

Carbon Footprint Assessment
for
Dumfries & Galloway College
(Stranraer Campus)

A Report by:



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1 Executive Summary

In 2009, Dumfries and Galloway College (Dagcol) signed the Universities and Colleges Climate Change Commitment for Scotland, acknowledging that it will take action to reduce its greenhouse gas emissions. To fulfil the commitment the College must calculate its baseline carbon footprint and produce a five-year action plan which is to be completed by February 2010.

An energy and water audit was carried out for the Stranraer main campus building (gas, electricity) and the Barony Centre (burning oil, electricity), which is leased by Dagcol. A building audit was also carried out for the main campus building. The baseline footprint year encompassed the period 1 August 2008 to 31 July 2009. The headline messages from the report are summarised below:

- Stranraer's total Scope 1 (direct energy and fugitive emissions) and Scope 2 (indirect energy emissions) GHG emissions were **242 tCO₂eq** (242,299 kgCO₂eq) in the 2008/09 baseline year. This takes into account burning oil (Barony), fugitive emissions from refrigeration and electricity use.

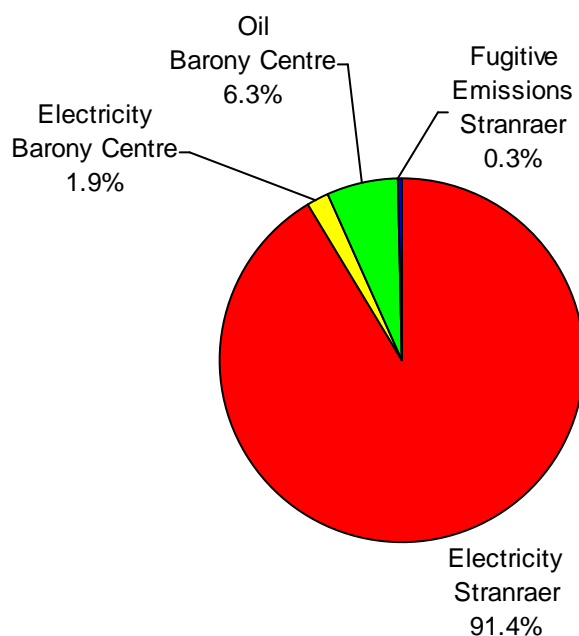


Figure 1.1: Breakdown of Total Emissions Produced by Stranraer Campus Scope 1 and 2 Emission Sources in 2008/09 Baseline Year

As highlighted in **Figure 1.1**, the majority of GHG emissions were associated with electricity consumption in the main building (~91%). Energy consumption at the Barony Centre accounts for the majority of the remainder (~8%). Fugitive emissions are minor (non material) in comparison to energy emissions (less than 0.5%).

- Supply chain GHG emissions resulting from the extraction, production and transportation of fuels were accounted for separately and totalled **257 tCO₂eq** (256,767 kgCO₂eq) in the 2008/09 baseline year. This takes into account burning oil and electricity consumption.

- Data gaps were identified in relation to the availability of gas and water invoices of the main campus building, with several being unavailable.

As a result of the baseline footprint calculations and conversations with Dagcol's Estates team, several recommendations have been suggested to reduce, or enable the reduction of the GHG emissions generated through energy consumption. The main recommendations and observations are highlighted below:

- Stranraer's main campus building is twenty years old and requires energy efficiency upgrades to improve its performance. These include the installation of insulation in the floor of the attic, a new heating system, as well as improvements to the workshop areas.
- Energy efficiency improvements could also be applied to the Barony Centre, however a long term lease should be secured before taking any initial steps.
- Energy efficient lighting has been situated throughout the Dumfries building, which is positive in terms of energy consumption. Further improvements could be made by replacing T8 fluorescent bulbs with T5 bulbs, which have a lower power consumption. This has the potential to provide an annual electricity saving of **7,500 kWh**, this equates to **£516** and GHG reductions of **4.1 tCO₂eq**. This is approximately 2% of electricity emissions at Stranraer.
- The quantity of electricity used for lighting could be reduced further by firstly promoting the issue of switching off lights when leaving the room to both staff and students. A secondary option would be to investigate the feasibility of installing passive infra red sensors in classrooms and offices.
- Dagcol has a progressive policy in relation to the procurement of energy efficient electrical equipment. This helps to reduce the quantity of electricity consumed by the Stranraer campus and should continue when present equipment needs replaced. This could be enhanced further through the promotion of behavioural change actions to staff and students, such as switching off PC monitors when not in use.

2 Introduction

In 2009, the Scottish Government committed the country to an 80% reduction in greenhouse gas (GHG) emissions by 2050, compared with 1990 levels, with an interim target of 42% by 2020¹. To assist in achieving this goal 47 universities and colleges, including Dumfries and Galloway College (Dagcol), have signed up for the **Universities and Colleges Climate Commitment for Scotland**. In signing the commitment the institutions acknowledge that GHG reduction should form an integral part of the strategic planning process.

Under the commitment, the baseline carbon footprint of Dagcol must be assessed and GHG emission reductions identified. Once this has been completed, a 5-year action plan, with targets and timescales, must be compiled and published by February 2010. In addition, measures must be taken to engage all staff and students in this process, enabling them to become involved in reducing Dagcol's carbon footprint.

When calculating an organisation's carbon footprint it is necessary to establish a baseline year and set the boundaries of the analysis. The baseline year for the carbon footprint has been selected as the 2008/09 financial year of 1 August 2008 to 31 July 2009. The baseline carbon footprint assessment will include emissions of the 'Kyoto basket of 6' greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) arising from the activities of the College across the Dumfries and Stranraer campuses. This report addresses emissions associated with the Stranraer campus from the sources detailed below. A survey was also carried out of lighting and electrical equipment utilised at the campus. Energy use at the leased Barony Centre premises (oil and electricity) is also assessed. Using this data, basic recommendations for areas where improvements can be made will be highlighted using illustrative examples where possible.

Emissions associated with the Dumfries campus, travel (fleet vehicles, business travel and commuting), and waste disposal are addressed in separate reports.

3.1 Emission Sources included in this Assessment.

Scope 1 – direct emissions from sources that are owned/controlled by Dagcol

Direct energy consumption – on site consumption of oil and gas for space and water heating and catering

Fugitive emissions – leakage of refrigerant gases from air conditioning/refrigeration equipment (Stranraer campus only)

Scope 2 – indirect energy emissions generated in the production of electricity

Purchased electricity consumed

Scope 3 – other indirect emissions

Embodied emissions from extraction, production and transportation of fuels

Line loss from electricity transmission and distribution

Water supply and waste water treatment (Stranraer campus only)

¹ Scottish Parliament (2009) Climate Change (Scotland) Act

3 Stranraer Campus – Building and Energy Survey

The Stranraer campus was established in 1990, providing further education opportunities and facilities to those that live in the west of Dumfries and Galloway. The campus building consists of two stories, containing classrooms, offices and workshops, as well as IT and catering facilities. In addition, Dagcol rents the Barony Centre, which is adjacent to the Stranraer campus. This provides additional teaching space for mechanical engineering courses. The campus currently hosts 303 full- and part-time students, as well as employing approximately 40 staff. Stranraer offers a number of course types ranging from business and IT to engineering and health & social studies. During the 2009/10 academic year, 31 full-time courses are offered, as well as opportunities for open and distance learning.

3.1 Building Survey – Fabric and Heating

A selective building survey was carried out by Mark McKenna (CCC – Project Manager), of the Stranraer campus building with a tour and explanation of the heating system given by Jim McWhirter (Dagcol – Janitor). This involved a non-invasive inspection of the main building, within the boundaries of the property. The main findings are summarised below and a copy is provided as a separate report.

The main findings of this survey were:

- The main college building is assumed to be constructed of fired bricks with the outer face being comprised of re-constituted sandstone. This construction would have an approximate U-value² of 0.40W/m²K, which does not meet 2007 Building Standards. The building's walls are not insulated, however the presence of the damp-proof membrane in the wall cavity means that cavity insulation is not suitable. This is due to a resulting adverse effect on the ventilation of the building fabric.
- With the exception of the workshop area and the West wing, the entire building is insulated at rafter level, rather than at ceiling level, using foil backed insulation approximately 50mm thick. The roof area above the building's workshops is not insulated. It is estimated that approximately two thirds of the building's roof is not insulated. However, it is noted that inconsistencies have been highlighted with regards to the drawing records, anecdotal evidence, and the apparent actual conditions. See the full report for a diagram illustrating the building's insulation coverage.
- The majority of the main building's windows and doors are double glazed, with the exception of the workshops, which are single glazed. An inspection of the double glazing highlighted signs of condensation on the inner panes, as well as between the double glazed panes. This could be occurring due to failing draught seals or poor air quality in the building, meaning it is unable to disperse the condensation. The general door opening into the building are of satisfactory condition, however the workshop doors are not airtight.
- The ceiling space on the first floor consists of polystyrene tiles on a lightweight steel frame. The main roof is insulated at the ridge, rather than on the first floor at ceiling level. This results in heat rising to the attic space instead of remaining

² A u-value is the measure of heat-loss from a building's internal and external walls, with a lower u-value indicating better insulation of the building.

at the first floor level. There are also signs of damp stains on tiles adjacent to external walls.

- The building is heated using three methods. Electronic underfloor cable heating is situated 6-4 inches under the floor and is controlled using six zones. The ground floor corridor zone is never switched on as this helps to control human reaction to the temperature of the building. When it is cooler in the corridors and 18°C in the rooms, it makes it seem warmer. The system is controlled from 2 plant rooms, with the zones set at 20-21°C and often reaching 22°C.
- Air handling units (AHUs) are also used to both provide heat and cool the building. There are 6 AHUs across the building, which are situated in the attic space, however there is no service history for the system. The system works by drawing air from outside the building and passing it through a heat exchanger, which warms the air before it enters the building. Existing air in the building is also extracted, acting as a cooling/ventilation system.
- Electric storage heaters are used to heat the workshops in the building. These heaters are controlled by computer and operate between 11pm and 7am. Presently, Diston Dryburgh is looking into upgrading this system.

3.2 Building Survey – Lighting

A survey of the lighting in the Stranraer campus building was carried out during an audit day on 1 September 2009. This consisted of the identification of specific bulb types used in the building as well as the total number in each room and corridor. Information regarding the various bulb types used at Stranraer was provided by Jim McWhirter³. For a full list of bulb types, see **Appendix A**.

During the survey it was observed that the majority of the light fittings were for fluorescent strip bulbs. In these fittings, T8 low energy fluorescents (36W) are used, which are situated in the majority of areas on the campus, including classrooms, workshops, offices and corridors. In all areas, these light fittings consisted of non-reflective covers, which reduced the available quantity of light, particularly for classrooms and offices. The lighting levels in all areas can appear dull at times as a result of this. There are presently no PIR sensors set up in classrooms, workshops or offices, increasing the possibility of lights being left on when rooms are unoccupied. The majority of the other bulbs used at Stranraer are low energy bulbs. 60W tungsten bulbs are still being stored, though these are rarely used.

3.3 Energy – Gas

Gas use represents a small proportion of the Stranraer campus energy use due to the building being heated using electricity. This method of space and water heating was chosen due to the campus being built before mains gas was established in Stranraer.⁴ The only location where gas is used is the teaching kitchen on the ground floor during term time. It was highlighted by the teaching chef that he would like to see the electric ovens replaced with gas ovens. This is because they produce instant heat, are less likely to be left on due to the blue flame produced and do not take as much time to cool down.

Presently, full invoice data is not available for gas consumption, which represents a data gap. As of 1 December 2009, invoices are only available for the following periods:

³ See appendix B for full bulb type and power consumption data

⁴ Currie (2009) Discussion Regarding Gas as an energy source at Dumfries and Galloway College: Stranraer Campus.

- 3 March 2009 – 11 June 2009
- 12 June 2009 – 28 August 2009

The consumption and spend during these periods are highlighted in **Table 3.1**, with significantly greater gas use during the March-June period.

Invoice number	Start date	End date	Total Units	Total Power Consumed (kWh)	Total cost of Gas Consumed (£)
1	03.03.09	11.06.09	226	2542	123.40
2	12.06.09	28.08.09	36	450	25.86

Table 3.1: Available Gas Consumption Data for Stranraer Campus

Gas is charged for at two different rates, however it is not clear when the switchover time for each of these rates occurs during the period of a day:

- Rate 1 – 6.081 pence/kWh (£0.0681/kWh)
- Rate 2 – 3.640 pence/kWh (£0.03640/kWh)

As gas used at Stranraer is charged at a VAT rate of 5%, there are no Climate Change Levy charges.

3.4 Energy – Electricity

Stranraer campus electricity consumption data was supplied by Diston Dryburgh for the 2008/09 baseline year in the form of invoices. Electricity is supplied by EDF Energy and is monitored through two meters (PN41-9700870/PN41-9700871). Presently, it has not been established whether the readings from these meters are combined to produce the invoice total, or whether they are taken as separated readings. This is currently being investigated.

Electricity consumption, associated costs, and GHG emissions for the baseline year are given in **Table 3.2**. During the baseline year, **407,115 kWh⁵** (407 MWh⁶) of electricity were consumed, at a total cost of over **£37,000** (including fixed costs, energy consumption charges, the Climate Change Levy and Value Added Tax). This purchased electricity resulted in GHG emissions⁷ of **221.5 tCO₂eq** (221,544 kgCO₂eq). Of this, **204.5 t CO₂eq** (204,526 kgCO₂eq) were emitted due to electricity generation, and **17.0 tCO₂eq (17,017 kgCO₂eq)** due to transmission line losses.⁸

Presently, the Stranraer campus is charged for electricity using two different tariffs, however it is unclear when the switchover time for each tariff occurs (e.g. between day/night tariffs):

- T1 – Night units (£0.057611 per unit)

⁵ kWh = kilowatt hours

⁶ MWh = megawatt hours

⁷ Includes total GHG emissions (CO₂, CH₄ and N₂O)

⁸ The movement of electricity from its place of generation to a home or business requires it to be transferred by the National Grid. During this process, a proportion of electricity is lost as it is transmitted through the grid. This is due to a number of physical means, including the resistive heating of transmissions lines and resistive losses in transformers (National Grid, 2008). In relation to Dumfries campus' electricity consumption, the standard UK transmission and distribution losses factor of 7.2% was applied as per guidance given in Defra/DECC (2009).

- T2 – Day units (£0.068265 per unit)

The Climate Change Levy is also applied to electricity consumption at a rate of £0.00456 per kWh in the 2007/08 tax year and £0.00470 per kWh in the 2008/09 tax year respectively.

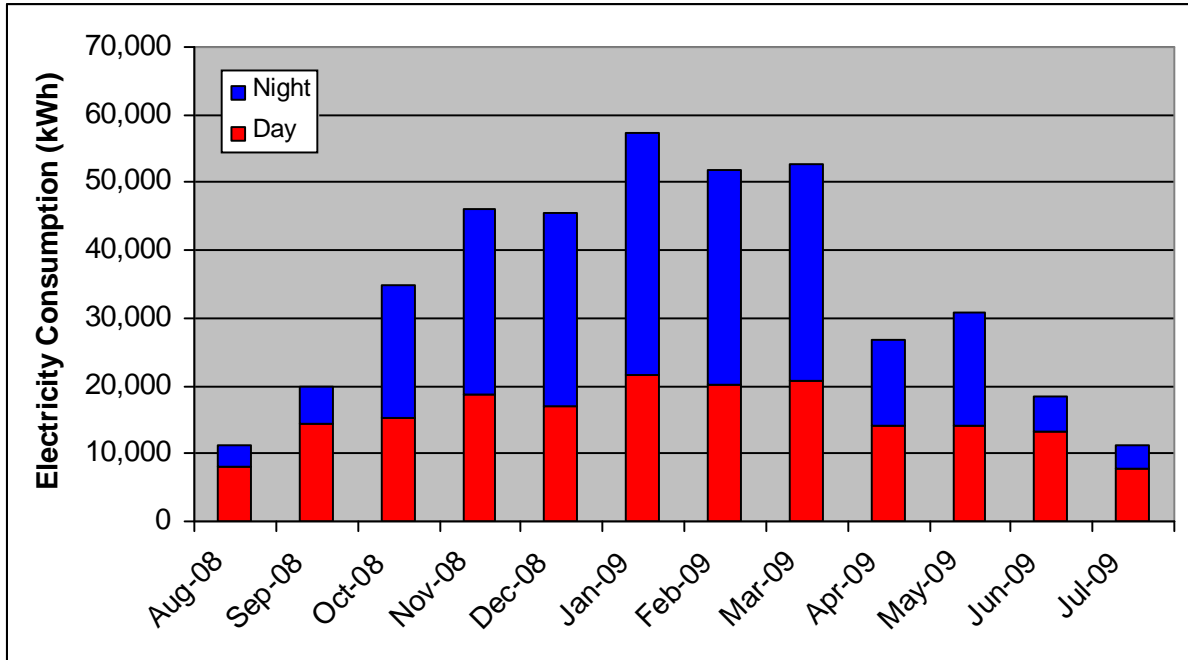


Figure 3.1: Electricity Consumption of Stranraer Campus for 2008/09 Baseline Year

Figure 3.1 shows the consumption of electricity through the year, with comparatively low consumption in the summer (August), increasing through autumn and winter (peaking in January), and then decreasing again through spring to summer. This reflects two factors. Firstly, as the building is heated by electricity, monthly consumption is influenced by the seasons and outside temperature. Secondly, the presence or absence of students, where there is a lower demand for appliance and lighting electricity in holiday periods (most notably the summer break).

To heat the main campus building, a Chidlow unit is charged overnight. This method uses electricity at night-time rates to produce heat overnight and store it within the unit. This heat is then dispersed throughout the day using the AHUs. Examination of night and day time electricity consumption therefore provides a first order estimate of the amount of electricity consumption associated with heating versus other uses. This is highlighted in **Figure 3.1** (see also **Table 3.2**), where the night time consumption is shown in blue bars (assumed to be dominated by the heating demand), and the day time consumption is shown in red bars (additional heating demand plus all other uses). The seasonality of the heating demand can be clearly seen, while the day time use is more constant over the year, with only moderate increases from summer to winter.

Table 3.3 and **Figure 3.2** shows the fuel mix of electricity sold by EDF Energy in 2007/2008 in comparison to the UK average⁹. The EDF fuel mix has a higher proportion of renewables, is lower in nuclear and gas and higher in coal. Given the GHG emissions intensity of these energy sources (see **Table 3.3**), the dominance of coal results in the

⁹ FuelMix (2009) EDF Energy Fuel Mix Disclosure 2008

Date	Fixed charge	Reactive Power Charge			Energy Use (kWh)				Energy Charge Sub Total	CCL		VAT	Total cost	Total CO ₂ eq Emissions		
	(£)	Rate (£)	Units	Cost	T1 <i>0.05761</i>	T2 <i>0.06827</i>	Night time consumption (%)	Total Units	(£)	Rate (£/kWh)	Cost (£)	(%)	(£)	Generation (kgCO ₂ eq)	Line Losses (kgCO ₂ eq)	Consumed (kgCO ₂ eq)
Aug-08	379.71	0.0028	1,698	4.75	3,210	8,144	28.3	11,354	1,125.35	0.00456	51.77	17.5%	1,383	5,704	475	6,179
Sep-08	379.71	0.0028	106.00	0.30	5,730	14,282	28.6	20,012	1,685.08	0.00456	91.25	17.5%	2,087	10,054	837	10,890
Oct-08	379.71	-	-	-	19,553	15,351	56.0	34,904	2,554.11	0.00456	159.16	17.5%	3,188	17,535	1,459	18,994
Nov-08	379.71	-	-	-	27,253	18,784	59.2	46,037	3,232.07	0.00456	209.93	17.5%	4,044	23,128	1,924	25,052
Dec-08	379.71	-	-	-	28,419	17,031	62.5	45,450	3,179.58	0.00456	207.25	15.0%	3,895	22,833	1,900	24,733
Jan-09	379.71	-	-	-	35,876	21,464	62.6	57,340	3,911.80	0.00456	261.47	15.0%	4,799	28,806	2,397	31,203
Feb-09	379.71	-	-	-	31,764	20,204	61.1	51,968	3,588.89	0.00456	236.97	15.0%	4,400	26,108	2,172	28,280
Mar-09	379.71	-	-	-	32,002	20,682	60.7	52,684	3,635.23	0.00456	240.24	15.0%	4,457	26,467	2,202	28,670
Apr-09	447.18	-	-	-	12,564	14,149	47.0	26,713	2,149.29	0.00470	125.55	15.0%	2,616	13,420	1,117	14,537
May-09	447.18	-	-	-	16,749	14,056	54.4	30,805	2,367.22	0.00470	144.78	15.0%	2,889	15,476	1,288	16,763
Jun-09	447.18	-	-	-	5,450	13,108	29.4	18,558	1,691.75	0.00470	87.22	15.0%	2,046	9,323	776	10,099
Jul-09	447.18	0.0028	1,195.00	3.35	3,520	7,770	31.2	11,290	1,203.80	0.00470	53.06	15.0%	1,445	5,672	472	6,144
TOTAL	4,826.40			8.40				407,115	30,324.17		1,868.68		37,249	204,526	17,017	221,544

Table 3.2: Electricity Consumption, Spend and Greenhouse Gas Emissions for Stranraer Campus in 2008/09 Baseline Year

overall emissions intensity of electricity supplied by EDF energy being higher than the national average.

It is noted that Dagcol will be changing their electricity supplier to Scottish Power in the near future. The Scottish Power fuel mix is also shown below in **Table 3.3** and **Figure 3.2**. While the renewable content in the Scottish Power fuel mix is higher than both EDF Energy and the UK average, so is the proportion of coal and gas. The carbon emissions intensity of Scottish Power electricity is therefore higher than both that of the UK average and EDF energy.

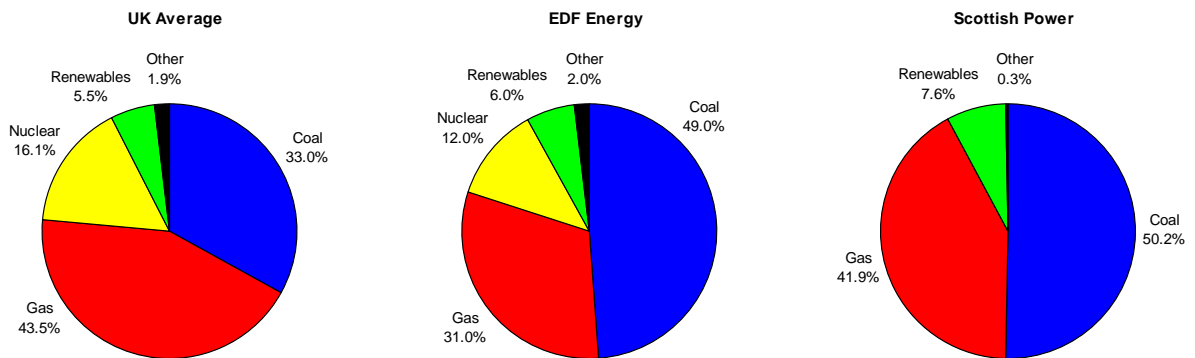


Figure 3.2: 2008 UK Average, EDF Energy and Scottish Power Fuel Mix (Source: www.fuelmix.co.uk)

Fuel Type	gCO ₂ /kWh	UK Average	EDF Energy	Scottish Power
Coal	910	33.0	49.0	50.2
Gas	360	43.5	31.0	41.9
Nuclear	0	16.1	12.0	0.0
Renewables	0	5.5	6.0	7.6
Other	610	1.9	2.0	0.3
gCO₂/kWh		468	569	610

Table 3.3: 2008 UK Average, EDF Energy and Scottish Power Fuel Mix (Source: www.fuelmix.co.uk)

3.5 Water

The consumption of water by at Stranraer is metered and invoiced by Scottish Water every quarter. Data was provided by Diston Dryburgh in the form of invoices, which detailed consumption, waste water and financial spend data (**Table 3.4**). The majority of the invoices were available; however the invoice for the August to October quarter of 2008 is presently unavailable, representing a data gap. Scottish Water has been contacted to obtain a copy.

Invoice Start date	Invoice End date	Water Consumption (m ³)	Waste Water Creation (m ³)	Cost (£)
05.11.08	02.02.09	325	308.75	1,523.84
03.02.09	12.05.09	327	310.65	1,680.26
12.05.09	03.08.09	401	380.95	1,650.03

Table 3.4: Water Consumption and Spend for Stranraer Campus for the 2008/9 Baseline Year

The public sink facilities provided for students and staff are geared towards low water use and waste, with push taps. This is not the case for disabled toilets, where turn taps are used due to accessibility purposes. There are also sinks in some classrooms, such as those for art, or special needs education, however these are the exception rather than the rule. The available data indicates that campus water consumption remains fairly constant throughout the year, with some indication of higher usage in the summer months (**Figure 3.3**).

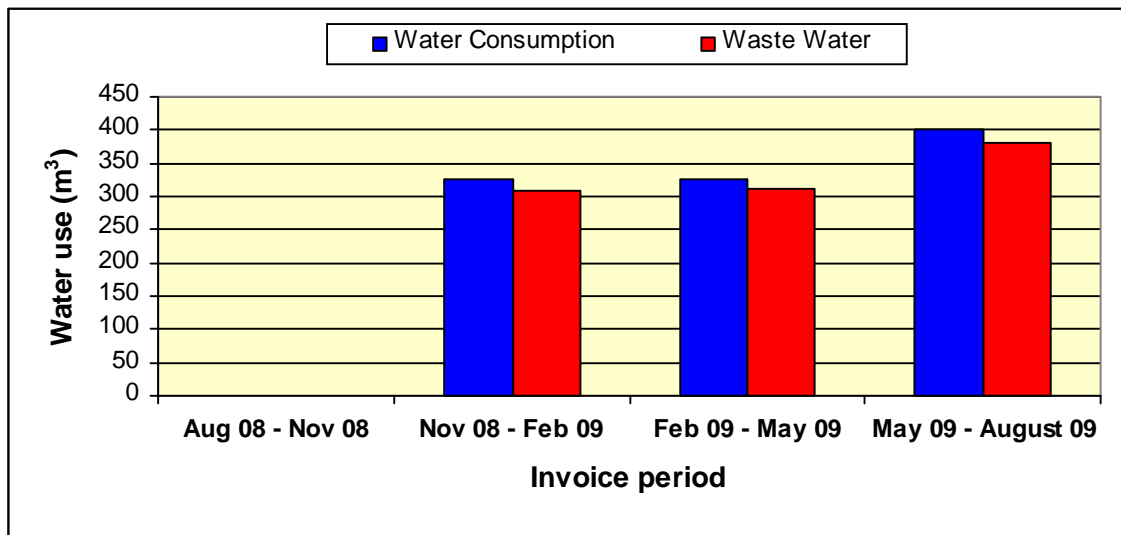


Figure 3.3: Water Consumption of Stranraer Campus for the 2008/09 Baseline Year

4 Stranraer Campus - Fugitive Emissions

Fugitive emissions refers to the leakage of GHGs from equipment such as air conditioning and refrigeration units. This leakage occurs during installation, daily use, refrigerant gas recharging and eventual disposal. Since the 1990s, hydrofluorocarbons (HFCs) have been used as refrigerants, replacing chlorofluorocarbons (CFCs), due to their ozone depleting properties. HFCs have a global warming potential many times greater than that of CO₂.

The Stranraer campus building does not have an air conditioning system, therefore the majority of fugitive emissions will result from refrigeration equipment. There are a number of refrigerators of varying sizes situated throughout the campus building. The majority of this equipment is located in the teaching kitchen in the catering department, with others found in staff areas and public café area for food and drink cooling.

Information on refrigerators was compiled from a survey of equipment where access could be gained. The survey was carried out in September 2009 and involved recording the make and model of the appliances and, where possible, the refrigerant gas type and charge (mass of gas in unit).

In the calculation of the fugitive emissions only those resulting from the operation of the refrigeration equipment was included. Emissions associated with installation and disposal were not (it is not thought that any new units were installed or old units disposed of in the baseline year). Where gas type and charge were not known, typical values for the appliance type (e.g. domestic or commercial unit) were used. Emissions were calculated following a screening method.¹⁰ In total, approximately **0.8 tCO₂eq** (799 kgCO₂eq) of fugitive GHG emissions were estimated. This is insignificant when compared to emissions related to energy consumption at the Stranraer campus (less than 0.4% of electricity emissions).

While there is a high level of uncertainty associated with the method employed to estimate fugitive emissions, given the very small contribution to total emissions, taking a more detailed approach would be unwarranted at this time.

5 Leased Property – The Barony Centre

The College offers several courses at Stranraer which they do not have the facilities to present within the campus building. As a result, Dagcol leases a building owned by the Barony Agricultural College, which is situated adjacent to the main campus building. The Barony Centre houses various mechanical engineering courses, including car mechanics.

The building is leased on an annual basis, for an initial period of three years from January 2007 and is up for renewal in 2010. Under this contract, Dagcol is responsible for any internal maintenance of surfaces and fitting, with any external work being carried out by Barony College. Internal modifications of the building can not be made by Dagcol without prior permission from the owners. Around 2006, alterations and improvements were made to the Barony Centre, with those carried out by Dagcol being related to security measures, improvements and refurbishment. Of the named list of

¹⁰ See Appendix C for the data collected using this method. See Annex 8 in Defra/DECC (2009) for further information on the methods used to estimate fugitive emissions.

changes carried out on the building, these do not include the fitting of double glazing or insulation.

In relation to utility bills, Dagcol is charged 70% of the total cost of water and heating oil costs. Whereas, the College is charged 100% of the invoice cost for electricity. The emissions resulting from these utilities are detailed below.

5.1 Energy Emissions

The Barony Centre building is heated by oil and full invoice data is available for the baseline year, as is data for electricity consumption. Total consumption, spend and GHG emissions for this period are shown in **Table 5.1** below. Spend data is available for water consumption and waste water production at these premises; however invoice data is not available for the volume of water used.

Energy type	Consumption (kWh)	Consumption (l)	Annual Cost incl VAT (£)	Total GHG Emissions (kgCO ₂ eq)
Burning Oil	-	5988	738.51	15,235
Electricity	8676	-	1135.17	4,722
TOTAL			1873.68	19,957

Table 5.1: Total Energy Consumption, Cost and Emissions Barony Centre for the 2008/09 Baseline Year

In comparison to the main Stranraer campus building, energy consumption is low, with **8676 kWh** of electricity being consumed at a cost of **£1135.17**, emitting **4.7 tCO₂eq** (4,722 kgCO₂eq) of GHGs. Of this total, **0.4 tCO₂eq** (363 kgCO₂eq) are the result of line losses during electricity transmission. In relation to oil usage, **5988 litres** were consumed. This was at a cost of **£738.51**, with the emission of **15.2 tCO₂eq** (15,235 kgCO₂eq). In total, **20.0 tCO₂eq** (19,957 kgCO₂eq) were emitted as a result of energy consumption at the Barony Centre.

6 Energy-related Supply Chain Emissions

Supply chain emissions related to energy consumption are within the boundaries of the Dagcol carbon footprint assessment. This is in line with advice provided to signatories for the UCCCfS regarding inclusion of Scope 3 emission sources (EAUC, 2009).

Scope 3 GHG emissions are indirect emissions related to the upstream and downstream supply chain that are not classed as Scope 1 or 2 GHG emissions – that is emissions that occur as a consequence of the activities of an organisation, but physically occur at sources not owned or controlled by the organisation and are not associated with purchased energy.

In relation to energy consumption, Scope 3 emissions are those associated with the supply and distribution of energy products – for example emissions arising from extraction, processing and transportation of fossil fuels. These emissions are estimated from expenditure (not including CCL or VAT) and emissions factors derived from Environmental Input-Output (EIO) models. It should be noted that these EIO derived

emissions factors are based on broad categories and represent a wide range of possible production methods. Two sets of EIO emissions factors have been utilised here. Firstly, the widely available supply chain emissions factors as provided in Annex 13 of Defra/DECC (2009). These factors were calculated by the Centre for Sustainability Accounting (CenSA - www.censa.org.uk) and are based on 2004 basic prices. Secondly, the more up to date supply chain emissions factors based on 2007 basic prices as calculated by Small World Consulting (SWC - www.smallworldconsulting.co.uk).

For oil use, the supply chain emission factor includes emissions due to the production and distribution of the fuel (**Table 6.1**). Therefore, the supply chain emissions (Scope 3) are added to the direct emissions arising from burning the fuel (Scope 1) to provide an estimate of total emissions due to oil use. Note the oil use for the Barony Centre is based on 70% of the total consumption (see Section 5).

	Consumption l	Spend £	Scope 1		Scope 3		TOTAL kgCO ₂ eq
			kgCO ₂ eq/l	kgCO ₂ eq	kgCO ₂ eq/£		
					SWC	CenSA	
Barony Centre	5,988	£ 1,989	2,5442	15,235	0.9212 - 2.8500	1,832 - 5,669	17,067 - 20,903

Table 6.1: Oil consumption supply chain emissions for Barony Centre

For electricity, the supply chain emission factor includes emissions due to the production and transport of the fuels used to generate the electricity (Scope 3), in addition to the emissions arising from the use of those fuels by the electricity producers (Scope 2). Therefore in this case, the calculated supply chain emissions provide an estimate of total emissions due to electricity use (Scope 2 + Scope 3). An estimate of the additional emissions due to production and transportation of the fuels (Scope 3) is derived by subtracting the estimated Scope 2 emissions for electricity (**Table 6.2**)

	Consumption kWh	Spend £	Scope 2		Scope 3		TOTAL kgCO ₂ eq
			kgCO ₂ eq/kWh	kgCO ₂ eq	kgCO ₂ eq/£		
					SWC	CenSA	
Stranraer	407,115	£ 30,324	0.54418	221,544	8.1182 - 9.7919	246,178 - 296,931	467,722 - 518,475
Barony Centre	8,678	£ 1,079	0.54418	4,722	8.1182 - 9.7919	8,757 - 10,563	13,479 - 15,285

Table 6.2: Electricity consumption supply chain emissions for Stranraer campus building and Barony Centre

For the purposes of calculating the total footprint of Dagcol, the supply chain emissions are based on the EIO emission factors in 2007 basic prices as calculated by SWC. Over the 2008/09 baseline year, a total of approximately **257 tCO₂eq** (256,767 kgCO₂eq) were produced by scope three supply chain emissions related to energy generation.

7 Recommendations

This section contains recommendations for areas where improvements could be made, resulting in both cost savings and reductions in GHG emissions.

7.1 Building Fabric and Heating

What follows are some basic recommendations that could be applied to the campus building. As indicated in the building survey, the insulation of the ridge area of the attic space leads to heat loss from the first floor. As a result the attic space is heated, rather the occupied room space below. The recommended/acceptable depth of roof/ceiling

insulation required to achieve good building performance is 300mm, but insulation should be a minimum of 150mm thick.

The workshops in the main College building have the potential to lose a significant quantity of heat due to the area not being air tight. Examples of this include the lack of insulation, use of single glazed windows and gaps below the workshop doors to the College car park. Making changes to these areas would reduce the quantity of heat that is being lost. Presently, an investigation of suitable heating system to replace the present method is being carried by Dagcol.

The double glazing throughout the building showed evidence of condensation under inspection, indicating wither the failure of the draught seals or poor air quality within the rooms reducing the ability to disperse condensation.

An additional point made in the building survey report was that the air handling units used to warm the College have no service history. It is possible the system could have problem that reduces its efficiency, therefore regular servicing of the units should begin.

It is recommended that a service of the air handling units be carried out to determine their condition.

Consider laying 150-300mm insulation over the ceiling area in the attic space instead of the ridge area to reduce heat loss from the first floor.

It is recommended that the original window and door schedules are obtained from archived records, then copied and updated to record defects/repair requirements. This will allow the college to put in place a programme and/or budget for repairing windows/doors in order of priority.

Investigate the feasibility of carrying out an energy efficiency upgrade of the workshop area of the College main building. This could include:

- **the fitting of draft excluder strips to the bottom of the workshop doors.**
- **the consideration of double glazed windows to replace the single glazed variety presently used in the workshop**
- **investigating the potential of fitting a false ceiling in the workshops and laying 150-300mm insulation.**

It is also recommended that a detailed options appraisal be carried out to determine the best solution for heating this section of the building, with consideration given to energy efficient and renewable options.

7.2 The Barony Centre

The leasing of the Barony Centre is recognised as a necessary requirement to continue mechanical engineering classes at the Stranraer campus. Making changes to a leased building to improve its energy efficiency can be difficult, with the landlord/tenant relationship potentially creating a barrier to improvements. This is particularly the case with short-term leases, which Dagcol presently has with Barony College and runs out in 2010.

It is recommended that Dagcol secures a long-term tenancy agreement for the Barony Centre, which would ensure that the College would reap the benefits of any energy efficiency improvements that are made to the building.

In relation to energy efficiency measures, it is recommended that single glazing windows are replaced with double glazing, with insulation to be installed in roof spaces. It is also suggested that Dagcol consider replacing T8 fluorescent bulbs with T5 bulbs, as well as install reflective fittings in classrooms and offices.

7.3 Lighting

The lighting used at the Stranraer mostly consists of low energy bulbs, which is a positive step. However, there is the potential to make further improvements that will reduce the quantity of electricity used as a result of lighting. In relation to the bulbs utilised at the campus, one option is to replace the T8 fluorescent bulbs (36W) used throughout the campus with the T5 version (28W). Making this change could result in significant energy savings, as illustrated in table 7.1.¹¹ By changing all 537 fluorescent bulbs has the potential to result in saving of over **7,500 kWh** of electricity, which is equivalent to **£516** and GHG emissions of **4,100 kgCO₂eq**.

Bulb Type	Total Bulbs	Power Consumption (W)	Total Power Consumption (kWh/day)	Total Power Consumption (kWh/term time)	Total Power Consumption (kWh/non-term time)	Total Power Consumption (kWh/year)
36W Fluorescent Bulb	537	36	164	29,414	4,601	34,015
28W Fluorescent Bulb	537	28	128	22,877	3,579	26,456

Table 7.1: Comparison of Energy Consumption by 36W and 28W Fluorescent Bulbs

In addition to these savings, the T5 bulb has a better light quality, reduces the amount of flicker and is more efficient in comparison. Replacing the T8 bulbs would require using an adaptor to install the T5 version; however this could be staggered with replacements only being carried out when a bulb has reached the end of its life.

The quality of light that is experienced in some parts of the campus can be dull at times, particularly where there is no additional natural light. In classroom and office areas, the light level could be increased by installing reflective light fittings, which enhance the light emitted by fluorescent bulbs. This would be increase further by changing the type of bulb used.

During the light survey carried out the campus, it was observed that passive infra red sensors are not present in the classrooms and offices. By placing this system within these areas ensures that lights are turned off when a room is not occupied and reduces the amount of electricity used. In addition, an awareness campaign could be conducted regarding energy use and College lighting, highlighting simple behavioural changes that could be made to reduce consumption.

It is recommended that an awareness campaign targeted at staff and students be carried out highlighting energy consumption and lighting. A potential measure in this campaign could be to place ‘switch off’ signs next to light switches.

Consider replacing T8 fluorescent bulbs with T5 bulbs, as well as installing reflective fittings in classrooms and offices.

¹¹ This is based on a scenario with all fluorescent bulbs being left for 8.5 hours per day, representing core class and working hours. In this scenario, there are a total of 179 term time days, with all bulbs being switched on during core hours. In relation to non-term time days, these total 70 days, with additional assumptions that only bulbs in offices and open areas will be in use. It is assumed that 60% of bulbs are situated in classrooms, with 20% in open areas (e.g. corridors) and the remaining 20% in offices and staff work areas.

It is recommended that the feasibility of installing passive infra red sensors in classrooms and offices be investigated.

7.4 Behavioural Change and Electrical Equipment

Stranraer has a number of electrical appliances that were previously energy star rated, which indicate that positive steps have been taken to reduce electricity consumption. It should be highlighted that a number of these appliances such as the Dell desktops and monitors do not reach current standards. Replacing them with Energy Star 5 rated appliances (or best practice standard at time of replacement) when they reach the end of life would reduce energy consumption in this area. Further savings could be made through 'behavioural changes' that can be made by staff and students. These have no cost and would require raising awareness of energy use by electrical equipment.

As highlighted in Section 4, a number of electrical appliances are being left on standby by both staff and students. It is recognised that it is not feasible to shutdown equipment during class and office hours, however by properly shutting down and switching off these items there is the potential to make a number of savings.

It is recommended that the procurement of Energy Star equipment continues and electrical equipment be replaced with electrical equipment that meets current standards.

To raise awareness of energy consumption on campus, an awareness campaign encompassing and involving all staff and students should be carried out to encourage the complete shutdown of computers and the switch off of monitors after use, as well as the switching off of printers at the end of the day.

7.5 Water Consumption

Water consumption reduction methods are present in the Stranraer campus, with push taps in the public toilets. Further reductions could be made by changing the flush system used for toilets throughout the building. An alternative could be the instalment of a dual flush system, allowing the user to choose between a full or half flush, with the potential to significantly reduce the campus' water consumption. An additional option would be to place hippo bags into the cisterns of each toilet. These reduce the amount of water that is held within the cistern and in turn the amount that is used to flush the toilet.

It is recommended that the single flush systems used in the public toilets be replaced by either dual flush systems or the hippo bags within the cisterns.

8 Conclusion

This draft report represents the energy portion of the baseline carbon footprint for the Stranraer Campus of Dagcol. It has been carried out in fulfilment of the Universities and College Climate Change Commitment for Scotland.

An audit of the energy data held by the campus has highlighted several data gaps. There are omitted invoices for both gas and water consumption at the main campus building. This means that the total emissions in these areas cannot be calculated. A full record of invoices is available for electricity use, with over **400,000 kWh** being consumed during the baseline year, resulting in GHG emissions of over **220 tCO₂eq**. Energy consumption at the Barony Centre, which is heated using burning oil, produced approximately **20 tCO₂eq** of GHG emissions during the 2008/09 baseline year.

The campus building is 19 years old, being completed in 1990 and generally is in good condition. However, some improvements could be made in relation to the insulation of the attic space and the workshops located in the main building. In terms of the building's lighting, the bulbs used throughout the campus are low energy. This could be further enhanced by replacing the T8 fluorescent bulbs with the T5 type. The majority of IT equipment is energy efficient, however it does not meet the present Energy Star standard. The College's green procurement policy should continue, with the replacement of IT equipment with those that meet this standard when they reach the end of their working life. There are other opportunities to reduce current levels of electricity, specifically through the promotion of behavioural change and switching off IT appliances at the plug at the end of the day.

9 References

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Appendix A – Stranraer Campus Bulb Types

Bulb Type	Power Consumption (W)	Total Bulbs
36W 4ft Fluorescent Bulb	36	537
16W 4-pin Bulb	16	16
8W Fire Exit Bulb	8	14
8W 2ft Fluorescent Bulb	8	104
150W High Intensity Discharge Bulb	150	3
60W Tungsten Bulb	60	1

Appendix B – Air Conditioning and Refrigeration Fugitive Emissions

Total GHG Emission Generated by Refrigeration Equipment at Stranraer Campus

Type of Refrigerator	Number of Units	x	Equipment Charge Capacity (kg)			x	Time Used During Reporting Period (year)	x	Annual Leak Rate	x	Refrigerant Global Warming Potential (GWP)			=	Total GHG Emissions (kgCO ₂ e)		
			Lower	Upper	Specific						Lower	Upper	Specific		Lower	Upper	Specific
Blast Chiller - Foster QCF 60	1	x	0.2	6	-	x	1	x	2.00%	x	0.001	1300	-	=	0.000004	156.00	-
King Refrigeration - Dairy and Butter Fridge	1	x	0.2	6	-	x	1	x	2.00%	x	0.001	1300	-	=	0.000004	156.00	-
Derby UF370DS - Freezer	1	x	0.2	6	-	x	1	x	2.00%	x		1300	=	5.20	156.00	-	
Gram - Freezer	1	x	-	-	0.205	x	1	x	2.00%	x		3260	=	-	-	13.37	
Gram - Beverage Fridge (15669627525)	1	x	0.2	6	-	x	1	x	2.00%	x	0.001	1300	-	=	0.0000040	156.00	-
Foster Refrigeration - Fridge (FW 400H/ECBBCR152)	1	x	0.2	6	-	x	1	x	2.00%	x	0.001	1300	-	=	0.0000040	156.00	-
Goldstar - Fridge (GR051 55F)	1	x	0.2	6	-	x	1	x	2.00%	x	0.001	1300	-	=	0.0000040	156.00	-
DITO - Sauce Fridge	1	x	0.2	6	-	x	1	x	2.00%	x		1300	=	0.0000000	0.00	-	
Hoover Aristocrat - Fridge	1	x	0.05	0.5	-	x	1	x	0.30%	x	0.001	1300	-	=	0.0000002	1.95	-
Lex Silverline - Fridge	1	x	0.05	0.5	-	x	1	x	0.30%	x	0.001	1300	-	=	0.0000002	1.95	-
Electrolux - Fridge/Freezer	1	x	0.05	0.5	-	x	1	x	0.30%	x	0.001	1300	-	=	0.0000002	1.95	-
Soft Drinks Vending Machine	3	x	0.2	6	-	x	1	x	2.00%	x	0.001	1300	-	=	0.0000120	468.00	-
Sandwich Chiller	1	x	0.2	6	-	x	1	x	2.00%	x	0.001	1300	-	=	0.0000040	156.00	-
TOTAL														=	5.20	1565.85	13.37

Appendix C - Emission Factors Summary

In the utilisation of emissions factors to convert the various transport activities in the scope of the Dagcol footprint, all of which were obtained from the Department of Environment, Fisheries and Rural Affairs (Defra). Below, the emission factor used for each activity in the footprint will be highlighted, along with its source and the reasoning behind its use.

Activity	Emission factor	Source	Reasoning behind use
Space and Water Heating	<u>Burning Oil</u> – 2.5442 kgCO ₂ eq/litre	2009 Standard emissions factors taken from DEFRA/DECC (2009) Guidelines to Defra/DECC's GHG conversion factors for company reporting	The Defra standard emission factors for energy consumption was used as they are the benchmark figures published by the Government. It must be noted however, that this factor includes the emissions caused by burning the fuel, it does not include the processes utilised in the drilling, removal or transport of the fuel.
Fugitive Emissions	<u>R410a</u> – 1,725 <u>R600a</u> – 0.001 <u>R134a</u> – 1,300 <u>R404a</u> – 3,260	2009 Standard emissions factors taken from DEFRA/DECC (2009) Guidelines to Defra/DECC's GHG conversion factors for company reporting	The Defra standard emission factors for fugitive emissions was used as they are the benchmark figures published by the Government. It should be noted that there are a number of uncertainties connected with these emissions factors.
Purchased Electricity	<u>Electricity Generated</u> – 0.50238 kg CO ₂ eq/kWh <u>Electricity Losses</u> – 0.04180 kg CO ₂ eq/kWh <u>Electricity Consumed</u> – 0.54418 kg CO ₂ eq/kWh	2009 Standard emissions factors taken from DEFRA/DECC (2009) Guidelines to Defra/DECC's GHG conversion factors for company reporting	The Defra standard emission factors for energy consumption was used as they are the benchmark figures published by the Government. It must be noted however, that this factor includes the emissions caused by burning the fuel, it does not include the processes utilised in the drilling, removal or transport of the fuel.

<p>Supply Chain Emissions</p>	<p><u>Refined Petroleum, Coke and Other Fuels</u> – 2.85 kgCO₂eq/£^a <u>Mains Electricity</u> – 9.79 kgCO₂eq/£^b</p>	<p>2009 Standard emissions factors taken from DEFRA/DECC (2009) Guidelines to Defra/DECC’s GHG conversion factors for company reporting</p>	<p>^aThese emissions related to the activities of the industries engaged in the extraction of energy carriers.¹² ^bThese emission factors relate to the supply and distribution of energy products for general consumption, and take into account emissions relating to the extraction and processing of energy carriers. Except in the case of electricity, they do not include emissions relating to you company’s use of the energy. In the case of electricity, these factors include the emissions relating to the production of the fuels used to generate electricity.¹³</p>
<p>Supply Chain Emission</p>	<p><u>Burning Oil</u> – 0.9212 kgCO₂eq/£ <u>Mains Electricity</u> – 8.1182 kgCO₂eq</p>		

¹² Ibid

¹³ Defra/Department of Energy and Climate Change (2009) 2009 Guidelines to Defra/DECC’s GHG Conversion Factors for Company Reporting v2.0 (London; Defra, DECC). Full text available from: <http://www.defra.gov.uk/environment/business/reporting/pdf/20090928-guidelines-ghg-conversion-factors.pdf>