audit undertaken January to March 2008

FOREWORD

The circumstances which led to the carbon footprint audit are outlined on page 9 of the report. In the report the authors present the findings of the audit to the Deacons and Kirk Session of Gilcomston South Church. The authors are members of the Church. They were assisted in undertaking the audit and in researching background information by others from the Church congregation.

The views expressed in the report are, nevertheless, those of the authors. They do not necessarily represent the views or established position of the Kirk Session or of the Church as a whole.

While the audit was being undertaken it became apparent that the work was attracting wider interest beyond Gilcomston South and requests for access to the report on its completion were received. Readers outwith the Church will need to recognise that the report is addressed to the Deacons and Kirk Session of Gilcomston South, and that findings and conclusions reached may not be relevant elsewhere where circumstances may be different.

For the benefit of readers not familiar with Gilcomston South, the Church is part of the Church of Scotland and is evangelical in tradition. It has congregations of about 300 on Sunday mornings and 200 on Sunday evenings. Wednesday evening Bible studies and Saturday evening prayer meetings each have attendances of up to about 50 people. Other Church activities also take place during the week and have been increasing in number and frequency since the audit was undertaken. The Church is in the centre of Aberdeen and its congregation is gathered from across the City, with some from beyond Aberdeen. The congregation has a broad age structure and significant numbers of students attend. There are four full-time staff who are based at the Church. The Church is a mid-nineteenth century building of granite and sandstone and comprises a galleried sanctuary (ground floor area 359 m²), a small hall (gfa 73 m²), two smaller meeting rooms (gfa 49 m² and 29 m²) and a fitted kitchen (gfa 20 m²). A refurbishment of the fabric was completed in 2004.

Authors

Kerri Bates
Michelle Horsfield
Andrew Mumford
Geoffrey Tudor

Gilcomston South Church, Aberdeen
Report of the Carbon Footprint Audit undertaken January to March 2008

CONGREGATIONAL SUMMARY

Introduction

With the agreement of the Deacons a small team was set up towards the end of 2007 to attempt to quantify emissions of greenhouse gases arising from our activities as a church. The team looked at six aspects which it considered contribute to our total emissions:

- use of gas
- use of electricity
- transport
- disposal of waste
- use and disposal of water
- purchasing

Some of these could readily be measured and an audit of these was undertaken early in 2008. Others were less amenable to measurement but are still identified here to provide a comprehensive view.

This initiative emerged from a series of sermons on the first few chapters of Genesis during morning services early in 2007 and from a presentation at Gilcomston on 12 November 2007 by Elaine Storkey to launch a Tearfund Global Poverty Prayer Week. The issue of climate change was considered specifically by the Church on two consecutive Wednesday evenings while the audit was in progress. On the first of these Wednesdays there was a showing, in place of the normal Bible study, of Al Gore's film 'An Inconvenient Truth'. Biblical principles pertinent to the issues of climate change were the subject of the following week's Bible study when there were also group discussions and an opportunity to question a panel.

This paper summarises a report that has been presented to the Deacons' Court and to the Kirk Session. A copy of the full report is available on request.

Scientific context

The majority scientific consensus is that global warming is occurring, at a rate unprecedented in recent geological time, as a result of increasing concentrations of greenhouse gases, of which carbon dioxide is the most important, and that this is as a result of human activity. Increasing global average temperatures are leading to changes in climate.

Carbon dioxide occurs naturally in the atmosphere but its concentration has increased from 280 ppmv (parts per million by volume) at the beginning of the industrial revolution to 360 ppmv now. A 'business as usual' scenario would be likely to result in a concentration of 500 ppmv 2050.

There is considerable concern about the implications for the environment and for human society if average global temperatures were to exceed pre-industrial revolution temperatures by more than 2°C. They are currently about 0.76°C higher; 1.8°C is probable given present concentrations of greenhouse gases. If emissions continue to grow at their present rate, temperatures in 2050 could have increased by 2°C – 3°C and in 2100 by 5°C – 6°C.

Gilcomston's Response

Why should this be of concern to us at Gilcomston? In so far as global warming is occurring as a result of human activity we are ourselves not excluded from implication in this. As Christians it is, perhaps, particularly important that we should consider what our contribution to the problem might be. We recognise from the first few chapters of Genesis and elsewhere the responsibility to care for creation for its own sake and for our well being, but particularly out of love and respect for its Creator. We are also commanded to love our neighbours. Those who are living in marginal situations around the world where changing weather conditions are making daily life increasingly difficult are amongst those who particularly need our care. The number of people living in such conditions is likely to increase. They live in areas where some of the missionaries from Gilcomston and from other churches in Aberdeen work. They are in areas where development and relief work by Tearfund (and other agencies) is undertaken. A recognition of, and perhaps repentance for, the carbon dioxide emissions arising from our activities would seem to accord well with Jesus's summary of the Commandments in Matthew 22:37-38.

Audit findings

Use of gas

About 40 tonnes of carbon dioxide are emitted from the use of gas by the Church over a year. Meter readings were taken at intervals during one week. They indicate that 54% of the gas usage occurs when the Church is closed (56.5% of the time). 4% is used immediately before and during Sunday services which occupy 3.6% of the time. The under-floor heating system uses gas throughout the week in maintaining background warmth but it is also necessary to consume additional gas when the building is closed to heat it adequately for following meetings and services.

The minimum temperature recorded in the Sanctuary on a Sunday during February and March was 67°F (19.5°C); on occasions it exceeded 70°F (21°C). A temperature of 70°F (21°C) was also recorded on one occasion on a weekday when the Church was closed.

Use of electricity

Use of electricity over a year accounts for approximately 14.5 tonnes of carbon dioxide emissions. 12.3% of use occurs during Sunday services and 46% when the Church is closed.

Transport

About 3 tonnes of carbon dioxide a year are emitted from the use by staff of their cars for church purposes.

Nearly 250,000 miles are travelled each year to and from the two Sunday services, the Wednesday Bible study and the Saturday prayer meeting. 136,000 of these miles are by car drivers and 79,000 by passengers in those cars. Nearly 43 tonnes of carbon dioxide are emitted from the use of cars by people attending the two services and the two meetings.

Nearly 11,000 miles are travelled by bus to attend the two services and the two meetings. This accounts for almost 2 tonnes of carbon dioxide emissions annually.

Disposal of waste

Approximately 0.75 tonnes of waste are disposed of each year by the Church. About half of this is recyclable. If all of the Church's waste were disposed of in landfill it would contribute directly to methane emissions from landfill sites. Indirectly, it would also contribute to the emissions from the additional energy required to produce paper, glass, plastic or steel from raw materials instead of from recycled material. The report does not seek to quantify the direct or indirect emissions that would arise if none of the waste were recycled.

Use and disposal of water

The supply of mains water and the treatment of waste water both require energy. The report is unable to quantify emissions attributable to the Church's use of water as its supply to the church building is not metered.

Purchasing

Energy is used in the manufacture, processing and transportation of goods and produce. There are consequently implications for carbon dioxide emissions attributable to the Church from the goods and produce which it uses. The audit team was not able to identify clear or consistent patterns of purchases by or on behalf of the Church, and the report does not therefore quantify emissions associated with purchasing.

Summary

As a consequence of the use of energy which it was possible to quantify (gas, electricity, travel), Gilcomston is responsible for the emission of approximately 104 tonnes of carbon dioxide a year as shown in the table. This compares with average UK household emissions of about 10 tonnes a year.

Gilcomston's Approximate Annual Emissions of Carbon Dioxide	
	Tonnes of CO ₂
Gas	42.1
Electricity	14.5
Staff travel by car	3.2
Car mileage by congregation to and from Gilcomston	42.9
Bus travel by congregation to and from Gilcomston	1.8
Waste	?
Water use	?
Purchasing	?
Total	104.5

Possible Action

The audit was carried out so that we might be aware of our contribution to emissions of greenhouse gases. Emissions generated directly or indirectly by the Church may seem insignificant in a global context and reducing them would not in itself resolve climate change. The problem however is a cumulative one to which many millions of individuals and thousands of organisations each contribute a small amount. The question is one of whether we have a moral obligation, both as a Church as a whole and as individual members, to review and adapt our own activities.

The audit team did not consider it part of their responsibility to make recommendations on ways to reduce emissions, partly because they did not have the resources to evaluate a comprehensive range of what could be done. Some options might contribute to a reduction in emissions but are unlikely to be considered practical either for cost or aesthetic reasons or because they would seriously affect the operation of the Church. Clearly, it would be possible to eliminate emissions entirely by closing down!

It is probable that some straightforward changes to our procedures or alterations to the church fabric could be made which would help to reduce emissions without significantly affecting our primary function as a church. There might also be cost savings if they were to relate to energy use, although these should be seen as incidental to a primary objective of reducing emissions. To stimulate further discussion the team did however make some suggestions which the Deacons' Court will be considering:

- draught proof doors, especially those that are rarely opened, eg at either end of the entrance vestibule;
- manually turn down or turn off radiators in areas of the building that are unlikely to be used for several days, eg entrance vestibule;
- install secondary glazing in sanctuary;
- turn off the electric water heater except when it is needed to cater for large numbers – buy a kettle for use when only a few people need tea or coffee (and boil no more water than is actually required);
- avoid leaving equipment on stand-by mode overnight;
- provide facilities for securing bicycles;
- encourage car sharing;
- introduce more structured procedures for the removal of waste for recycling.

*May the glory of the Lord endure forever;
may the Lord rejoice in his works*

Ps. 104:31

GILCOMSTON SOUTH CHURCH, ABERDEEN

REPORT OF THE CARBON FOOTPRINT AUDIT UNDERTAKEN JANUARY TO MARCH 2008

Introduction

1. With the agreement of the Deacons a small team was set up towards the end of 2007 to attempt to quantify emissions of greenhouse gases arising from our activities as a church. We looked at six aspects which we considered contribute to our total emissions:

- use of gas
- use of electricity
- transport
- production of waste
- use and disposal of water
- purchasing

Some of these we were able to measure and an audit of these was undertaken early in 2008. Others were less amenable to measurement but are still discussed below to provide a comprehensive view.

2. This initiative emerged from a series of sermons on the first few chapters of Genesis during morning services early in 2007 and from a presentation at Gilcomston on 12 November 2007 by Elaine Storkey to launch a Tearfund Global Poverty Prayer Week. The issue of climate change was considered specifically by the Church on two consecutive Wednesday evenings while the audit was in progress. On the first of these Wednesdays there was a showing, in place of the normal Bible study, of Al Gore's film 'An Inconvenient Truth'. Biblical principles pertinent to the issues of climate change were the subject of the following week's Bible study when there were also group discussions and an opportunity to question a panel.

Audit Findings

1. Use of gas

3. Gas is used in the church for space and water heating and for cooking. Over the year from November 2006 to October 2007, the Church used 19,651 cu m of gas, equivalent to 221,507 kWh of energy. (The cost was £6,590.) With emissions of 0.19kg of CO₂ per kWh¹, the Church emitted 42.09 tonnes of CO₂ from its use of gas over the twelve months. (Table 1)

4. The gas meter was read at intervals during a week at the end of February 2008. It had also been read throughout most of a week during December 2007, but a gap in readings during that week did not allow consolidation of figures for the two weeks. Where there were figures for comparable intervals during the two weeks they were seen to be broadly similar.

Table 1 : Gas Consumption November 2006 to October 2007

	Cu m	Calorific value	kWh	^a Cost £
Nov	855	39.9	9,642	287.41
Dec	2,226	39.6	25,040	743.24
Jan	1,634	39.8	18,474	547.80
Feb	3,673	39.8	41,426	1,230.34
Mar	2,817	39.7	31,769	941.30
Apr	2,247	39.6	25,277	749.46
May	1,960	39.7	22,104	656.75
May	1,960	39.7	22,104	656.75
Jun	1,643	39.5	18,436	548.65
Jul	921	39.7	10,387	311.25
Aug	929	39.6	10,450	313.27
Sep	121	39.7	1,365	45.02
Oct	625	40.2	7,137	215.31
Total	19,651		221,507	£6,589.80
Annual emissions @ 0.19kg per kWh			42,086 kg	
^a Cost of gas consumed is dependent on supplier and tariff				

5. Intervals were chosen to accord with time periods when the Church was being used for its principal activities. Broadly, the following periods were identified:

- Sunday morning service
- Sunday evening service
- Bible Study
- Saturday prayer meeting
- Office hours
- Street Pastors
- Closed time

6. It was recognised that allocation of gas usage to different activities would only be approximate. In particular it was not possible to read the meter at the moment when the heating started to warm the building for an activity due to take place some hours later. The meter was read, for example, at 10.30 am on the Sunday morning although the heating would have switched on some hours previously to prepare the building for the 11.00 am service.

7. During the week beginning 24 February 2008, 1.63 tonnes of CO₂ were emitted from the Church's use of gas. The analysis between the various intervals is shown in Table 2. The following points emerge from these figures:

- a) average hourly emissions during that week were 9.7 kg;
- b) Sunday services accounted for 3.6% of the time and 4% of the gas usage;
- c) office hours accounted for 27.9% of the time and 30.6% of the gas usage;
- d) the Church was closed for 56.5% of the week but during this time 54% of the gas was consumed.

Table 2: Gas Consumption Week Beginning 24 February 2008

	cu m	kWh	Decimal equivalent hours	Av kWh/hour	CO2/kWh kg	Total emissions kg	Average emissions /hour kg	% time	% emissions
<u>Week beginning 24/02/08</u>									
Sunday morning service	16.54	182.20	3.00	60.73	0.19	34.6	11.5	1.8%	2.1%
Sunday evening service	15.12	166.56	3.00	55.52	0.19	31.6	10.5	1.8%	1.9%
Bible study	10.47	115.34	2.60	44.36	0.19	21.9	8.4	1.6%	1.3%
Saturday prayer meeting	13.01	143.32	2.25	63.70	0.19	27.2	12.1	1.3%	1.7%
Office hours	238.55	2627.85	46.73	56.24	0.19	499.3	10.7	27.9%	30.6%
Street Pastors	64.33	708.65	15.28	46.37	0.19	134.6	8.8	9.1%	8.3%
Closed time	421.00	4637.70	94.49	49.08	0.19	881.2	9.3	56.5%	54.0%
Totals	779.02	8581.62	167.35	51.28	0.19	1630.5	9.7	100.0%	100.0%

8. There were variations in terms of gas usage between the different time intervals, and when the Church building was being actively used the amount of gas used was higher, but the variations were not great. The under-floor heating system uses gas throughout the week in maintaining background warmth but it is necessary to consume additional gas when the building is closed to heat it adequately for following services and meetings.

9. If the relative amounts of gas used during that week were consistent throughout the year, emissions attributable to the activities identified would be as in Table 3.

	% time	% emissions	Annual emissions tonnes
Sunday services	3.6%	4.0%	1.71
Wednesday Bible Study	1.6%	1.3%	0.57
Saturday prayer meeting	1.3%	1.7%	0.70
Office hours	27.9%	30.6%	12.89
Friday evening Street Pastors	9.1%	8.3%	3.48
Closed time	56.5%	54.1%	22.74
Total	100%	100.0%	42.09

10. It has been presumed that most gas usage relates to space heating. An attempt was made over several weeks at the beginning of 2008 to gauge the temperature in different parts of the building at different times. It proved difficult to do this in a consistent way but the results do provide some indications which may be helpful. Appendix 1 lists the temperatures which were recorded.

11. The minimum temperature recorded in the Sanctuary on a Sunday was 67°F (19.5°C); on occasions it exceeded 70°F (21°C). A temperature range of 62.5°F (17°C) to 70°F (21°C) is generally regarded as comfortable.

12. Temperatures on other occasions were generally lower, but there were exceptions. For example, on 24 March (Easter Monday) the temperature in the front vestibule was 70°F (21°C) although it was bitterly cold outside. Only the temperature logger was present in the building at the time and there were no plans for its use that day.

2. Use of electricity

13. Electricity is used principally for lighting and to power office, kitchen and cleaning equipment and the organ blower. During the year November 2006 to October 2007 data were not available for two months, but figures have been interpolated and approximately 33,800 kWh of electricity were used by the Church (Table 4). (The cost was approximately £3,700.) With emissions of 0.43kg of CO₂ per kWh², the Church's use of electricity accounted for the emission of approximately 14.52 tonnes of CO₂ over the twelve months.

	Off-peak kWh	Peak kWh	Total kWh	^b Cost £
Nov	1,747	972	2,719	293.95
Dec	2,022	1,159	3,181	342.29
Jan	2,882	1,178	4,060	430.45
Feb	2,649	1,016	3,665	388.83
Mar	^a 1,384	797	2,181	236.13
Apr	2,294	861	3,155	335.84
May	1,978	702	2,680	286.29
Jun	^a 1,824	1,050	2,874	311.17
Jul	(127)	1,816	1,689	210.74
Aug	1,519	830	2,349	255.10
Sep	1,713	1,016	2,729	295.56
Oct	1,544	943	2,487	270.12
Total	21,428	12,340	33,768	£3,656.47
Annual emissions @ 0.43kg per kWh			14,520 kg	
^a Interpolated figures				
^b Cost of electricity consumed is dependent on supplier and tariff				

14. The electricity meters were also read at intervals during the week beginning 24 February 2008. During that week, 0.3 tonnes of CO₂ were emitted as a result of the Church's use of electricity. The analysis between the various intervals is shown in Table 5. The following points emerge from these figures:

- a) average hourly emissions from electricity use were 1.8 kg;
- b) Sunday services accounted for 3.6% of the time but 12.3% of the emissions;
- c) the Wednesday Bible Study accounted for 1.6% of the time but 4.3% of the emissions;
- d) office hours accounted for 27.9% of the time and 29.1% of the emissions;
- e) the Church was closed for 56.1% of the week but 46% of the emissions still were attributable to electricity use at this time.

15. Use of electricity during Sunday services and the Bible Study is significantly out of proportion to the duration of these events. This probably is attributable to the current drawn by the high energy bulbs providing the high level lighting in the Sanctuary. Of more concern, however, is the proportion of electricity used when the Church was deemed to have been closed.

Table 5: Electricity Consumption Week Beginning 24 February 2008

	kWh	Decimal equivalent hours	Av kWh/hour	CO2/kWh kg	Total emissions Kg	Average emissions /hour kg	% time	% emissions
<u>Week beginning 24/02/08</u>								
Sunday morning service	41.9	3.11	13.48	0.43	18.0	5.8	1.9%	6.0%
Sunday evening service	43.5	3.07	14.18	0.43	18.7	6.1	1.8%	6.3%
Bible study	30.2	2.68	11.25	0.43	13.0	4.8	1.6%	4.3%
Saturday prayer meeting	13.6	2.27	6.00	0.43	5.8	2.6	1.4%	2.0%
Office hours	202.1	46.78	4.32	0.43	86.9	1.9	27.9%	29.1%
Street Pastors	43.8	15.77	2.78	0.43	18.8	1.2	9.4%	6.3%
Closed time	319.5	94.09	3.40	0.43	137.4	1.5	56.1%	46.0%
Totals	694.6	167.77	4.14	0.43	298.7	1.8	100.0%	100.0%

16. If the relative amounts of electricity used during that week were consistent throughout the year, emissions attributable to the activities identified would be as in Table 6.

	% time	% emissions	Annual emissions tonnes
Sunday services	3.6%	12.3%	1.79
Wednesday Bible Study	1.6%	4.3%	0.63
Saturday prayer meeting	1.4%	2.0%	0.28
Office hours	27.9%	29.1%	4.22
Friday evening Street Pastors	9.4%	6.3%	0.92
Closed time	56.1%	46.0%	6.68
Total	100%	100.0%	14.52

3. Travel

17. Travel accounts for about 25% of UK CO₂ emissions and is the most rapidly increasing source. Of this, private cars account for about 42%, road freight 27% and aviation 21%. Public transport and shipping account for the remainder³. There is particular concern about emissions from aeroplanes with increasing numbers of flights, especially since the emissions are at high altitude.

18. To assess the impact of Gilcomston's activities we looked at travel by staff and by the congregation in attending the principal events of a typical week.

Staff Travel

19. Gilcomston staff use public transport for their work related travel outwith Aberdeen whenever possible. This includes the use of trains and buses and making occasional flights. Emissions from these sources have not been included in our calculations principally because no information was available on the distances travelled. It might in any case be assumed that a bus or train service or a scheduled flight would have occurred whether or not the individual staff member had been on board, although this is not usually the position taken in environmental impact studies. It can be argued that their purchase of a ticket contributed to demand and that without demand the particular flight or bus or train service would not be made available. Conversely, increased demand for bus and, to some extent, train travel could be beneficial if it led to an increased level of service encouraging further use by other members of the public.

20. Carbon dioxide emissions from public transport per passenger kilometre are given in Table 7.

Table 7 : Average Emissions of CO₂ by Public Transport per Passenger Km

Bus	0.107 kg/passenger km
Train	0.060 kg/passenger km
Plane - domestic	0.175 kg/passenger km
- short haul	0.098 kg/passenger km
- long haul	0.111 kg/passenger km

Source : Defra, *Guidelines to Defra's GHG Conversion Factors*, 2008

21. Approximately 11,300 miles are travelled annually for work purposes by staff in their cars. Some 3.23 tonnes of carbon dioxide were emitted from the fuel used.

Travel by Congregation to and from Church

22. Surveys were undertaken of mode of travel and distance travelled by members of the congregation attending the two Sunday services, the Wednesday Bible Study and the Saturday prayer meeting. These were taken to be the four principal activities of the Church attended by significant numbers of people. The surveys were conducted once at each of these meetings during a two week period in February 2008. Forms were issued to all those attending each of these meetings. The numbers of valid forms returned on each occasion and percentage sample sizes are given in Table 8.

Table 8 : Travel Survey Sample Size

	Attendance People > 12 years	Forms returned	Sample size
Wednesday Bible Study	55	52	94.5%
Saturday prayer meeting	24	20	83.3%
Sunday morning service	299	198	66.2%
Sunday evening service	166	102	61.4%

23. There was a baptism at the Sunday morning service and it was known that a number of visitors from Edinburgh were present. Several forms showed distances of 120 miles travelled by car to Gilcomston. Inclusion of these returns would have skewed the results significantly. As they were taken not to be typical these returns were excluded from the calculations of total distances travelled.

24. On the survey days there was a total attendance of 540 at the four services/meetings. Table 9 sets out how people travelled to and from the Church. A single individual may have attended all four meetings and will have been recorded separately on each occasion. It was assumed that the distance travelled on a journey returning from the church was the same as the distance travelled to the church.

Table 9 : Journeys During Survey Week

	Walk	Bicycle	Car drivers	Car passengers	Taxi	Bus	Train	Other	Total
Wednesday Bible Study	19		24	10		2			55
Saturday prayer meeting	4		17	3					24
Sunday morning service	81	8	121	70		15			295
Sunday evening service	28	3	79	48		8			166
	132	11	241	131	-	25	-	-	540

25. Table 10 gives the total number of miles travelled on journeys in both directions by each mode of transport. Some 4,690 miles were travelled in total to and from the two services and the two meetings. 4,130 were travelled by car, of which 1,520 were travelled by passengers and 2,610 by the car drivers. 320 miles were walked to and from the church, 40 miles were travelled by bicycle and 200 miles by bus.

Table 10 : Return Mileage During Survey Week

	Walk	Bicycle	Car drivers	Car passengers	Taxi	Bus	Train	Other	Total
Wednesday Bible Study	37		194	50		42			323
Saturday prayer meeting	10		137	12					159
Sunday morning service	195	35	1581	1060		120			2991
Sunday evening service	76	5	699	394		43			1217
	318	40	2611	1516	-	205	-	-	4690

26. If the results were typical, the distances travelled over a full year to the four principal meetings of the Church would be approximately as shown in Table 11. It is, of course, possible that during summer months modes of transport might be different with more people walking or cycling.

Table 11 : Annual Return Mileage

	Walk	Bicycle	Car Drivers	Car Passengers	Bus	Total
Wednesday Bible Study	1,900		10,100	2,600	2,200	16,800
Saturday prayer meeting	500		7,100	600		8,200
Sunday morning service	10,200	1,800	82,200	55,100	6,300	155,600
Sunday evening service	3,900	300	36,400	20,500	2,200	63,300
	<u>16,500</u>	<u>2,100</u>	<u>135,800</u>	<u>78,800</u>	<u>10,700</u>	<u>243,900</u>

27. The survey requested information from car drivers about the model, engine size and age of their cars. Official fuel consumption figures were obtained from the Wisebuyer's motoring web site and the fuel used by cars was estimated. Urban cycle figures were assumed to apply to one way journeys of 10 miles or less and combined cycle figures to journeys in excess of 10 miles. 10.4 kg of carbon dioxide are emitted from the combustion of a gallon of petrol, 12.2 kg from the combustion of a gallon of diesel and 7.0 kg from a gallon of LPG. These figures were applied to the fuel usage to obtain an estimate of total emissions.

28. Carbon dioxide emissions from the use of cars to travel to and from the four principal Church services and meetings during the survey week are given in Table 12. The table also gives annual emissions on the assumption that the survey week was typical.

Table 12 : CO₂ Emissions from Use of Cars to Travel to and from Gilcomston

	Survey Week kg	Annual tonnes
Wednesday Bible Study	65.4	3.40
Saturday prayer meeting	46.8	2.44
Sunday morning service	490.8	25.52
Sunday evening service	221.4	11.51
	<u>824.4</u>	<u>42.87</u>

29. Carbon dioxide emissions which might be attributable to the use of buses by those attending Gilcomston are given in Table 13. These figures are based on average emissions per passenger although, as with staff use of buses, it could be assumed that the bus service would have operated with or without the Gilcomston bound passengers.

Table 13 : CO₂ Emissions from Use of Buses to Travel to and from Gilcomston

	Survey Week kg	Annual tonnes
Wednesday Bible Study	7.3	0.38
Saturday prayer meeting	-	-
Sunday morning service	20.6	1.07
Sunday evening service	7.4	0.38
	<u>35.3</u>	<u>1.83</u>

4. Waste

30. Between 3 March and 24 March 2008 waste from Gilcomston was sorted into paper and card, glass, tins, plastic bottles and general waste and each was weighed. (General waste for this purpose includes mainly kitchen waste but also items such as used photocopier cartridges.) This was only possible with the co-operation and assistance of the Church Officer and those working in the kitchen to whom thanks are due. The process stimulated interest in the concept of recycling of the Church's waste and the Deacons' Court may wish to take advantage of this interest to encourage this further in an organised way.

31. Table 14 sets out the weight of each of the different categories of waste during the three weeks and, assuming the weeks to be typical, the amount that would be disposed of in a full year.

Table 14 : Weight of Waste Disposed of by Gilcomston

	3 to 24 March 2008 kg	%	Annual Total tonnes
Paper & card	16.44	38.3%	0.29
Glass	1.25	2.9%	0.02
Tins	1.47	3.4%	0.03
Plastic bottles	1.93	4.5%	0.03
General waste	<u>21.89</u>	50.9%	<u>0.38</u>
Total	42.98		0.75

32. If all this waste were placed in the bin near the church in Summer Street it would be removed by the City Council and disposed of as landfill. As waste in landfill sites decomposes it releases methane, which is a potent greenhouse gas. Emissions from any tonne of waste will vary according to the composition of the waste. Glass, for example, will not decompose and will not produce any emissions. We have not therefore been able

to find any typical figures that would enable us estimate what emissions would arise from volumes of waste produced by at Gilcomston if it were all disposed of through landfill.

33. Good practice is to lessen the volume of waste produced by reducing initial consumption and re-using material whenever possible. This should take place before giving consideration to recycling. At Gilcomston the reduce/re-use options may not be practicable in any significant way, but about half by weight of the waste produced (paper and card, glass, tins and plastic bottles) could be recycled. There are currently no recycling collections by the City Council in the city centre, but some of the waste produced by the Church is removed for recycling.

34. Local authorities have statutory targets setting minimum proportions of waste that must be recycled. This relates as much to a lack of suitable landfill sites as to concerns about reduction of greenhouse gas emissions from landfill sites. Since, however, manufacture of 'new' paper and card, glass or plastic from recycled materials generally requires less energy input than manufacture from raw materials, recycling can less directly reduce greenhouse gas emissions.

35. The paper and card waste produced by Gilcomston (nearly 40% of our total waste by weight) would decompose in landfill. Recycling it would (and does) reduce the emissions from landfill for which we are directly responsible. Recycling paper and card, and the glass, tin and plastic we throw away (nearly 11% by weight of our waste), would further reduce emissions in manufacturing; not doing so increases our indirect responsibility for emissions. These are complicated relationships and we have not sought to quantify them.

5. Water

36. 0.47 kWh of energy is required on average in the UK to treat and supply a cubic metre of mains water⁴. Consequent emissions of CO₂e are said to be 0.2021 kg/cu m. Other sources (eg greenliving.co.uk⁵) suggest 0.41 kg of CO₂e is emitted per cubic metre of water supplied. Scottish Water require 0.91 kWh to treat and supply a cubic metre of mains water, suggesting emissions of 0.3913 kg/cu m of CO₂e.

37. 0.415 kWh of energy is required in the treatment of a cubic metre of waste water⁶ with consequent emissions of 0.1785 kg/cu m of CO₂e. We could not discover comparable figures for Scottish Water.

38. Water supply to the Church's premises is not metered and we have therefore been unable to quantify carbon dioxide equivalent emissions from its use.

6. Purchasing

39. Energy is used in the manufacture, processing and transportation of goods and produce. What goods and produce are purchased and where they are sourced do carry implications for carbon dioxide emissions attributable to the Church.

40. There do not appear to be any clear or consistent patterns for the purchase of the materials or food used at Gilcomston or records of the amounts purchased and we have not been able to make any estimate of emissions attributable to their use by the Church. We give here, for illustration, some information related to the types of items which the Church does purchase or which are purchased for its use.

41. The manufacture of paper from recycled material is quoted as using 4,000 kWh less energy per tonne of paper produced than when it is made from virgin fibres⁷. This represents 1.32 tonnes of CO₂e emissions less per tonne of paper⁸ and is approximately 60% less than required for manufacture from virgin fibres⁹. There would seem to be advantage in purchasing recycled paper, when this is not already done, whenever it is suitable for purpose.

42. Much of the food consumed at Church functions is supplied by individual members and, presumably, has mostly been bought as part of normal household shopping. The UK imports between 60% and 80% of the food it consumes¹⁰. It has been calculated that the average household meal has travelled 2,000 miles from farm to plate¹¹.

43. The majority of emissions from the transport of food destined for consumption in the UK are generated before the food reaches the UK¹². Within the UK, the transport of food to supermarkets by lorry currently accounts for 40% of road freight; supermarket lorries travel around 670 million miles a year¹³. This traffic generates 3.5% of total UK's emissions of carbon dioxide; a further 1% of total emissions is generated by car borne shopping trips for groceries¹⁴.

44. Purchase by the community as a whole of local produce in season, in preference to produce from abroad, would lead to a significant, although unquantified, reduction in emissions. The purchase of items such as stationery from local suppliers may have similar transportation implications.

7. Summary

45. Estimated annual emissions from activities at Gilcomston are summarised in Table 15. From the use of energy which it was possible to quantify (gas, electricity, travel), the Church is responsible for the emission of approximately 104 tonnes of carbon dioxide a year.

46. For comparison, the average UK household emissions of carbon dioxide in 2007 was approximately 10 tonnes per annum, taking into account heating, lighting, use of domestic appliances and travel¹⁵. From the same source, comparable emissions for an individual were 4.2 tonnes per annum. Tearfund suggests that the average individual in the UK has a carbon footprint of 9.4 tonnes of carbon dioxide¹⁶. This would include a per capita share of industrial emissions, 5 tonnes according to *Resurgence*.

Table 15 : Gilcomston's Approximate Annual Emissions of CO₂

	Tonnes of CO ₂
Gas	42.09
Electricity	14.52
Staff travel by car	3.23
Car mileage by congregation to and from Gilcomston	42.87
Bus travel by congregation to and from Gilcomston	1.83
Waste	?
Water use	?
Purchasing	?
	<hr/>
Total	104.54

A Summary of the Scientific Context

47. The overwhelming majority of scientific opinion in relevant fields now agrees that global warming and consequent climate change is currently occurring at a rate unprecedented in the last 10,000 years, and that this is as a consequence of human activity.

48. There has been an increase of average global temperature by about 0.76°C since the beginning of the 19th Century. Extreme weather conditions are becoming increasingly frequent and more intense. Wind damage, flooding and drought are being experienced more widely and more frequently. Seasonal rains on which the production of crops and the provision of grazing are dependent are failing or much reduced year after year in many areas of marginal climate and severe hardship is being experienced, only some of which gets reported by the media.

49. Variations in global temperature do occur naturally. Cyclical changes in the earth's orbit around the sun affect long term temperature variations, but the cycles are now well known and do not account for recent changes. Dust emitted into the atmosphere during volcanic eruptions tends to reduce temperatures as it prevents the sun's rays from warming the surface of the earth, but the impact of a volcano will last for no more than a few years. Low sun-spot activity probably accounted for the small ice-age of the 1750s, and although activity increased after about 1850 it has been decreasing again more recently.

50. The majority scientific consensus is that global warming is occurring as a result of increasing concentrations of greenhouse gases. Six gases or groups of gases have an impact on global temperature by restricting heat radiation from the earth. Gilcomston contributes to at least two of them, carbon dioxide and, to a lesser extent, methane. More

information about the six gases or groups of gases, of which carbon dioxide, methane and water vapour are the most significant, is given in Appendix 2.

51. Scientific concern centres around the impact of carbon dioxide, and emissions of other gases are frequently measured in terms of emissions of carbon dioxide that would have an equivalent impact (CO₂e). Carbon dioxide occurs naturally in the atmosphere but its concentration has increased from 280 ppmv (parts per million by volume) at the beginning of the industrial revolution to 360 ppmv now. A 'business as usual' scenario would be likely to result in a concentration of 500 ppmv by 2050. There is more carbon dioxide in the atmosphere now than there has been for at least 650,000 years¹⁷.

52. If immediate, drastic action were taken to eliminate emissions of greenhouse gases, a further increase in average global temperature of between 0.5°C and 1°C is still considered to be inevitable. A temperature of 1.8°C above pre-industrial levels is probable. If emissions continue to grow at their present rate, temperatures in 2050 could have increased by 2°C – 3°C and in 2100 by 5°C – 6°C. A reduction in emissions of 80% below 1990 levels is considered to be necessary in the UK as its contribution to preventing very serious global consequences.

53. Examples of some of the implications include:–

With an increase of 1°C – 2°C:

- glaciers in the Andes will disappear threatening the water supply to 50m people
- sea levels will rise by between 1 and 3 metres during this century as the ice caps of Greenland and Antarctica are affected – 56m people would be affected by a rise in sea level of up to 1 metre especially in South East Asia, China and the Nile delta – some island states, eg Maldives, Marshall Islands, would disappear;
- 20-30% of species would be at risk of extinction – significant in its own right but also because of the impact it would have on human wellbeing.

With an increase of more than 2°C:

- 30% of the world's land area could experience severe drought at any one time (currently on 3% might so experience drought);
- at 3°C increase 80-100% of Arctic sea ice would be lost;
- at 5°C increase the Himalayas would be without glaciers – a quarter of the population of China would be without water and there would be a serious impact on food supply as rivers cease to flow.

54. These examples are taken from a summary published by Tearfund 'Two Degrees, One Chance'. Copies are available.

55. Increasing global temperatures as a consequence of increasing concentrations of greenhouse gases, particularly carbon dioxide, can be expected to lead to further warming as the result of positive feedback effects. For example:

- as ground previously under snow cover is exposed, solar radiation heats and is absorbed by the ground rather than melting the snow or being reflected back into space;

- as the Amazon forest suffers from drought it will become a source of carbon dioxide emissions rather than acting as a carbon sink;
- increased activity by soil bacteria will break down leaf litter more rapidly so that the soil emits carbon dioxide rather than absorbing it;
- warming oceans are unable to hold so much carbon dioxide and will emit rather than absorb it, and ultimately there is potential for the release of methane from deep oceans.

Gilcomston's Response

56. Why should this be of concern to us at Gilcomston? In so far as global warming is occurring as a result of human activity we are ourselves not excluded from implication in this. As Christians it is, perhaps, particularly important that we should consider what our contribution to the problem might be. We recognise from the first few chapters of Genesis and elsewhere the responsibility to care for creation for its own sake and for our well being, but particularly out of love and respect for its Creator. We are also commanded to love our neighbours. Those who are living in marginal situations around the world where changing weather conditions are making daily life increasingly difficult are amongst those who particularly need our care. The number of people living in such conditions is likely to increase. They live in areas where some of the missionaries from Gilcomston and from other churches in Aberdeen work. They are in areas where development and relief work by Tearfund (and other agencies) is undertaken. A recognition of, and perhaps repentance for, the carbon dioxide emissions arising from our activities would seem to accord well with Jesus's summary of the Commandments in Matthew 22:37-38.

Possible Action

57. The audit was carried out so that we might be aware of our contribution to emissions of greenhouse gases. The Church may feel that it should consider whether it should take any action to reduce the level of emissions for which it is responsible. Emissions generated directly or indirectly by the Church may seem insignificant in a global context and reducing them would not in itself resolve climate change. The problem however is a cumulative one to which many millions of individuals and thousands of organisations each contribute a small amount. The question is one of whether we have a moral obligation, both as a Church as a whole and as individual members, to review and adapt our own activities.

58. It is probable that some straightforward changes to our procedures or alterations to the church fabric could be made which would help to reduce emissions without significantly affecting our primary function as a church. There might also be cost savings if they were to relate to energy use, although these should be seen as incidental to a primary objective of reducing emissions.

59. We did not consider it part of our responsibility to make recommendations for action. Indeed we did not have the resources available to us to identify a comprehensive range of what might be possible nor to evaluate what benefits might accrue. During the course of our discussions, however, several suggestions did emerge. Some were perhaps more fanciful than others. While all would contribute to a reduction in emissions some were unlikely to be considered practical either for cost or aesthetic reasons or because they would seriously affect the operation of the Church. Clearly, it would be possible to eliminate emissions entirely by closing down!

60. To stimulate further discussions here are a few suggestions of relatively simple actions that might be taken:

- draught proof doors, especially those that are rarely opened, eg at either end of the entrance vestibule;
- manually turn down or turn off radiators in areas of the building that are unlikely to be used for several days, eg entrance vestibule;
- install secondary glazing in sanctuary;
- turn off the electric water heater except when it is needed to cater for large numbers – buy a kettle for use when only a few people need tea or coffee (and boil no more water than is actually required);
- avoid leaving equipment on stand-by mode overnight;
- provide facilities for securing bicycles;
- encourage car sharing;
- introduce more structured procedures for the removal of waste for recycling.

61. Perhaps at this stage it would be desirable formally to:

1. recognise that in the activities for which we are responsible together as a Church we do contribute to the emission of greenhouse gases and thereby to climate change;
2. adopt and promote a policy of reducing quantifiable emissions, particularly through the direct use of energy;
3. investigate and implement specific actions;
4. annually monitor and review progress in reducing emissions.

*May the glory of the Lord endure forever;
may the Lord rejoice in his works*

Ps. 104:31

Appendix 1 : Temperatures 26 February to 24 March 2008

Date	Day	Time	Location	Temp ^a °F	Logger
26/02/2008	Tues	08:45	Hall - external wall	64	KB
26/02/2008	Tues	08:45	Hall - internal wall	67	KB
26/02/2008	Tues	08:45	Upper hall - internal wall	65	KB
26/02/2008	Tues	08:45	Sanct. pulpit steps	63	KB
26/02/2008	Tues	18:10	Hall - internal wall	67	KB
26/02/2008	Tues	18:10	Hall - external wall	65	KB
26/02/2008	Tues	18:10	Upper hall - internal wall	67	KB
26/02/2008	Tues	18:20	Sanct. pulpit steps	65	KB
26/02/2008	Tues	18:20	Sanct. front	68	KB
26/02/2008	Tues	18:20	Sanct. bookstall	68	KB
26/02/2008	Tues	18:20	Sanct. upstairs middle back	69	KB
26/02/2008	Tues	18:20	Side staircase	64	KB
27/02/2008	Wed	21:30	Sanct. bookstall	67	KB
27/02/2008	Wed	21:30	Hall - external wall	62	KB
27/02/2008	Wed	21:30	Hall - internal wall	64	KB
27/02/2008	Wed	21:30	Sanct. upstairs middle back	68	KB
27/02/2008	Wed	21:30	Sanct. centre	70	KB
28/02/2008	Thurs	09:20	Hall - internal wall	64	KB
28/02/2008	Thurs	09:20	Hall - external wall	61	KB
28/02/2008	Thurs	09:20	Sanct. bookstall	65	KB
28/02/2008	Thurs	09:20	Sanct. upstairs middle back	63	KB
28/02/2008	Thurs	09:20	Boiler house porch	56	KB
09/03/2008	Sun	10:35	Sanct. front right	68	SG
09/03/2008	Sun	11:00	Sanct. upstairs side back	67	KB
09/03/2008	Sun	11:00	Sanct. back left	75	HB
09/03/2008	Sun	11:05	Sanct. front right	70	SG
09/03/2008	Sun	11:30	Sanct. front right	70	SG
09/03/2008	Sun	11:30	Sanct. back left	70	HB
09/03/2008	Sun	12:00	Sanct. front right	69	SG
09/03/2008	Sun	12:00	Sanct. upstairs side back	69	KB
09/03/2008	Sun	12:30	Sanct. front right	70	SG
09/03/2008	Sun	18:00	Sanct. left back	68	GRT
09/03/2008	Sun	18:20	Sanct. front right	68	SG
09/03/2008	Sun	18:40	Sanct. left back	70	GRT
09/03/2008	Sun	18:50	Sanct. front right	68	SG
09/03/2008	Sun	19:00	Sanct. centre	70	KB
09/03/2008	Sun	19:10	Sanct. left back	71	GRT
09/03/2008	Sun	19:25	Sanct. front right	68	SG

^a Thermometers which could be readily made available to the team were calibrated only in Fahrenheit

Date	Day	Time	Location	Temp °F	Logger
09/03/2008	Sun	19:40	Sanct. left back	73	GRT
09/03/2008	Sun	19:55	Sanct. front right	70	SG
09/03/2008	Sun	20:00	Sanct. centre	70	KB
09/03/2008	Sun	20:00	Sanct. centre	75	NS
09/03/2008	Sun	20:20	Sanct. front right	70	SG
10/03/2008	Mon	09:55	Hall	69	GRT
10/03/2008	Mon	10:10	Inner hall	65	GRT
10/03/2008	Mon	10:55	Sanct. centre	65	GRT
10/03/2008	Mon	11:00	Upper hall	67	GRT
10/03/2008	Mon	11:05	Inner hall	67	GRT
15/03/2008	Sat	18:50	Hall	70	GRT
16/03/2008	Sun	10:45	Sanct. left front	69	GRT
16/03/2008	Sun	10:55	Sanct. front right	68	SG
16/03/2008	Sun	11:25	Sanct. front right	68	SG
16/03/2008	Sun	11:55	Sanct. front right	68	SG
16/03/2008	Sun	12:00	Sanct. left front	70	GRT
16/03/2008	Sun	12:25	Sanct. front right	69	SG
16/03/2008	Sun	12:45	Sanct. left front	73	GRT
16/03/2008	Sun	18:30	Sanct. front right	68	SG
16/03/2008	Sun	18:45	Sanct. left centre	70	GRT
16/03/2008	Sun	19:05	Sanct. front right	68	SG
16/03/2008	Sun	19:10	Sanct. left centre	72	GRT
16/03/2008	Sun	19:30	Sanct. front right	68	SG
16/03/2008	Sun	19:40	Sanct. left centre	70	GRT
24/03/2008	Mon	10:30	SS Room	65	GRT
24/03/2008	Mon	10:30	Hall	67	GRT
24/03/2008	Mon	10:35	Inner hall	65	GRT
24/03/2008	Mon	10:35	Kitchen	51	GRT
24/03/2008	Mon	10:40	Sanct. front	60	GRT
24/03/2008	Mon	10:40	Sanct. rear	62	GRT
24/03/2008	Mon	10:40	Gallery	63	GRT
24/03/2008	Mon	10:45	Vestibule	70	GRT

Appendix 2 : Greenhouse Gases

1. Carbon dioxide is released by the consumption of fossil fuels, especially in power stations, and by certain industrial activities, especially cement production. Emissions from transport is the most rapidly growing source of emissions.
2. Methane is emitted by agriculture and landfill. It is more potent as a greenhouse gas than carbon dioxide, but has a shorter life in the atmosphere.
3. Water Vapour occurs naturally, but as temperatures rise increased evaporation from the oceans and the land surface increases the amount in the atmosphere creating a positive feedback to climate change. On the other hand, when water vapour turns to clouds more sunlight is reflected back into space without warming the earth's surface.
4. Nitrogen Dioxide is released by certain industrial processes. Its impact is relatively minor but it has a long life of 120 years.
5. Ozone The impact of ozone is complicated because of the effect on it of CFCs.
6. Fluorocarbons – CFCs, HFCs, HCFCs and perfluorocarbons

References

- 1 www.resurgence.org/carboncalculator
- 2 www.resurgence.org/carboncalculator
- 3 Office of National Statistics in Spencer and White, 2007, Christianity, Climate Change and Sustainable Living
- 4 Clark, D, 2006, The Rough Guide to Ethical Living
- 5 www.greenliving.co.uk
- 6 Clark, 2006
- 7 www.wasteonline.org.uk
- 8 www.wrap.org.uk
- 9 www.quotemepint.com
- 10 DETR, 1998, General Information Report No 53 Building a Sustainable Future, and SAFE Alliance Foodmiles campaign
- 11 Vale, B and R, 2000, The New Autonomous House
- 12 Garnett, T, 2003, Wise Moves: Exploring the Relationship between Food, Transport and CO₂, Transport 2000 in Spencer and White
- 13 Friends of the Earth, 2005 in Spencer and White
- 14 Garnett, 2003
- 15 DEFRA, 2008, Act on CO₂ Calculator
- 16 Tearfund, My Global Impact
- 17 IPCC, 2007, Climate Change 2007: The Physical Basis – Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge