Creating a Climate Responsible Campus:

A Report on the 2010-2011 Carbon Footprint of Grenfell Campus, Memorial University

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List of Acronyms

ACUPCC – American College and University Presidents' Climate Commitment

CA-CP – Clean Air – Cool Planet

CNA – College of the North Atlantic

ECM – Enterprise Carbon Management

GHG – Greenhouse Gas

GWP – Global Warming Potential

ISO – International Standards Association

KPI – Key Progress Indicators

LCA – Life Cycle Assessment

LEED – Leadership in Energy Efficiency and Design

MTA- Mount Allison University

MUN – Memorial University of Newfoundland

SHE – Sustainability in Higher Education

TCR – The Climate Registry

UCPCCSAC – University and College President's Climate Change Statement of Action for Canada

UNBC – University of Northern British Columbia

Executive Summary

Universities and colleges have a responsibility to be leaders in the challenge to become a sustainable society, practicing what they teach by integrating sustainability policies and practices into their own operations. Developing a carbon footprint, or Greenhouse Gas (GHG) Inventory, to track and reduce greenhouse gas emissions is one way institutions are taking action on climate change and promoting sustainability. There is no standard method for developing a carbon footprint. Institutions across Canada are using a variety of methods and tools for tracking their emissions including SMARTTool, developed by the Government of British Columbia, and the Campus Carbon Calculator, developed by Clean Air – Cool Planet, a non-profit organization based in the United States, and the Sierra Youth Coalition in Canada.

Most methods and calculators are consistent with the standards established by the World Resource Institute (WRI) and the World Business Council on Sustainable Development (WBCSD)'s Greenhouse Gas Protocol (World Resource Institute and World Business Council on Sustainable Development, 2004). The Greenhouse Gas Protocol facilitates the preparation of GHG Inventories by separating emission sources into three levels of responsibility. Scope 1 emissions are direct emissions from sources that are owned or controlled by the organization. Scope 2 emissions are indirect emissions from the generation of purchased electricity. Scope 3 emissions include all other indirect emissions that are a consequence of the organizations activities but are not owned or operated by the organization. Scope 1 and 2 emissions are required for most inventories. Scope 3 emissions are often considered optional because they have been vaguely defined and are difficult to estimate (Pandey et al., 2011). However, depending on the organization, Scope 3 activities may contribute significantly to the total carbon footprint.

This report contains the first Carbon Footprint, or GHG Inventory, developed for the Grenfell Campus of Memorial University for the fiscal year 2010-2011. The organizational and operational boundaries of the inventory were established according to the GHG Protocol. The inventory includes all Scope 1 and 2 emissions as well as Scope 3 emissions from waste. Emission factors and calculations were completed using CarbonConnect, a web-based, third-party verified application tool designed by CarbonCounted, a Canadian based, not-for-profit organization.

The results of the inventory show that Grenfell Campus emitted 101.07 tonnes of carbon dioxide equivalent (CO_2eq) from Scope 1 sources (fuel consumed by the vehicle fleet and site maintenance equipment and fugitive emissions from refrigerants) and 306.45 tonnes of CO_2eq from Scope 2 sources (electricity consumption). This is a total of 407.52 tonnes from Scope 1 and 2 sources. Emissions from land filled waste (Scope 3) were estimated at 1,425.96 tonnes CO_2eq, which exceeds that of larger institutions. Although calculation methods and waste diversion programs vary between institutions, this number seems high. The Grenfell data is based on a number of assumptions including that all the dumpsters are full at the time of pick up and the composition of the waste is the same as that of municipal solid waste. Looking at all three scopes, Scope 3 appears to be the largest contributor of emissions. However, if we compare just Scopes 1 and 2, electricity consumption becomes the largest contributor.

This inventory represents a baseline for future inventories and the first step towards developing polices, targets, and an emission reduction plan. We recommend that the next inventory be completed in the summer or fall of 2012 and suggest that this can be achieved by integrating the process into the curriculum, hiring a student, or hiring a Sustainability Coordinator. We also suggest ways to improve the accuracy of the data such as obtaining an estimate of the yearly consumption of propane and diesel on campus rather than relying on purchasing data. We also recommend gathering more detailed electricity consumption data to identify the major contributors to this emission source on campus. Rather than using waste density and volume estimates to determine emissions from waste we recommend working with the contractor to gather data on the actual weight of the waste at the time of pickup. The inventory could also be improved by including other Scope 3 sources such as commuting, directly financed travel, and emissions associated with paper, food, and fuel procurement. We encourage Grenfell to commit to emissions reductions by signing the University and College President's Climate Change Statement of Action for Canada (Appendix B) and implementing two of the actions recommended by the Statement in the fiscal year 2012-2013.

1. Introduction

If higher education is not relevant to solving the crisis of global

warming, it is not relevant, period.

—David F. Hales, President, College of the Atlantic

1.1 Sustainability in Higher Education (SHE)

Post secondary institutions have a responsibility to contribute to research and action on sustainability. Today's students will be tomorrow's leaders, professionals, and informed citizens. Many believe that we are facing humanity's greatest challenge: to achieve a healthy, just, and sustainable society. The next generation will need the skills to meet this challenge, which post secondary institutions can, and arguably must, provide. Institutions of higher education can lead by example and practice what they teach, integrating sustainable practices into their own operations.

The importance of this role has been recognized by the signatories of the Talloires Declaration,[1] the American College and University Presidents' Climate Commitment (ACUPCC),[2] and the University and College Presidents' Climate Change Statement of Action for Canada.[3] The Talloires Declaration is a ten point action plan for incorporating sustainability into teaching, research, operations and outreach at colleges and universities. As of November 3, 2011 it has been signed by 436 university presidents and chancellors in over 50 countries. Thirty seven Canadian universities have signed on (Appendix A). The

[1] The Talloires Declaration http://www.ulsf.org/programs_talloires.html

[2] The American College and University President's Climate Commitment (ACUPCC) http://www.presidentsclimatecommitment.org/

[3] University and College Presidents Climate Change Statement of Action for Canada. http://www.climatechangeaction.ca/

Association of University Leaders for a Sustainable Future (ULSF) is the Secretariat for the signatories of the declaration.

The ACUPCC is the initiative of a network of colleges and universities in the United States that have committed to reduce greenhouse gas emissions, promote research, and provide education and leadership on climate change. ACUPCC institutions agree to complete a greenhouse gas emissions inventory, set a target date and milestones for becoming carbon neutral within two years, take immediate and short term steps to reduce greenhouse gas emissions, Integrate sustainability into the curriculum, and make reports and action plans publicly available (Presidents' Climate Commitment, 2007-2012). To date it has 676 signatories. The University and College Presidents' Climate Change Statement of Action for Canada was developed for Canadian institutions, based on the ACUPCC. As of November, 2011 it has been signed by 22 institutions (Appendix B).

Recognition of the importance of this role is also indicated by the number of institutions that have created Sustainability Offices, the development of the term 'SHE' - Sustainability in Higher Education and the International Journal of Sustainability in Higher Education (IJSHE), and initiatives such as the Association for the Advancement of Sustainability in Higher Education (AASHE). AASHE is a North American organization founded in 2006 to advance sustainability in all sectors of higher education.[4] APPA, an association for Facilities Management Professionals at educational institutions, also lists sustainability as one of its core competencies.[5] And in Atlantic Canada, the Atlantic University and College Sustainability Network (AUCSN) has formed to facilitate the sharing of information among university and college sustainability professionals in the region.

Post Secondary Institutions are also developing policies, declarations, and action plans related to campus sustainability. Memorial University of Newfoundland officially signed a Sustainability

[4] The Association for the Advancement of Sustainability in Higher Education (AASHE) http://www.aashe.org/about

[5] APPA: Leadership in Educational Facilities. http://www.appa.org/index.cfm

Declaration on October 6th, 2009. The declaration embraces a vision of Memorial as a "sustainable and progressive university in all areas of operation, education, research, and outreach providing leadership for today and future generations" (Memorial University of Newfoundland [MUN], 2009). To achieve this, Memorial has agreed "to promote a community committed to sustainability within and beyond the university…[by] develop[ing] a comprehensive and collaborative action plan with measurable outcomes" (MUN, 2009)

The goals that the university has outlined to implement this mandate are:

- "To measure and assess the university's environmental impacts and establish specific targets to reduce them
- To integrate sustainable policies and systems into university governance and operations
- To encourage academic curriculum, research and outreach on sustainability and
- To create sustainable working and living environments across all campuses" (MUN, 2009)

1.2 The Carbon Footprint Project

Corner Brook, Newfoundland and Labrador, has two post-secondary educational institutions with specializations in teaching and research on the environment. The Grenfell Campus of Memorial University has approximately 1400 students, 156 faculty, and 235 staff. It offers undergraduate programs in Environmental Science, Environmental Studies, Sustainable Resource Management, and will soon have a Master of Arts in Environmental Policy (Fall 2012). It has a new Environmental Policy Institute, a sustainability committee made up of faculty, staff and student representatives (the Vice-President's Advisory Committee on Sustainability [VPACS]), and a student society called the Environmental Affairs Committee (EAC).

The Corner Brook campus of the College of the North Atlantic (CNA) has approximately 700 full-time students and 100 part-time students per semester. Approximately 1,200 students participate in Continuing Education evening courses. It offers an Environmental Technology program with courses such as Environmental Citizenship, Environmental Auditing, Environmental Law and Policy, and Environmental Site Assessment. In January 2010, the CNA adopted an Environmental Sustainability policy (PO-006) which commits the college to develop a sustainability plan; integrate sustainability into the curriculum, procedures, operations, and corporate documents; and work collaboratively to share best practices (College of the North Atlantic, 2010).

The Environmental Policy Institute and the Vice President's Advisory Committee on Sustainability (VPACS) at Grenfell partnered with the College of the North Atlantic on a proposal for a carbon footprint project in June 2010. The objective of the project was to develop a method for analyzing the carbon footprint of a small campus by determining the carbon footprint of Grenfell and the CNA-Corner Brook campus. In addition, the project aimed to engage students in innovative sustainability projects on their own campuses and take the first step towards reducing carbon emissions, prioritizing sustainability actions, and measuring progress.

The initial Co-Investigators on the project were Susan Pottle, Research and Project Officer, Environmental Policy Institute, Grenfell Campus and Tera McDonald, Instructor, College of the North Atlantic. In the summer of 2011 Ms. McDonald accepted another position at the College's Gander campus. Thus, this report contains only Grenfell's carbon footprint. Bekah Reagan, an Environmental Studies student at Grenfell, was hired as a research assistant in the summer of 2011 and continued to work on the project as the basis of her independent project (to be completed in April 2012). The Grenfell Carbon Footprint Project Team included Dennis Waterman, former Director of Administration and Finance; Brian Duffy, Administration and Finance; Randy Rowsell, Direcor, Computing and Communications; Javis Hulan, Manager, Facilities Management; Robert Scott, Associate Professor, Sustainable Resource Management; Susan Pottle and Bekah Reagan.

This report outlines what we have learned about carbon footprints. It includes the research we have completed on different methods for developing an inventory, gathering data, and determining next steps to engage students and, ultimately, reduce our carbon emissions. We hope that this report will be used as a baseline for Grenfell to develop policies, targets, and an emission reduction action plan. We also hope that it helps Grenfell, and other institutions including the CNA, complete an annual carbon footprint.

1.3 What is a carbon footprint?

The carbon footprint concept originated from the idea of the ecological footprint, developed by Wackernagel and Rees in 1996 (Pandey, Agrawal, & Pandey, 2011). The ecological footprint of a human population refers to the resources (productive land and sea, in global hectares) required to sustain the population. It is from this concept that it is estimated that we would need four planet Earths to sustain the global population if everyone lived the way the average Canadian does (World Wildlife Fund, 2011). As the need for action to reduce greenhouse gas (GHG) emissions gained international attention, the carbon footprint concept, which focused this idea specifically on carbon emissions, evolved into an independent tool used to measure and manage emissions.

The concept has been successful in capturing the attention of the public and the corporate world as indicated by the number of consultancies and websites offering services and carbon footprint calculators. Standards have been developed by a number of organizations including the International Standards Organization (ISO), the British Standard Institution (BSI), the International Panel on Climate Change (IPCC), the World Business Council for Sustainable Development (WBCSD) and the World Resource Institute (WRI). Several national initiatives have been developed by organizations such as Carbon Trust in the UK and the Environmental Protection Agency (EPA) in the US (Pandey et al., 2011). The Greenhouse Gas Protocol developed by the WBCSD and WRI forms the basis for many of these initiatives. These standards are used by the organizations that offer carbon management services. The GHGs included and the boundaries of the footprint are defined by the objective of the footprint, the activity, and methodology chosen (Pandey et al., 2011).

The Greenhouse Gas Protocol Initiative was launched by the WBCSD and WRI in 1998 (World Resources Institute [WRI] & World Business Council for Sustainable Development [WBCSD], 2004). The initiative is a multi-stakeholder partnership of businesses, nongovernmental organizations, governments and other organizations with a mission to develop internationally accepted standards for corporate accounting and reporting. In 2001 it produced the first version of the Greenhouse Gas Protocol Corporate Standard. A revised edition was released in 2004. The GHG Protocol standard includes emissions from the six greenhouse gases covered under the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perflurocarbons (PFCs), and sulphur hexafluoride (SF_6). These are the most important contributors to global warming [i.e. they have a high global warming potential (GWP)]. Chlorofluorocarbons also have a high GWP; however their levels are now under control due to the Montreal Protocol (Pandey et al., 2011). Carbon dioxide from fossil fuel combustion is the main GHG; the emissions from the other gases are expressed in carbon dioxide equivalent (CO_2eq) by multiplying the amount of the gas by its GWP (Environment Canada, 2010). The GHGs included in an inventory depend on a few factors, such as the type of activity. For example, power generation typically produces CO_2; agricultural operations typically produce CH_4, CO_2, and N_2O emissions.

Carbon footprints have been calculated for countries, regions, institutions, businesses, investment funds, and products (Wiedmann & Minx, 2008). Provincial legislation is one of the drivers of GHG reporting in Canada. Reporting GHG emissions has become mandatory for the public sector in British Columbia and for facilities in Ontario that emit 25,000 tonnes of carbon dioxide equivalent (CO_2eq) or more per year. British Columbia, Manitoba, Ontario, and Quebec are part of the Western Climate Initiative (WCI), a partnership of independent jurisdictions working together to implement policies to address climate change at a regional level.[6]

[6] For more information on the Western Climate Initiative, refer to: http://www.westernclimateinitiative.org/index.php

Carbon footprints are commonly defined as the amount of greenhouse gas emissions produced by an organization, event, product or person (Wiedmann & Minx, 2008). This definition is broad and thus can be interpreted in different ways. It does not indicate which GHGs are included, the boundaries of the inventory, or the method of calculation. There is no universally accepted definition, standard, method or unit of measurement for developing a carbon footprint, leading to confusion and the inability to compare results (Pandey et. al., 2011; Peters, 2010; Wiedmann & Minx, 2008). Applications of the concept range from accounting for only direct carbon dioxide emissions to much broader measures such as Life Cycle Assessments (LCA) (Weidema et al., 2008). LCAs consider the entire environmental impact, from beginning to end, of a product or process. Including all possible emissions becomes complex, however, and most methodologies suggest boundaries for carbon footprint calculations.

Adding to the confusion is the use of multiple synonymous terms: greenhouse gas emissions inventory, greenhouse gas footprint, fossil fuel footprint and climate footprint, to name a few. Some argue that 'footprint' suggests area based units, and most carbon footprints are actually weight based, expressed in kilograms or tonnes of carbon dioxide equivalents (Hammond, 2007). Others suggest that only carbon dioxide emissions should be included in a carbon footprint and that if other GHGs are included the term 'climate footprint' should be used (Wiedmann & Minx, 2008). According to Weidema et al. (2008), the confusion over carbon footprints is because their development has been driven by nongovernmental organizations, businesses, and private initiatives with different objectives and definitions.

Pandey et al. (2011), suggests the following definition: A carbon footprint is "the quantity of GHGs expressed in terms of carbon dioxide equivalents, emitted into the atmosphere by an individual, organization, process, product or event from within a specified boundary" where the GHGs included and the boundaries are determined by the methodology and objective (p. 138). Due to the recognition of multiple GHGs, carbon dioxide equivalents, and boundaries, this definition will be used in this report.

2. Methodology

As noted above, there is no industry or institutional standard for developing a greenhouse gas inventory. In May, 2011, we completed a four part course on GHG (Carbon) Measurement and Reporting offered by the Sustainability Learning Centre.[7] Through this course and our research we learned about the many different tools and methods we could use to calculate our footprint. We also researched what other universities and colleges are doing. The challenge throughout this project has been deciding which options would be simple enough to input the data and understand the process, yet reliable enough to accurately process the data. The next section discusses research on other post secondary institutions in Canada and their carbon footprint or GHG inventory methodology.

2.1 Case Studies

Many colleges and universities across Canada and the United States have undertaken the task of completing a carbon footprint of their campus. We began this project by researching other institutions hoping to find a standard methodology. However, we soon realized that post secondary institutions are using a wide variety of tools and methods to track their emissions (Table 1). Therefore we decided to focus on three institutions that had completed a comprehensive inventory using different methodologies and were currently using these inventories successfully to reduce their carbon footprints.[8] The three institutions chosen for analysis were: Dalhousie University, Halifax, NS; the University of Victoria, Victoria, BC; and Mount Allison University, Sackville, NB. All three have their inventories, policies, and action plans publically available and promoted on their websites. The University of Victoria and Dalhousie University have signed the Taillores Declaration; Dalhousie is also a signatory of the University and College President's Climate Change Statement of Action for Canada. The three institutions are located in different provinces, which provides a range of tools and calculation methods. Although Dalhousie University and University of Victoria are both larger than Grenfell Campus,

[7] The Sustainability Learning Centre. http://www.sustainabilitylearningcentre.com/

[8] Refer to: Reagan, B. (2012) for a more in-depth exploration of the case studies.

they are similar in size to Memorial University's St. John's Campus. Mount Allison University is a comparable size to the Grenfell campus with 2,500 students. Table 1 contains basic information on some of the institutions we researched. The three case studies are presented in more detail below.

Table 1: Information on carbon footprints conducted at several Canadian Universities.

Institution	**Location**	**Number of Students**[9]	**Year of first GHG Inventory**	**Approach**	**Commitment(s)**	**Tool**	**Completed by**	**Total GHG Emissions* (tonnes CO_2eq)**
Dalhousie University	Halifax, NS	16,693 (2010)	2008-2009	Scope 1, 2 and 3 (emissions from commuter travel – online survey)	University and College President's Climate Change Statement of Action for Canada (UCPCCSA)	CSA Standard, The Climate Registry General Reporting Protocol	Office of Sustainability	109,510 (2008-2009)
University of Victoria	Victoria. BC	19,475 (2007)	2006	Scope 1, 2, and 3 (emissions from commuting by car or public transit to campus and new building construction)	Provincial Greenhouse Gas Reduction Targets Act (Bill 44)	SMARTTool**	The Institute for Integrated Energy Systems at UVic (IESVic)	35,612 (2006) 15,546 (2010)

[9] The number of students is from the Association of Canadian Universities and Colleges (AUCC) except where noted. http://www.aucc.ca/canadian-universities/our-universities

Institution	Location	Number of Students[10]	Year of first GHG Inventory	Approach	Commitment(s)	Tool	Completed by	Total GHG Emissions* (tonnes CO_2eq)
University of Northern British Columbia	Prince George, BC	4,183 (2010)	2010	Scope 1, 2, and 3 (emissions from paper procurement)	Provincial Greenhouse Gas Reduction Targets Act (Bill 44)	SMARTTool**	Green University Committee and Staff	5,688.72 (2010)
Mount Allison University	Sackville, NB	2,500	First environmental audit: 1998 First GHG inventory: 2005	Scope 1, 2, and 3 (emissions from solid waste, fertilizer and food production)	Mt. Allison policy 2101 and 2102	Canada Mortgage and Housing Corporation Survey (2000), Clean Air-Cool Planet (since 2005)	Mt. Allison students – summer employment	11, 634 (2005)
Queens University	Kingston, ON	19,982 (2008)	2008	Scope 1 and 2	UCPCCSA	GHG Protocol	The Delphi Group	55,658 (2009)

[10] The number of students is from the Association of Canadian Universities and Colleges (AUCC) except where noted. http://www.aucc.ca/canadian-universities/our-universities

Institution	Location	Number of Students[11]	Year of first GHG Inventory	Approach	Commitment(s)	Tool	Completed by	Total GHG Emissions* (tonnes CO_2eq)
University of Calgary	Calgary, AB	31,000 (2011)[12]	2008-2009	Scope 1 , 2, and 3 (emissions from commuting, directly financed travel, solid waste, wastewater emissions and transmission and distribution losses)	Tailloires Declaration, UCPCCSA	Clean Air-Cool Planet (CA-CP)	Office of Sustainability	328,575.41 (2008-2009)
University of Toronto, St. George Campus	Toronto, ON	41,182 undergraduates 14,229 graduates (2011-2012)[13]	2008-2009	Total Scope 1, 2, and 3 (emissions from commuting, directly financed travel, and waste)	Ontario Universities Committed to a Greener World pledge	Clean Air-Cool Planet	Facilities and Services	164,491 (2008-2009)

* Please note: Methods for calculating emissions and scopes included are inconsistent.

** All post secondary institutions in BC are required to use SMARTTool to calculate their greenhouse gas emissions. They are required to pay an initial fee to install and configure the software and then an annual maintenance fee for the next 3 to 4 years. It is estimated that the installation fee costs between $7,000 and $33,000 depending on the size of the institution. The purpose of the fees is to recover the cost of developing and deploying SMARTTool. The Ministry of Advanced Education provides funding to help with the cost of SMARTTool (Webster & Moore, 2009).

[11] The number of students is from the Association of Canadian Universities and Colleges (AUCC) except where noted. http://www.aucc.ca/canadian-universities/our-universities

[12] The University of Calgary: http://www.ucalgary.ca/about/

[13] The University of Toronto: http://media.utoronto.ca/factsheet/

Dalhousie University, Halifax, Nova Scotia

On December 11, 2009 Dalhousie University signed on to the University and College's Climate Change Statement for Canada and committed to completing a comprehensive inventory of greenhouse gas emissions within one year and releasing a climate plan with targets within two years of the inventory (Dalhousie Office of Sustainability, 2009).

The Canadian Standards Association "Greenhouse Gases – Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals" (Adopted ISO 14064-1:2006, first edition, 2006-03-01) was used as a framework for Dalhousie's GHG Inventory. The Climate Registry (TCR) – General Reporting Protocol – v. 1.1, 2008 was used to calculate their GHG emissions. Emissions related to electricity consumption were calculated using the Nova Scotia Power (NSP) emission factor while all other emission factors were derived from TCR's January 2010 emission factor spreadsheet. All three campuses (Studley, Carleton, and Sexton) and all university owned and financially controlled facilities are included in the inventory. Because the buildings do not have individual metering, all facilities are considered as one group. Leased space or vehicles are not included. The Dalhousie Inventory reports all direct (Scope 1), Indirect (Scope 2), and, where credible data exits, indirect consequences of their operations (Scope 3).

The Dalhousie Office of Sustainability is committed to completing an annual GHG inventory and publishing the results on the Office of Sustainability website. Dalhousie has also completed a Climate Change Plan which details strategies and specific targets for emission reductions. Some of the actions from the 2010 Climate Change plan include: conversion and updating of campus energy systems; retrofitting current buildings and new construction of LEED certified green buildings; promotion of sustainable transportation, such as bicycles; implementing the ReThink Program, new curriculum pertaining to sustainability and funding for student, faculty, and staff research concerning climate change; and purchasing "gold standard" carbon offsets and sinks. The 2009 inventory was established as the baseline for further reports with a goal of attaining

carbon neutrality by 2050. To stay on track, public reporting of sustainability indicators and targets will be released by the Dalhousie University Sustainability Plan every three to five years (Dalhousie University, 2010).

University of Victoria, Victoria, British Columbia

British Columbia enacted a Carbon Neutral Government Regulation (Bill 44) in 2008 requiring all public sector organizations to measure, reduce and offset greenhouse gas (GHG) emissions from buildings, vehicle fleets, and paper use (Province of British Columbia, 2011). All public sector institutions, including colleges and universities, must be carbon neutral in their operations by 2010. This requirement has made BC the first carbon neutral jurisdiction in North America (Waddell & Aben, 2010). As such, the University of Victoria (UVic) has committed to advancing sustainability in all areas of its operations and reducing their carbon footprint. The university developed a Sustainability Action Plan for Campus Operations (2009-2014) which includes aggressive targets:

- Become Carbon Neutral by 2010
- Reduce campus electricity consumption by 20% by 2015
- Increase renewable energy portfolio
- Reduce greenhouse gas emissions by 20% over 2007 baseline by 2015
- Quantify the risks to university resources and infrastructure associated with global climate change by 2015.

British Columbia developed a framework, called SMARTTool ,to help the public sector complete their GHG inventories. SMARTTool includes four different scopes:

- Buildings (energy and electricity consumptions)

- Fleet Vehicles (and non-standard fleet)
- Fugitive Emissions (refrigerants)
- Paper Procurement (8 ½ X 11, 8 ½ X 14, and 11 X 17 paper)

With respect to these four scopes, any emissions will have to be reduced and offset at a value of $25.00/metric tonne to the Pacific Carbon Trust (Royal Roads University, 1997-2012). The Government of British Columbia also released a report called the "Methodology for Reporting B.C. Public Sector Greenhouse Gas Emissions" in February 2011 which details the emission factors that will be used for reporting province-wide (Province of British Columbia, 2011).

According to the 2010 Carbon Neutral Action Report, the University of Victoria has upgraded its metering system on all buildings on campus and done extensive renovations and upgrades on six of the oldest buildings on campus. It also reduces temperature settings and shuts down all unnecessary lighting and electrical equipment over the December break. These are just a few of the ways in which the University is aiming to achieve their goal of a 20% reduction in emissions by 2015 (University of Victoria, 2010).

Mount Allison University, Sackville, New Brunswick

Mount Allison University students have been conducting environmental audits of the university every two to three years since 1998 through a summer employment program. These audits include an assessment of the curriculum, paper, food, solid waste, hazardous waste, grounds, new buildings and renovations, energy, water, transportation, emissions and procurement. They

are used as a benchmark to evaluate the progress the university has made since implementing Policy 2102: Environmental Policy in 1999.[14]

The audits include a section on emissions, however challenges such as inconsistent and incomplete records, estimated food related emissions, and the use of different methodologies for calculations are often noted. The 2008 report recommended working with other universities and colleges in Atlantic Canada to develop a standardized calculation system (Mount Allison, 2008). In 2009 Mount Allison adopted an Emission Reduction Policy (Policy 2101).[15] This policy committed the Controller to collect information and report metrics and progress on emission reduction in the annual Review of Operations. The 2009-2010 Carbon Footprint was 12,993 tonnes for the one year period ending on April 30, 2010 (Mount Allison, 2010). With the creation of strategies, implementation of action plans, planned upgrades, and the conversion from oil to natural gas in some of the central boilers, a dramatic reduction of Mount Allison's carbon footprint is expected.

These case studies are analyzed further in Bekah Reagan's independent project report (Reagan, 2012). Reagan compares and contrasts the methodologies, action plans, and results of the three institutions' carbon footprints. Through this analysis, the conditions necessary for a successful carbon footprint, including a proactive university community, an existing policy on GHG reduction, knowledge about inventory benefits, selection of inventory framework and process, access to accurate data, and a budget were identified (Reagan, 2012). This research also showed that institutions have included different emission sources. The next step in developing Grenfell's carbon footprint was to determine what to measure. The next section describes the GHG Protocol approach to defining GHG Inventory boundaries.

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[14] Mount Allison Environmental Policy (2007). Retrieved from: http://www.mta.ca/administration/vp/policies/2102.htm

[15] Mount Allison Emission Reduction Policy (2009). Retrieved from: http://www.mta.ca/administration/vp/policies/2101.htm

2.2 Inventory Boundaries

Before data is collected and calculations are performed the boundaries of the inventory must be decided. The more comprehensive an inventory, the more useful it is. However, reliable data may not exist for all emission sources. Further, setting boundaries makes the project more manageable. It is important to carefully consider what will be included and to apply this consistently. It is also important to disclose what is not included in the inventory. The World Business Council for Sustainable Development (WBCSD) and the World Resource Institute (WRI) have set standards to help organizations define inventory boundaries (WRI & WBCSD, 2004). These can be found in the GHG Protocol and are described briefly in the next three sections.

2.2.1 Organizational Boundaries

Organizational boundaries define what facilities or equipment will be included in the inventory. The GHG Protocol suggests two different approaches: measuring emissions from facilities that are control financially and/or operationally by the organization, regardless of ownership (the control approach) or measuring emissions from facilities that are owned by the organization (the equity share approach) (World Resources Institute and World Business Council for Sustainable Development, 2004).

For this project we are only assessing the footprint of the Grenfell Campus of Memorial University of Newfoundland (MUN) and are using the financial control approach. This approach has the effect of excluding buildings that are operated but not financially controlled by the university. The Pepsi Centre is owned by the City of Corner Brook but operated by Memorial University. However, it is financially controlled by Western Sports and Entertainment Inc. which is a Separately Incorporated Entity of MUN. Although the Western Sports and Entertainment Inc. does share MUN's policies it is completely financially independent.

The Grenfell Campus consists of 17 buildings that it owns and operates (Table 2 and Figure 2). The Academic Building extension listed in Table 2 is set to open in 2012 and is not included in the carbon footprint calculations in this report.

Table 2: Buildings owned and operated by Grenfell Campus, Memorial University

Building	**Square Footage**	**% of Campus**
Fine Arts	58,010	13.90%
Forestry Centre	39,807	9.50%
Library	29,584	7.10%
Arts & Science/Residence	198,500	47.40%
NRCAN Storage Building	1,230	0.30%
Greenhouse	570	0.10%
Chemical Storage	312	0.10%
Maintenance Shed	495	0.10%
GC Residence #1	4,230	1.00%
GC Residence #2	10,484	2.50%
GC Residence #3	8,380	2.00%
GC Residence #4	8,380	2.00%
GC Residence #5	8,380	2.00%
GC Residence #6	8,380	2.00%
GC Residence #7	10,484	2.50%
GC Residence #8	8,380	2.00%
Rec Plex	23,000	5.50%
TOTAL	418,606	100%
Extension (completed 2012)	54,000	12.90%

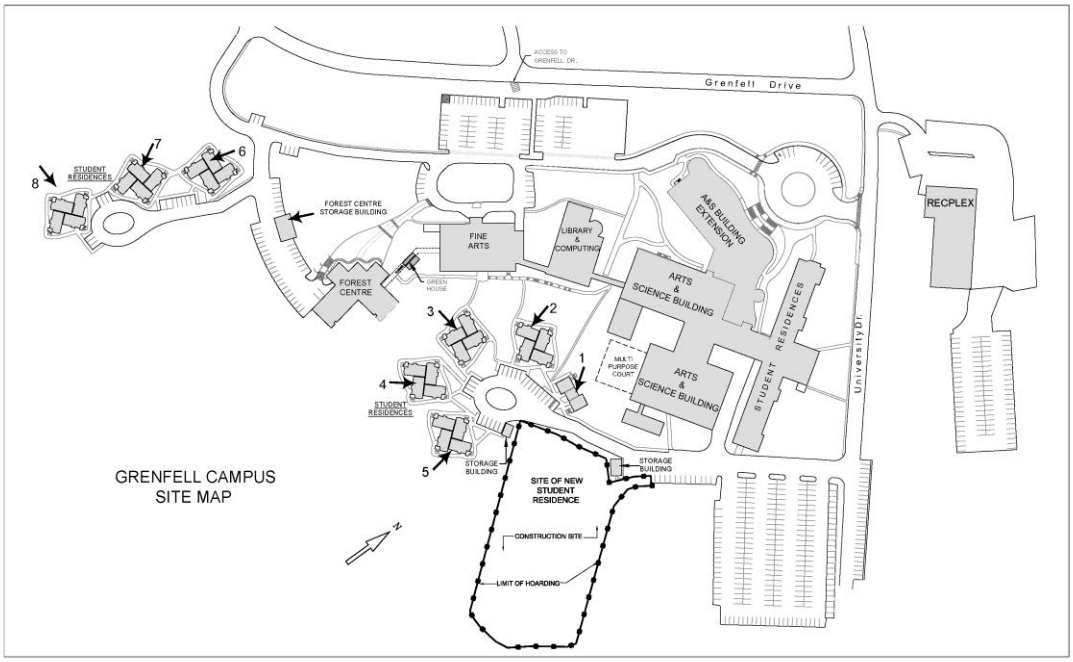

Figure 2: Grenfell Campus Site Map

2.2.2 Operational Boundaries

Operational boundaries define which emission sources will be measured. The GHG Protocol defines three levels of responsibility, Scope 1, 2, and 3 (Figure 1) (WRI and WBCSD, 2004). Scope 1 emissions are direct emissions from sources that are owned by the organization such as emissions from boilers, furnaces, and vehicles. Scope 2 emissions are indirect emissions from sources that are neither owned nor operated by the organization but are consequences of on-site energy consumption. These emissions are considered indirect because they occur where the electricity is generated. Scope 3 emissions are indirect emissions from sources that are neither owned nor operated by the organization but are a consequence of the activities of the organization. Examples of Scope 3 emissions include employee travel, waste disposal, emissions from the extraction, production, and transportation of purchased goods, outsourced activities, and losses associated with energy transmission and distribution.

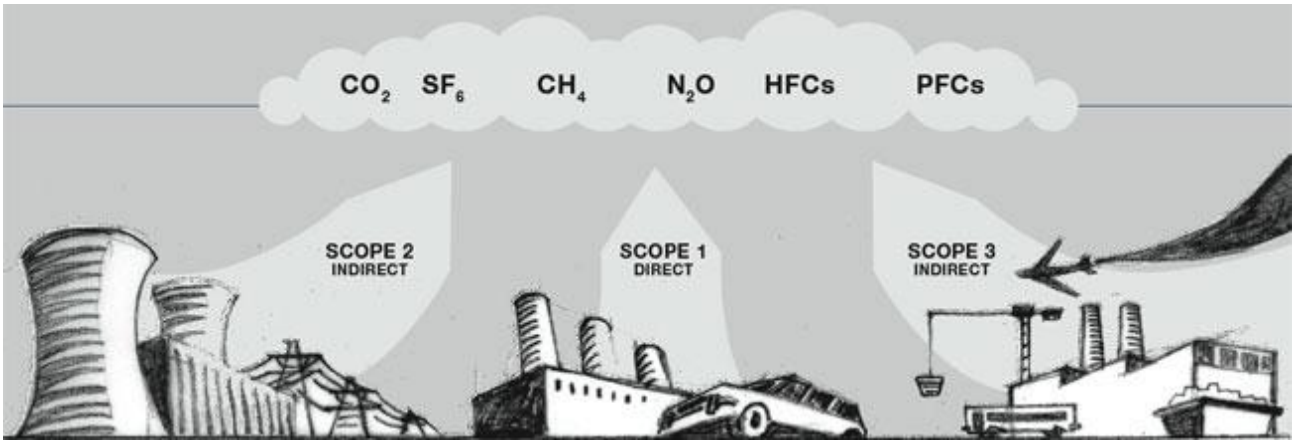

Figure 1: Greenhouse gas emission sources (New Zealand Business Council for Sustainable Development, n.d. http://www.nzbcsd.org.nz/emissions/content.asp?id=423)

The ACUPCC states that all signatories must report Scope 1 and 2 emissions. Signatories are strongly encouraged to report Scope 3 emissions, especially those from commuting and directly financed air travel, to the extent that data is available (Dautremont-Smith, Cortese, Dyer & Walton, 2009). In comprehensive carbon footprint studies (i.e. those that have included Scope 3 emissions) conducted by other universities, Scope 2 activities were found to be the biggest sources of emissions (Pandey et al., 2011). According to the ACUPCC the main focus should be on CO_2 emissions since PFCs or SF_6 are unlikely to originate on campus, and emissions of CH_4, N_2O, and HFCs are likely to represent only a small percentage of the institution's total emissions (Dautremont-Smith et al., 2009).

Our approach is to focus on Scope 1 and 2 emissions, that is, to include all direct emissions from sources that are owned and/or operated by the institution and all indirect emissions related to on campus energy consumption. Where reliable data exists, we will include Scope 3 emissions that are directly financed by the university, such as waste management (Table 3).

Table 3: GHG Emission sources included in Grenfell Campus 2010-2011 carbon footprint

Scope	Grenfell emission sources
1 **Direct emissions**	Direct transportation sources: Combustion of vehicle fleet gasoline and diesel
	Stationary combustion: Emissions from combustion of propane for lab use
	Fugitive emissions: Refrigerant losses from cooling units on campus
2 **Indirect emissions**	Purchased electricity: Indirect emissions from the production of the electricity used on campus (produced by Newfoundland Power)
3 **Other indirect emissions**	Solid waste management: Emissions from managing the institution's waste

2.2.3 Temporal Boundaries

We are using data from the 2010 – 2011 fiscal year (April 2010 to March 2011). This inventory is the first completed for Grenfell Campus, and earlier data is unreliable. The standard practice, to allow for comparability, is to calculate and report emissions over a one year period (Dautremont-Smith et al., 2009). This one year period may be the calendar year, academic year, or fiscal year as long as it remains consistent. It is hoped that the next inventory 2011 – 2012 will be completed in the summer or fall semester of 2012. If improvements in data collection methods could be implemented in 2012 (for example, more accurate waste data, detailed electricity consumption data, and transportation data), the next inventory (2012 – 2013) could be more comprehensive. For more information please refer to the section on next steps. Selection of a calculation tool was the next step in the development of Grenfell's carbon footprint. The next section discusses three commonly used carbon management tools.

2.3 Carbon Management Tools

A number of methodologies and software options were investigated through the process of developing Grenfell Campus' carbon footprint. Several of the options used by other institutions including the Clean Air-Cool Planet Calculator, The Climate Registry, and carbon management software from various companies (for example, E3 Solutions Inc., CarbonCounted, Zero Footprint, Climate Smart) are discussed in this section.

2.3.1 Cool Air-Clean Planet Calculator

Clean Air – Cool Planet (CA-CP) is a non-profit organization that partners with institutions, communities, and corporations to find solutions to reduce their carbon emissions. CA-CP has developed a free Campus Climate Action Toolkit and a Campus Carbon Calculator that can be downloaded from their website. It is promoted as a "a free, comprehensive, transparent, and customizable solution to measuring and analyzing institutional greenhouse gas emissions" (Clean Air-Cool Planet [CA-CP], 2008) and many universities have used this framework. The American College and University Presidents Climate Commitment (ACUPCC) signatories are encouraged to use this calculator to conduct their emission inventories (APPA, 2009).

The Campus Carbon Calculator is a Microsoft Excel file with a series of spreadsheets (Appendix C). All formulas, conversion factors, and emission factors are built-in. The calculations are made automatically when the data is entered. The calculator can create graphs and tables to show the climate impact of the campus and highlight trends over time. The most recent version of the calculator has new modules that determine project pay back and help analyze emission reduction options.

There are a few drawbacks to the CA-CP calculator. The spreadsheets include every potential source of emissions from an institution, such as multiple sources of energy, transportation and agriculture, many of which Grenfell Campus does not have. This makes the process overly

complex for a small institution. Also, because the file is downloaded it is not automatically updated with new emission factors or other calculations. If updates become available the new version must be downloaded and the data must be copied into the new version. Versions of the U.S. calculator are updated frequently, whereas there is only one Canadian version. CA-CP seems to be aware of these limitations and plans to launch a new web-based campus carbon calculator in the summer of 2012.

2.3.2 The Climate Registry

The Climate Registry (TCR) is a non-profit organization with the mission to establish carbon emission accounting standards for businesses and governments in North America. Corporations, governments, and other organizations can become 'Climate Registered' members or 'Basic' members. 'Climate Registered' members agree to have their annual GHG inventory verified by a third party and publicly reported. As of September 2011 there were 11 educational institutions, all based in the US, that are members of TCR. The Climate Registry General Reporting Protocol, developed by The Climate Registry and available free online, is often used independently by organizations or software developers. As previously mentioned, it has been used by Dalhousie University and the government of British Columbia.

2.3.3 Enterprise Carbon Management (ECM) software

Enterprise Carbon Management (ECM) software programs deliver a user friendly interface for developing, managing, and reporting an organization's GHG inventory. They are designed specifically for GHG management and usually have built in calculations and emission factors that update regularly. The software can also be customized to include only the emission sources that are relevant to the organization. There are many different options available for tracking, managing, and reporting emissions such as automated data approval, compliance with different GHG reporting standards, performance indicator tracking, and analysis of various operating scenarios. Companies which offer ECM software are numerous. The Greater Toronto Airport Authority (GTAA) and the Toronto and Region Conservation Authority (TRCA) Partners in Project

Green Carbon 101 Reduction Program includes a database of ECM vendors which allows a comparison of the different software options. [16]

As with any software there are advantages and disadvantages. One major benefit is that the software is specifically designed to calculate and manage a carbon footprint. Thus, it is compliant with standards, such as ISO, and is updated automatically. The software has automated tracking and reporting which allows the user to have frequent updates of key progress indicators (KPI's) such as carbon emissions per day, per employee, per unit of space, per facility, and so on. If the user has a strategy to reduce emissions, the software is able to create different operating scenarios which allow the user to test those proposed reduction strategies. Technical support is typically offered to sort out any issues with the software. Finally, the ECM software often has tools to engage and communicate with stakeholders, including employees, the community, and students. Some of the disadvantages of ECM software are the cost of the software and the training required for the employees who are going to be using it within the company or institution (Sustainability Learning Centre, 2010).

We contacted three Canadian companies to discuss their ECM software packages: Zerofootprint, e3 Solutions Inc., and CarbonCounted. We did not hear back from Zerofootprint. e3 Solutions Inc.[17] gave the project team two demonstrations of their software (one initial demonstration on June 16, 2011 and one using Grenfell data submitted by the project team on July 20, 2011). e3 helps clients achieve their carbon management goals by providing carbon accounting methods, environmental management solutions, carbon reduction, waste management and fleet management programs, green purchasing strategies, and employee engagement. e3's e3CAT carbon management tool is internet based software that helps organizations collect, manage, and report greenhouse gas emissions data. e3 submitted a cost proposal on August 9, 2011 for three options – dedicated instance of the e3CAT software hosted by either e3 or Memorial or

[16] For a comparison of ECM vendors go to: http://www.partnersinprojectgreen.com/get-help/training/carbon-101-reduction-program

[17] For more information on e3 Solutions, visit their website: http://www.e3solutionsinc.com/

the option of software as a service (SaaS). These options ranged from $12,000 per year (SaaS) to $40,000 per year (dedicated instance of the software, hosted by e3). Although this was above our project budget, engaging with e3 in the future for carbon management services could be considered by Grenfell administration.

CarbonCounted[18] is a Canadian not-for-profit organization based in Toronto. CarbonCounted's web based carbon management software, CarbonConnect, is third-party verified. The software is open to all consultants and businesses, not just one service provider. Their mandate is to enable fast, cost efficient, third-party verified carbon footprints. The software is constantly evolving and updates are available to new and existing clients. A demo of CarbonConnect was conducted with the project team on August 17, 2011. Following this session CarbonCounted also submitted its services and price list (see Appendix D). Use of the software requires an annual membership ranging from a standard membership of $100/year to gold ($5,000/year) or platinum membership. Additional services such as custom report templates, data uploading, and training seminars can be purchased for a fee.

The project team decided to engage with CarbonCounted in order to get a baseline carbon footprint analysis completed within the time frame and budget of the project. The $100 membership fee was paid through the project budget and privacy clearance from the Memorial University Information Access and Privacy Protection (IAPP) office to upload the data to the internet using the web based software was granted (September 16, 2011). All data uploaded must be reported in aggregate form and must not include personal information.

2.4 Data Collection and Calculations

A site was set up in CarbonConnect, CarbonCounted's online software. A site can be any physical structure that contains emission sources. Each CarbonCounted membership allows for up to 10

[18] For more information on CarbonCounted visit their website: http://www.carboncounted.com/

sites. The Grenfell campus was set up as one site. The next step is to add emission sources. Emission sources are anything within the organization that emits greenhouse gases. CarbonConnect has default emission sources to select. Additional emission sources may be found with the search tool using lists created by certified CarbonConnect auditors. In addition to the CarbonCounted list we also used emission sources from Pinchin Environmental Ltd. Once emission sources have been added to the site, the relevant data is entered in the activity data field in the "Edit/View Source Details" screen (Figure 3). This screen shows the emission factor that is used to calculate the emissions from each of the sources. The formulas, as well as the emission factors, are built into the software. The origins of the emission factors are referenced in the "Details" section. These can be viewed by the user but not edited.

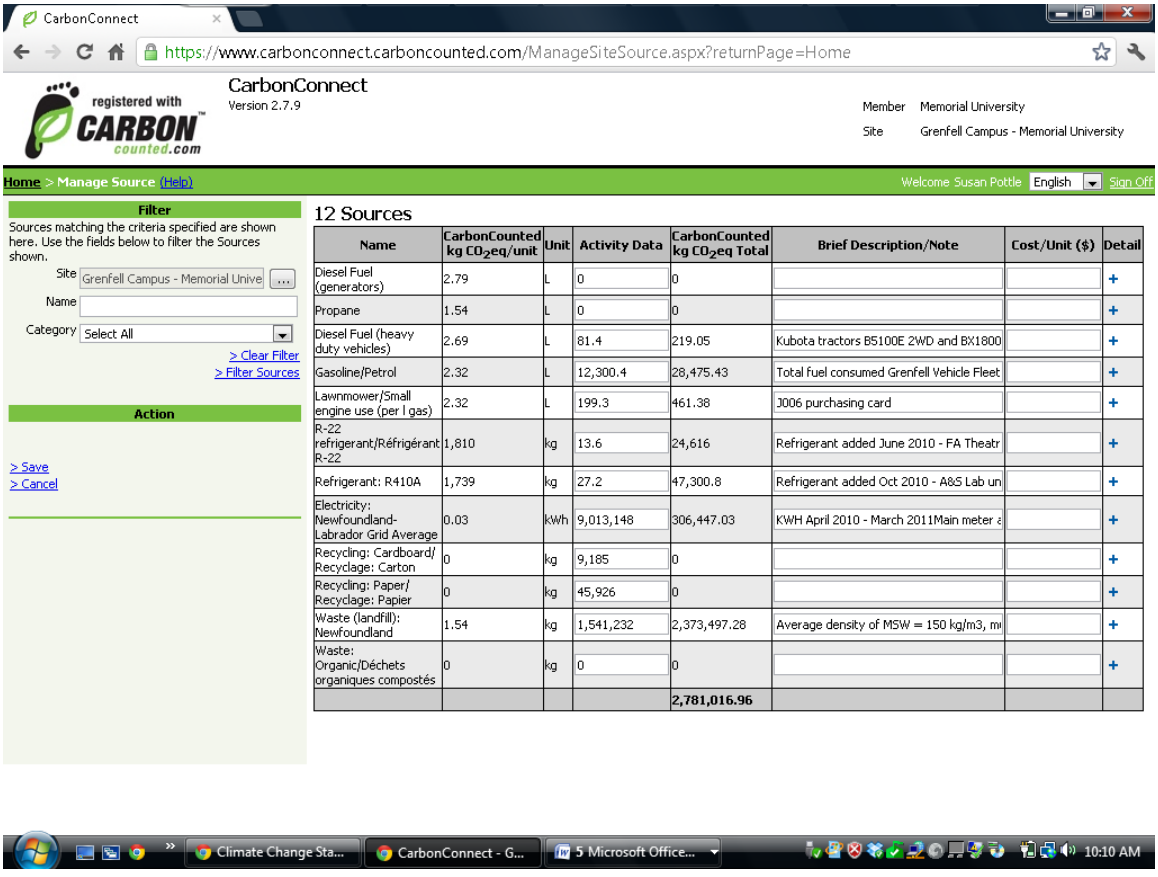

Figure 3: Screen shot of the "Edit/View Source Details" screen in CarbonConnect.

The calculation is:

Source 1 CO_2 Emissions (t CO_2eq) = Activity Data (units) X Emission Factor (kg CO_2/unit)/ 1000 (kg/t)

Where:

t = tonne (metric tonne/metric ton)

Emission factor = a value used to convert activity data (for example, electricity or fuel consumed) into the amount of greenhouse gas emitted by the activity. Values are available from sources such as The Climate Registry, Environment Canada, Utility companies etc.

CO_2eq = Carbon dioxide equivalent. The emissions of six of the main greenhouse gases (CO_2, CH_4, N_2O, HFC, PFC, and SF_6) are converted into CO_2eq on the basis of their global warming potential (GWP) relative to CO_2.

2.4.1 Scope 1 Sources

Vehicle Fleet

Fuel consumption data for the Grenfell vehicle fleet was determined from the purchase card reports obtained from Facilities Management for all vehicles from April 1, 2010 to March 31, 2011 (Appendix E, Table 1). All purchases for each vehicle from each report were added to get the total amount of fuel purchased per vehicle and per fleet (12,300.4L) (Appendix E, Table 2). All vehicle fuel was assumed to be regular gasoline in the calculations. The kilometer data was obtained from the Administration and Finance office records. However, records for two of the vehicles were unavailable because the vehicles are no longer leased. The kilometers travelled

data for these two vehicles was estimated using the liters consumed data and the Natural Resource Canada Fuel Consumption Rating site.[19] A combined highway and city driving fuel consumption rating was used. There was also a small amount of fuel consumed by the Kubota tractors, lawn mowers, and snow blowers (J006 records). This data was considered separately as site maintenance related emissions (Appendix E, Table 3).

CarbonConnect does not allow adding multiples of the same type of emission source. Thus, to be able to input the data we have gathered on each vehicle, we add them as 'Products'. 'Products' are used to create metrics or key performance indicators (KPIs). Adding vehicles as products is more complicated but allows the user to determine the emissions per kilometer travelled, per vehicle. It also allows vehicle emissions to be tracked year after year which will be important as the vehicle fleet changes. To determine the emissions from each vehicle the total liters of gasoline consumed by the fleet is added as activity data. Then, each vehicle is added as a 'Product' and the kilometers the vehicle travelled in the given time frame (in this case April 2010 – March 2011) is added as the 'Activity Data'. Then, the product loadings must be corrected by selecting 'Manage Sources' select each source and then 'Edit Product Loadings'. The default product loading for all sources is 100%. This means that you must manually edit the product loadings of each source to 0% except, in this case, the vehicle data. For example, when you 'Edit Product Loadings' for electricity, the values for all of the vehicle products should be 0. The correct percentage of the total fuel consumed that is relevant to each vehicle is added in the 'Edit Product Loadings' screen under the source 'Gasoline/Petrol'. It is critical that the activity data units for the products (km) is different from the activity data units for the sources, in the case of the vehicle fleet data, kilometers (km) and liters (L), respectively.

[19] Natural Resource Canada. 2008 Fuel Consumption Ratings. http://oee.nrcan.gc.ca/transportation/tools/fuelratings/ratings-search.cfm

Percentage of total fuel consumed by vehicle = [Total fuel consumed by vehicle (L) / Total fuel consumed by fleet (L)] x 100

For example, for Grenfell's Chevy Colorado (J146):

Percentage of fuel consumed for the Chevy Colorado = (1789.82L/12300.4L) x 100

= 14.5%

The data is provided in Appendix E and these steps are also outlined in the CarbonConnect User Manual, Appendix D.

Propane

There are three propane tanks on campus, one for laboratory use and two for use by the food vendors. The propane is supplied by Superior Propane and according to their records they did not sell any propane to the campus between April 2010 and March 2011. The food vendors, which are separate entities on campus, are billed individually so this data is not included as part of the campus footprint. Information on propane used on campus was provided by the Science Department and Superior Propane.

Diesel

The diesel fuel consumed by the two Kubota tractors owned by Facilities Management, models B5100E (year unknown) and BX1800 (2002), are included in this report (data from J006 records). As mentioned, the tractors are not considered part of the vehicle fleet in this analysis; the diesel fuel consumed was added as a separate source. A new four wheel drive BX25 was purchased in

2012 and is not included in this report. There is also an emergency diesel generator in the Fine Arts building. This unit provides emergency lighting in the case of a power outage. According to Facilities Management it is rarely used, and diesel is only purchased as needed. Thus, there is no data to include in this report.

Refrigerants

Grenfell campus also has a Heating, Ventilation and Air Conditioning (HVAC) system that consumes a limited amount of refrigerants, specifically R-22 and R-410A (Table 4). Consumption refers to the amount refilled in the given time period. R-22, also known as HCFC-22 is a GHG and also contributes to ozone depletion. It is being phased out under the Montreal Protocol. As of January, 2010, new HVAC units are not allowed to use R-22. Because of this phase out, it is considered 'non-scope' under the GHG Protocol and other standards, however we have included it in this report as a Scope 1 emission source. Information on refrigerants was provided by Honeywell (Appendix E, Table 1).

Table 4: Type and quantity of refrigerants present on Grenfell Campus, including consumption (loss), April 2010-March 2011.

Building	**Unit**	**Refrigerant**	**Total quantity (lbs)**	**Consumption (in lbs and kgs) April 2010 – March 2011**
Forest Centre	16 Heat pumps	R-22	10 (each)	
Fine Arts	Gallery unit	R-22	30	
	Theatre unit	R-22	62	30 13.6
	Sound booth unit	R-22	8	
Library	Chiller	R-22	140	
Arts and Science	Dectron unit (pool)	R-22	108	
	Café unit	R-22	80	

	GCSU unit	R-22	16	
	Admin unit	R-22	40	
	Classroom unit	R-410A	40	
	Lab unit	R-410A	120	60 27.2
	Mac lab unit	R-410A	8	
	Server Rm 5 Ton	R-22	8	
	Server Rm 10 Ton	R-410A	10	
	Mini Split Units student services	R-22	30	
	Data Closet mini split	R-410A	3	
RecPlex	Classroom unit	R-22	5	
Total				**90** **40.8**

2.4.2 Scope 2 Sources

Purchased Electricity

Indirect emissions generated in the production of energy consumed on campus come from provincial electricity generation. There are currently two main meters on campus, one for the Rec Plex and one for the rest of the campus. These meters are read by Newfoundland Power. There are six additional meters on campus, measuring electricity consumed by the library, the Forest Centre, the Fine Arts building, Martin's Canteen, Pizza Delight, and Treats. The Grenfell electrician reads these meters and bills external organizations according to usage. For example, part of the Forest Centre is rented by Natural Resources Canada so a percentage of the energy consumed in the Forest Centre is billed to that department. However, the consumption data for the external organizations has not been subtracted from the total, because the breakdown was not available. Thus, the total energy consumed on campus is used in the calculations. To adhere to the organizational boundaries set out in this methodology (i.e. the financial control approach, see Section 2.2.1), and as applied in the case of the Pepsi Centre, this data should be excluded

from the total electricity consumption. The data was provided by Facilities Management in the form of electricity bills from Newfoundland Power and is summarized in Table 5.

For comparison with future inventories, it is also important to note that this inventory does not include the extension on the Arts and Science Building (opening in 2012) and a new 200 bed residence building to be completed in 2013. These buildings will need to be included in future inventories which will affect the institution's carbon footprint. According to the GHG Protocol, this 'organic growth or decline' does not trigger a base year recalculation. This growth results in a change in emissions and should be part of the institution's emission profile (WRI & WBCSD, 2004.)

Table 5: Total Purchased Electricity for the Grenfell Campus, Memorial University, April 2010 – March 2011

Billing Month	**Main Meter - KWH**	**Main Meter - Cost**	**Rec Plex Meter – KWH**	**Rec Plex- Cost**
Apr-10	932,598	76,986	18,720	1,897
May-10	702,108	58,611	12,960	1,382
Jun-10	612,458	50,625	11,040	1,248
Jul-10	567,360	47,190	9,120	1,092
Aug-10	485,802	41,853	6,480	912
Sep-10	485,802	41,914	5,520	786
Oct-10	634,734	54,010	9,600	1,182
Nov-10	656,010	56,574	11,280	1,369
Dec-10	875,862	76,994	15,360	1,747
Jan-11	843,948	74,651	16,320	1,784
Feb-11	1,074,438	94,322	19,200	2,072
Mar-11	985,788	88,049	20,640	2,566
Total	**8,856,908**	**$761,779**	**156,240**	**$18,036**
Total KWH				**9,013,148**

2.4.3 Scope 3 Sources

Waste Management

The only source of Scope 3 emissions included in this report is from the disposal of waste generated in operations (Table 6). The amount of waste generated on campus was estimated using data on the number of dumpsters, the size of the dumpsters, and the frequency of disposal. Three dumpsters are picked up five days a week for the full year. There is also one dumpster that is picked up twice a week for the year and one that is picked up once a week for the year. The remaining three dumpsters are picked up three times a week for eight months of the year and only once a week from May through August. This data was obtained via personal communication with Facilities Management (Appendix E, Table 1). In the calculation shown below, it is assumed that all dumpsters are full and that the waste composition is the same as that of municipal solid waste. The average density of non-compacted municipal solid waste used in the calculations, 150 kg/m^3, is from Henry and Heinke (1996), a number also used by Industry Canada to estimate waste production.[20] Although the same data for recycled paper and cardboard is available, no emission factors for recycling have been developed.

Weight of land filled waste (kg/year) = Volume of dumpster (m^3) x # of dumpsters x # of pickups/yr x 150 kg/m^3

For example:

For the three dumpsters that are picked up five times a week:

Weight of land filled waste (kg/year) = 4.587 m^3 x 3 dumpsters x 261 pickups/year x 150 kg/m^3

[20] Industry Canada. (2011). Corporate Social Responsibility: Waste Management. Retrieved from: http://www.ic.gc.ca/eic/site/csr-rse.nsf/eng/rs00181.html

= 538,778 kg/year

For the dumpsters that are picked up 3 times a week for eight months and once a week for four months:

Weight of landfilled waste (kg/year) = 4.587 m3 x 122 pickups/year x 150 kg/m3

= 83,948 kg/year

Table 6: Location, volume of dumpsters, frequency of disposal, and estimated weight of land filled waste per year at Grenfell Campus, Memorial University.

Location	**# of Dumpsters**	**Volume (y^3)**	**Volume (m^3)***	**Frequency disposal****	**Days *****	**Weight conversion[21] (kg/m^3)**	**Weight (kg/yr)**
Arts and Science	3	6	4.587	M,T, W, Th, F (5/week x 12 months [52 weeks])	261	150	538,778
Chalet site 1	1	8	6.116	M,W,F (3/week x 8 months [35 weeks]) + 1/week x 4 months (17.4 weeks)	122	150	111,930
Chalet site 1	1	6	4.587	M,W,F (3/week x 8 months [35 weeks]) + 1/week x 4 months (17.4 weeks)	122	150	83,948
Chalet site 2	1	6	4.587	M,W,F (3/week x 8 months [35 weeks]) + 1/week x 4 months (17.4 weeks)	122	150	83,948
Fine Arts	1	6	4.587	M,T (2/week x 12 months)	104	150	71,562
Forest Centre	1	6	4.587	M (1/week x 12 months)	52	150	35,781

[21] Henry, S. and Heinke, G. (1996). Environmental Science and Engineering. New Jersey: Simon and Schuster, p. 574

Total	**925,946.5**

* 1 y^3 = 0.765 m^3

** 1 month = 4.348 weeks

3. Results

3.1 Scope 1 Emissions

From April 2010 – March 2011 Grenfell had five vehicles. The emissions produced by the vehicle fleet are summarized in Table 7. The percentage of total fuel consumed was necessary to be able to attribute emissions per vehicle for the product loading calculations in the CarbonConnect software. Otherwise, the total litres consumed (12,300.4) could be simply multiplied by the emission factor (2.32) and the total emissions calculated (28,475.4).The totals shown are those calculated by CarbonConnect and are slightly different from the totals using the rounded numbers provided in these tables. For example, the gasoline/petrol source emission factor is actually 2.315 and the software shows a rounded value of 2.32. The total emissions produced by the fleet are 28,475.43 kg CO_2eq. The emissions produced by the university's site maintenance equipment such as tractors, lawn mowers, and snow blowers are presented in Table 8.

Table 7: Fuel consumed, kilometers driven, and emissions produced by university owned vehicles, Grenfell campus, Memorial University, April 2010 - March 2011

Vehicle	Make	Type	Year	Fuel	Quantity (L)	% of total fuel	Km/ Yr	Emissions ($kgCO_2eq$/ km)	Emissions ($kgCO_2eq$)
J146	GMC Canyon Pick-up	Truck	2007	Gas	1789.87	14.6	15,839*	0.26	4,118.1
J147	Chevrolet Uplander	SUV	2007	Gas	2957.7	24.0	23,163	0.3	6,948.9
J157	Chevrolet Uplander	SUV	2008	Gas	3635	29.6	29,242	0.29	8,480.2
J151	Chevrolet Colorado	Truck	2007	Gas	1249.8	10.2	12,086	0.24	2,900.6

J101	Ford F150	Truck	2009	Gas	2668.1	21.7	21,092*	0.29	6,116.7
Total					**12,300.4**	**100**	**101,422**		**28,475.43**

*Actual km data was unavailable because these vehicles are no longer leased by Grenfell. The km travelled was estimated using Litres consumed (below) and fuel consumption ratings from Natural Resources Canada http://oee.nrcan.gc.ca/transportation/tools/fuelratings/ratings-search.cfm

Table 8: Fuel consumed and emissions produced by Grenfell's site maintenance equipment

Vehicle	**Make/Type**	**Fuel**	**Quantity (L)**	**Emissions ($kgCO_2eq$)**
J006	Kubota Tractors B5100E 2WD and BX1800 4WD	Diesel	81.4	219.05
	Lawn mowers, snow blowers etc.	Gas	199.3	461.38
Total			**280.7**	**680.43**

The only other source of direct emissions included in this inventory is fugitive emissions from refrigerants in the HVAC system. The theatre unit in the Fine Arts building and the lab unit in the Arts and Science building both needed refrigerants replaced in the given time frame. This loss is considered consumption for the purposes of estimating emissions. The resulting emissions totaled 71,916.8 kg CO_2eq (Table 9), the largest source of direct emissions for Grenfell Campus. Although there were no purchases of propane or diesel for the labs or emergency generators in 2010-2011, it does not mean that there was no combustion of these gases over the year. A better way of estimating the consumption of these fuels on an annual basis should be determined with Facilities Management.

Table 9: GHG emissions associated with the loss/consumption of refrigerants, Grenfell Campus, Memorial University, April 2010 – March 2011

Building	**Unit**	**Refrigerant**	**Consumption (kgs) April q010 – March 2011**	**Emissions ($kgCO_2eq$)**
Fine Arts	Theatre unit	R-22	13.6	24,616
Arts and Science	Lab unit	R-410A	27.2	47,300.8
Total			**40.8**	**71,916.8**

3.2 Scope 2 Emissions

The Scope 2, or indirect emissions, associated with purchased electricity at Grenfell is shown in Table 10. The emission factor shown here is a rounded number. The resulting total is from the software which uses a more accurate number in its calculations.

Table 10: Scope 2 Emissions, Grenfell Campus, Memorial University, April 2010 - March 2011

Energy Source	**Consumption (KWH)**	**Emission Factor ($kgCO_2eq$/unit)**	**Emissions ($kgCO_2eq$)**
Electricity	9,013,148	0.03	306,447.03

3.3 Scope 3 Emissions

All university waste goes to a municipal landfill with no methane (CH_4) recovery. To determine the emissions associated with this waste, the total weight of the waste is multiplied by the landfill waste emission factor for Newfoundland and Labrador, obtained through CarbonCounted. The number, derived by Pinchin Environmental Limited, uses the IPCC's first-order decay (FOD) modeling method using a methane generation factor and the GWP for

methane.[22] In this method it is assumed that all of the methane that will be generated from the material over 100 years is attributed to the year that it was placed in the landfill. The emissions calculated for landfilled waste was much higher than expected and resulted in waste being the largest source of emissions for the Grenfell campus at 1,425,957.62 kg CO_2eq or 1,425.96 t CO_2eq.

[22] 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Chapter 3: Solid Waste. http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_3_Ch3_SWDS.pdf

4. Discussion: GHG Emissions from the Grenfell Campus

In summary, Grenfell's Scope 1, 2, and 3 greenhouse gas emissions calculated in this report total 1,833,477 kg CO_2eq for the 2010-2011 fiscal year (Table 11, Figure 4). If Scope 3 emissions (emissions from waste) are removed from the analysis the footprint for the campus is 407,489.2 kg CO_2eq (Figure 5). The emissions from waste were calculated using a number of assumptions: the amount of waste generated (volume and weight) is not accurately measured by the university and the emission factor for land filled waste is generated from a highly complex emissions model. Thus, the measure of confidence in this data is relatively low.

Table 11: Summary of GHG Emissions at Grenfell Campus by Scope, April 2010 – March 2011

Scope	**Data**	**Emission Factor (kg CO_2eq /unit)**	**GHG Emissions CO_2eq kg/year**
Scope 1			
Vehicle Fleet	12,300 L	2.32	28,475.43
Site Maintenance	Diesel: 81.4 L Gasoline: 199.3L	2.69 2.32	219.05 461.38
Propane	0.0 L	1.54	0
Diesel	0.0 L	2.79	0
Refrigerants **R-22** **R-410A**	 13.60 kg 27.20 kg	 1,810 1,739	 24,616 47,300.80
TOTAL Scope 1			**101,072.66**
Scope 2			
Electricity	8,857,908 KWH	0.03	306,447.03
TOTAL Scope 1 and 2			**407,489.2**
Scope 3			
Landfilled Waste	925,946.5 kg/year	1.54	1,425,957.62
TOTAL Scope 1, 2 and 3			**1,833,477.3**

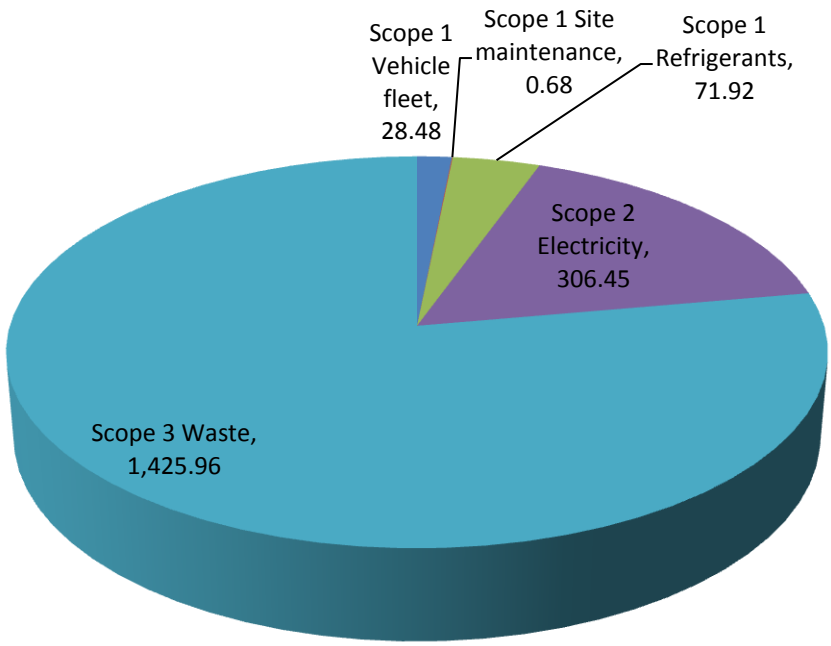

Figure 4: Total GHG Emissions in tonnes CO_2eq by Scope, Grenfell Campus, Memorial University

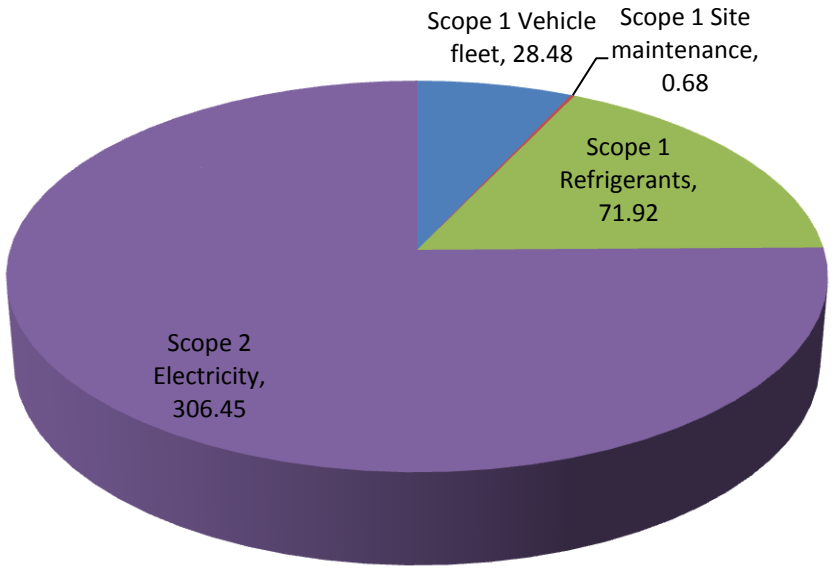

Figure 5: Scope 1 and 2 emissions in tonnes CO_2eq, Grenfell Campus, Memorial University

These results were compared to two other small institutions (less than 5,000 students) in Canada who completed a GHG inventory between 2010 and 2011 (Table 12, Figure 6). Based on this analysis it appears that the Grenfell campus has significantly lower carbon emissions from Scope 1 and 2 sources. Carbon emissions per student was calculated as a Key Progress Indicator (KPI) for comparison, using Scope 1 and 2 data. The calculation methods, scope, and reliability of Scope 3 data is too variable among institutions to be included. Grenfell also has lower emissions per student (0.29 t CO_2eq/student/year) than the University of Northern British Columbia (UNBC) (1.58 t CO_2eq/student/year) and Mount Allison University (MTA) (3.98 t CO_2eq/student/year).

These differences can be explained by the universities' sources of emissions. For example, both UNBC and MTA both have a higher amount of direct emissions through on campus fuel combustion and vehicle fleets. Natural gas is used for heating at UNBC. In order to reach their

carbon neutral mandate, the university constructed a Bioenergy Plant to provide heat to the core campus buildings and reduce the consumption of natural gas by 86% (UNBC 2010). The Bioenergy Plant uses sawmill residue (hog fuel) from Lakeland Mills of Prince George. The system became operational in March 2011 and should result in a significant decrease in Scope 1 emissions in UNBC's 2011 GHG Inventory, not yet released. Bunker A is used to heat at Mount Allison University. MTA also had significantly higher Scope 2 emissions from electricity consumption. This could be because electricity generation in New Brunswick uses a variety of energy sources, including hydro, nuclear, oil and coal, and contributes 23 times more greenhouse gases than electricity generation in Newfoundland and Labrador or British Columbia.[23] In addition to differences in emission sources, the inconsistency of the methods used to calculate the carbon footprints is also a factor when comparing carbon footprints.

However, emissions from waste at Grenfell Campus are significantly higher compared to other institutions. Mount Allison has double the student population, however, according to the data, emissions from our waste are approximately 3 times more (1,425.96 t CO_2eq compared to 425 t CO_2eq, respectively). For comparison, GHG emissions attributed to waste at the University of Calgary, which has over 31,000 students, is 1,991 t CO_2eq. The emissions attributed to waste at the University of Toronto, which has approximately 55,000 students, is 2,041 t CO_2eq. Although methods for calculation vary between institutions and institutions have different waste diversion programs, the number for Grenfell seems high. Thus, more investigation into this source of emissions needs to occur. In fall 2011 the Grenfell campus, in partnership with the Multi-Materials Stewardship Board (MMSB) and the College of the North Atlantic, installed an industrial composter. This composter will help divert approximately 20 percent of the institutions organic waste which will help to reduce Grenfell's carbon footprint.

[23] Environment Canada Electricity Intensity Tables. 2010. Retrieved from: http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=EAF0E96A-1#section5

Table 12: Comparison of Scope 1, 2, and 3 GHG emissions at three small university campuses

Institution	Number of Students 2011-2012 (undergraduates, graduates, full and part-time)[24]	Inventory Year	Emission Scopes	GHG Emissions (tonnes CO_2eq)	Percentage of Emissions (%)	Emissions per student (Scope 1 & 2 only) (tonnes CO_2eq)
Grenfell Campus, Memorial University	1,400	2010-2011 Fiscal Year	Scope 1	101.07	5.5	0.29
			Scope 2	306.45	16.7	
			Total Scope 1 & 2	407.52	22.2	
			Scope 3 (land filled waste)	1,425.96	77.8	
			Total	**1,833.48**	**100**	
University of Northern British Columbia[25,26]	3,580	2010 Calendar year	Scope 1 (Stationary combustion and mobile combustion)	5,202.67	91	1.58
			Scope 2 (Purchased energy)	469.93	8.3	
			Total Scopes 1 & 2	5,672.6	99.3	
			Scope 3	15.30	0.27	

[24] Association of Universities and Colleges of Canada. 2012. Retrieved from: http://www.aucc.ca/canadian-universities/our-universities

[25] UNBC 2010 Carbon Neutral Action Report. Retrieved from: http://www.livesmartbc.ca/attachments/carbon_neutral_action_reports/UNBC_2010.pdf

[26] UNBC SMARTTool GHG Inventory Report. Retrieved from: http://www.unbc.ca/assets/pics/unbc_smarttool_2010.pdf

			(paper procurement)			
			Non-scope (biomass)	0.83	0.01	
			Total	**5,688.72**	**100**	
Mount Allison University[27]	2,660	2010 – 2011 Fiscal Year	Scope 1 (Bunker A, Natural gas, propane, diesel, refrigerants and fleet)	5,716	47	3.98
			Scope 2 (Electricity)	4,859	40	
			Total Scope 1 & 2	10,575	87	
			Scope 3 (travel)	1,261	10	
			Scope 3 (waste)	425	3.5	
			Total:	**12,201**	**100**	

[27] Mount Allison University Environmental Audit 2011. Retrieved from: http://www.mta.ca/environment/environmentalaudit2011.pdf

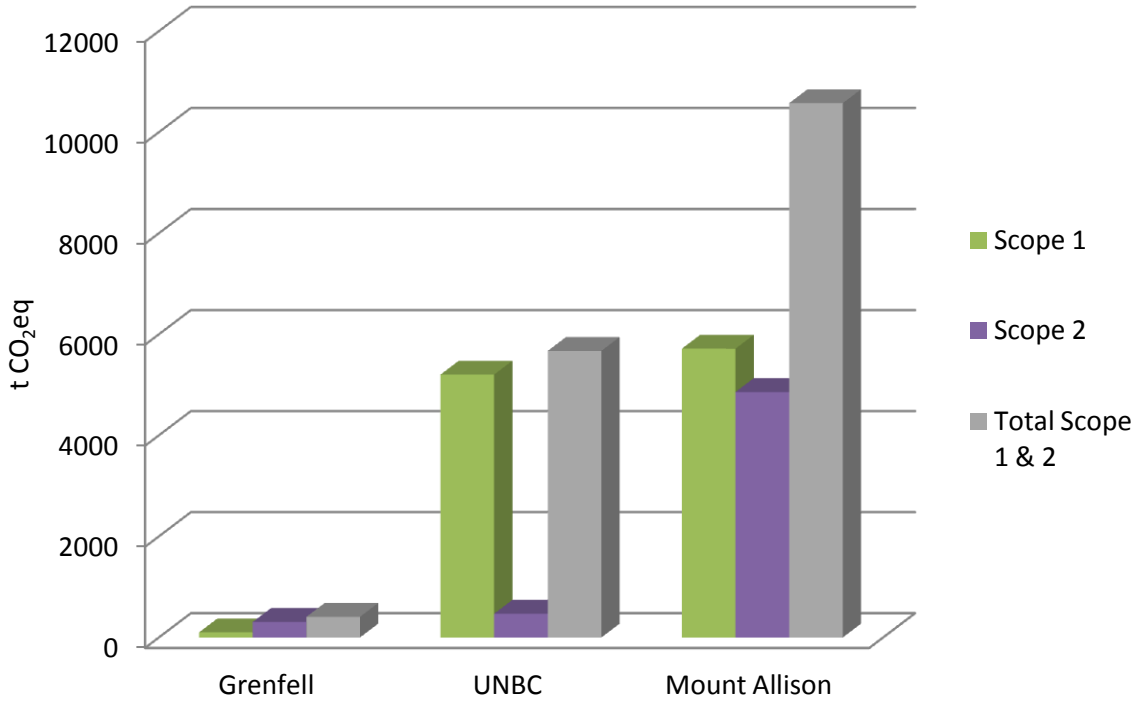

Figure 6: Comparison of Scope 1 & 2 GHG Emissions from Grenfell Campus, Memorial University; the University of Northern British Columbia; and Mount Allison University.

In Canada, industries that emit 50,000 tonnes of GHGs or more are required to submit a report to Environment Canada's Greenhouse Gas Emissions Reporting Program. In the big picture, Grenfell's Scope 1 and 2 emissions totaling 407.52 t CO_2eq do not come close to this requirement. However, this amount is equivalent to driving an average car 2,037,446 km [28] or 50 times around the circumference of the earth.[29] For another comparison, the cost to offset Grenfell's footprint (without including Scope 3) would be $10,188 based on the current market value of $25 per tonne of CO_2eq (The International Institute for Sustainable Development, 2011).

[28] The fuel economy of the average car is estimated at 8.6L/100km, or 0.086L/km. This number multiplied by the 2.32 emission factor for gasoline equals 0.200 kg CO_2e/km. Grenfell's carbon footprint is then divided by this number to get 2,037,446 km.

[29] Earth's circumference = 40,075.017km.

5. Recommendations and Next Steps

Now that we have estimated the carbon footprint of the Grenfell campus for 2010-2011, what's next? Although we have compared Grenfell's footprint to other institutions, the main objective of this project was to develop a methodology for creating an annual GHG inventory at Grenfell. Comparing the university's carbon footprint, year after year, using the same methodology will provide much more reliable and useful data. This inventory serves as a starting point for Grenfell to track emissions and take steps to reduce its carbon footprint. Thus, this report should be discussed with Grenfell administration and Facilities Management to determine how this information can be used. The following recommendations will help to improve the current methodology as well as suggest the next steps Grenfell can take towards managing its GHG emissions.

1. Repeat the Inventory

The first priority is to develop a plan to complete an emissions inventory for the Grenfell campus on an annual basis. An annual inventory could be completed by the Environmental Policy Institute, Facilities Management, the Vice Presidents' Advisory Committee on Sustainability (VPACS), or the Environmental Affairs Committee. The university could establish a paid summer student position to complete the inventory every year, like Mount Allison University. Alternatively, this could become part of the curriculum in one of the environmental programs, for example courses such as Introduction to Environmental Studies (Environmental Studies 1000), Environmental Economics (Environmental Studies 3000), Environmental Planning and Management (Sustainable Resource Management 3000), Research Design and Quantitative Methods in Geography (Geography 3222), Environmental Policy (Political Science 3731), and Sustainable Resource Management Research Seminar (SRM 4010). Incorporating the inventory into an existing course is recommended by the writers of this report in an effort to bridge academic and practical education. Encouraging academic curriculum, research, and outreach on sustainability is also a part of the university's Sustainability Declaration. In addition, the methodology used here could also be applied to the St. John's campus, the Marine Institute, the

Labrador Institute, the Bonne Bay Marine Station, the Programme Frecker in Saint Pierre, and the Harlow Campus in England. It could also be applied to campuses of the College of the North Atlantic to determine their carbon footprints. The College could integrate the inventory into courses such as Environmental Citizenship (EN 2120) and Environmental Auditing (EN 3300).

This report, excel files, and access to the CarbonCounted site should reduce the time and effort required to complete annual inventories and should ensure that the methods used are relatively consistent, although there are improvements that could be made to the methodology.

2. Improve the Data and Expand

It is important that the inventory be as accurate as possible. When planning steps to reduce emissions, valuable resources may be allocated to addressing the wrong sources if the data is erroneous. To avoid this mistake, we recommend that the inventory be third-party verified and that steps are taken to improve the existing methodology as well as expand the inventory to include more Scope 3 sources.

In this inventory there are zero emissions attributed to the combustion of propane and diesel on campus (Scope 1). This is because no propane or diesel was purchased. However, this does not mean that these fuels were not used. It is recommended that a method for calculating or estimating the amount of fuels used per year be developed. For consistency, the 2010-2011 inventory could be revised to include this amount.

When collecting energy consumption data for the next inventory it is recommended to request not only the information from the two meters that are billed by Newfoundland Power (the main meter and the Rec Plex) but also the electrician's data for the other six meters on campus to be able to subtract the energy consumed by external organizations located on campus. These

businesses are not owned or operated by the university and thus should be excluded from the carbon footprint of Grenfell campus according to the organizational boundaries set in this methodology. For areas that are not individually metered, such as the campus residences, smart meters could be installed to help obtain accurate data on the amount of energy consumed in these buildings and identify specific energy efficiency opportunities. Many universities have annual campus residence energy conservation challenges, such as the C3 challenge,[30] however participation requires a reliable method to determine energy consumption per residence.

Although Scope 3 emissions are considered optional in corporate inventories, institutions are often encouraged to include this category to the extent that data is available. Efforts should be made towards getting an actual measurement of the weight of the waste rather than using the average density of municipal solid waste and an estimated volume used in this report. This could be achieved by weighing the dumpsters before pick up or by working with the contractor to collect this data.[31] Some institutions have a Solid Waste Tracking Tool which helps to organize collection and diversion data. In future inventories Grenfell should also include regular commuting (commuting to and from campus on a day to day basis) by students, faculty, and staff and air travel paid for by or through the institution. This would require compiling data from travel claims and conducting a survey of commuter travel.[32] Travel encouraged by the institution such as study abroad programs like the Grenfell Harlow Visual Arts program could also be included. Developing this part of the inventory could be another class or independent project.

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[30] For more information: http://www.mta.ca/c3/

[31] Refer to: Andrews, D. (2003). Sir Wilfred Grenfell College Environmental Audit. HRDC Youth Internship Canada Program. for ways to determine the volume and composition of waste generated on campus through a waste audit.

[32] See Dalhousie University Office of Sustainability.(2009). Greenhouse Gas (GHG) Inventory Report 2008-2009. Retrieved from: http://www.dal.ca/content/dam/dalhousie/pdf/sustainability/Dalhousie_GHG_Inventory_2008-2009.pdf

Other Scope 3 emission sources that could be included are upstream emissions associated with directly financed purchases such as paper, food, and fuel. Paper procurement is mandatory for public institutions in BC, these institutions would be a good resource when determining a method for measurement. If efforts to make these improvements and include more scope 3 sources are made in 2012, the 2012-2013 inventory could be more accurate and comprehensive than the 2010-2011 and 2011-2012 (to be completed) inventories.

3. Select a Carbon Management Tool

We recommend purchasing an annual CarbonCounted membership ($100) and continuing to use their CarbonConnect software to maintain consistency. However, the software has limitations and does not always work the way that we would like it to. We made the existing template work for our purposes, however, developing a customized CarbonConnect site would be advantageous. A third party verification of the 2010-2011 carbon footprint could also be useful for developing future inventories and a customized site. Grenfell could also work with other institutions as an 'Industry Group' to develop a customized site and reduce the cost per institution. One avenue for such collaboration is through the Atlantic University and College Sustainability Network (AUCSN). A standardized methodology would also help in comparisons between institutions.

If the Canadian version of the Clean Air – Cool Planet calculator is updated and becomes web based it would also be a good tool to use, given that it is widely used by campuses in the U.S. and is recommended by the ACUPCC. If Grenfell commits to completing a yearly carbon footprint report it could also consider becoming a 'Basic' member of TCR. The annual fee is based on an organization's annual revenue or operating budget and ranges from $750 (under $20 million) to $5,500 (over $2 billion) for non-profit, government, and educational institutions. Using the TCR General Reporting Protocol as a guide for developing a carbon footprint without becoming a member is an option; however, there is no calculator or technical support provided.

Another potential student project could compare the results of several different carbon footprint calculation methods.

4. Commit to Emissions Reductions

To demonstrate Grenfell's commitment to action on climate change, the Vice-President could consider signing the University and College Presidents' Climate Change Statement of Action for Canada (Appendix B). The initial step required by the commitment is to complete a GHG inventory within one year of signing. This step has already been completed. Then, after the first year, an inventory must be completed at least every other year. The Statement of Action also requires a planning body that includes students, staff, faculty, researchers and administrators. The Vice-President's Advisory Committee on Sustainability (VPACS) could take on this role. Within two years of signing, the university must complete a climate action plan with targets and strategies to reduce greenhouse gases. This would require dedicated staff time, perhaps through the hiring of a Sustainability Coordinator for the Grenfell Campus or a Research Assistant through the Environmental Policy Institute. The Climate Action Plan could also be a part of a comprehensive Sustainability Action Plan. Developing a Sustainability Action Plan is one of the mandates of Memorial University's Sustainability Declaration. The plan would report on the environmental footprint of all campuses, including sections on energy, emissions, waste, water, transportation, food, buildings, policies, procurement, curriculum, and student involvement. Many universities and colleges across Canada have already completed Sustainability Action Plans.

The ultimate goal for the Grenfell campus should be to become Carbon Neutral, that is to have no net GHG emissions. This can be achieved through such measures as conservation, renewable energy, and carbon offsets. A carbon neutral policy and targets to meet this goal would be set out in an action plan. There are also many actions that can be taken in the short term that will help to reduce GHG emissions.

5. Implement Immediate Actions

The signatories of the ACUPCC and the Canadian Statement for Action agree to take tangible actions to reduce greenhouse gas emissions while creating a long term climate action plan. The ACUPCC outlines seven specific actions that can be implemented in the short term (Dautremont-Smith et al., 2009):

1. Develop a Green Building Policy
2. Adopt an Energy Star Procurement Policy
3. Develop a Air Travel Offset Policy
4. Encourage use of public transportation
5. Purchase or produce renewable energy
6. Establish a Sustainable Investment Policy or Committee
7. Adopt measures to reduce waste. For example, establish a recycling program, reuse packing material, replace paper forms and materials with online versions, set default double sided printer settings, create a zero waste policy for events, create a policy concerning disposable containers in the cafeteria.

Grenfell could start with a goal of implementing two of these actions in the fiscal year 2012-2013. In addition to the recommendations discussed here, Reagan (2012) has outlined an implementation plan for Grenfell based on the key requirements of successful carbon footprints as identified in her research (Figure 6). The plan includes short term actions and the lead individuals or groups and timelines necessary to ensure that this project and other sustainability initiatives move forward. The four main steps outlined in the plan are: 1. Gather support by inviting all sustainability related groups and initiatives on campus to work together on a common goal, 2. Educate the Grenfell community on the benefits of sustainability on campus, 3. Develop a policy and 4. Hire an individual who can help coordinate these initiatives such as a Sustainability Coordinator for the Grenfell campus (Table 14).

Required Conditions:

1. Proactive University Community
2. Existing Policy on GHG Reduction
3. Knowledge about Inventory Benefits
4. Selection of Inventory Framework & Process
5. Access to Accurate Data

Not Required, But Helpful:

6. Available Budget

Figure 6: Conditions necessary for a successful GHG Inventory (Reagan, 2012)

Table 14: Proposed Implementation Plan (Reagan, 2012)

Required Actions	Lead Person/Group	Timeline
Educating the university community (including students, faculty & staff) **(Required Condition 3: Knowledge of Benefits)**	Environmental Affairs Committee (E.A.C.) & Environmental Policy Institute (E.P.I.)	*Ongoing*
Push for sustainability action at Grenfell Campus **(Required Condition 1: Proactive University Community)**	Student body to lobby VP	*Ongoing*
Form committee (called V.P.A.C.S.) which will: Motivate, build bridges across depts. and disciplines, & foster a mindset of collaboration for looking broadly at campus environmental challenges in general and GHG reduction solutions in particular **(Required Condition 1: Proactive University Community)**	Composed of: • Sustainability directors, top admin. leaders and trustees, faculty, students, key professional staff • need stakeholders from all aspects of the university Consider external partners (e.g. Margaret McKeon)	*April 5th-October 1st, 2012*
Budget request **(Beneficial Condition: Available Budget)**	Budget proposed by Subcommittee of V.P.A.C.S. to Finance and Admin. Office	Begin Draft: *October 1st-Dec 1st, 2012* Submit Draft: *December 1st, 2012* Receive allocation: *July 2013*
Design proposal for a Sustainability Coordinator position	Subcommittee of V.P.A.C.S.	*October 1st-December 1st, 2012*
Sustainability Coordinator position established **(Required Condition 4: Knowledge about the Inventory Process & Required Condition 5: Accurate Data)**	Draft by Subcommittee of V.P.A.C.S. for submission to V.P. and Finance	Submitted, Amended & Revised: *End of June 2013*
Post Sustainability Coordinator job opening	Administration and Finance	*July 1st-August 1st, '13*
Hire Sustainability Coordinator (with renewable contract) **(Required Condition 4: Knowledge about the Inventory Process &**	E.P.I. & Administration and Finance	Interviews: *August 1st-August 8th, '13* Hire: *August 15th, '13* Position Start: *August 20th, '13*

Required Condition 5: Accurate Data)		
Overarching GHG Policy development with Action Plan & Timeline Targets **(Required Condition 2: Existing Policy on GHG Reduction)**	Draft by Sustainability Coordinator & V.P.A.C.S. for submission to V.P. and Finance	Begin Draft: *August 20th, '13* 1st Draft due: *October 1st, '13*
GHG Policy amendments and changes after review by VP	Sustainability Coordinator, V.P.A.C.S. & Administration and Finance	Revise: *November 1st-December 1st, '13* Resubmitted to VP: *December 1st, '13*
Official signing of GHG Policy	V.P.	*January 15th, 2014*
Conduct GHG Emissions Inventory	Sustainability Coordinator	*Ongoing*
Action Plan (Green Initiatives)	Sustainability Coordinator, E.A.C., E.P.I., V.P.A.C.S., all students, faculty, and staff	Begin initiating: *ASAP* Monitor: *Ongoing* Audit: *Once a year*

In conclusion, this report contains the 2010-2011 Carbon Footprint for the Grenfell Campus of Memorial University and can be used as a template to establish an annual inventory at Grenfell Campus and at other institutions. The results can be used as a benchmark for comparing future footprints and the impact of environmental projects. Based on the inventory, it appears that the footprint or emissions per student for Scope 1 and 2 sources is relatively low at Grenfell – and this is something that Grenfell could celebrate and attempt to improve on an annual basis. However, for a more comprehensive carbon footprint, more work is needed on methods for collecting reliable data for Scope 3 sources. Data to date indicates that Grenfell Campus has relatively high emissions from these sources. To provide a coherent policy framework to this inventory, we recommend Grenfell make a commitment to further action on climate change by signing the University and College President's Climate Change Statement of Action for Canada and working towards a Climate Change Action Plan. There are also many short term initiatives that the campus could implement such as developing environmental policies, encouraging public transportation and active transportation options, and implementing waste reduction programs. The importance of a sustainability coordinator and a committee with representation from faculty, staff, and students has been emphasized by many organizations and institutions, as essential to creating and implementing these new initiatives. Leadership is needed to coordinate the sustainability efforts of the entire Grenfell community.

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Appendix A: Canadian University and College Talloires Signatories

1. Acadia University, Wolfville, Nova Scotia
2. Algonquin College, Ottawa, Ontario
3. Atlantic School of Theology, Halifax, Nova Scotia
4. Bishop's University, Sherbrooke, Quebec; Michael Goldbloom; Principal and Vice-Chancellor; 15 May 2010
5. Carleton University, Ottawa, Ontario
6. Concordia University, Montreal, Quebec
7. Dalhousie University, Halifax, Nova Scotia
8. Dawson College, Westmount, Quebec
9. Emily Carr Institute of Art and Design, British Columbia
10. Grant MacEwan College, Edmonton, Alberta
11. Lakehead University, Thunder Bay, Ontario
12. McGill University, Monteal, Quebec
13. McMaster University, Hamilton, Ontario, Canada; Patrick Deane, President and Vice-Chancellor; 18 October 2010
14. Mount Saint Vincent University, Halifax, Nova Scotia
15. Okanagan College, Kelowna, British Columbia; Jim Hamilton, President; 14 January 2011
16. Royal Roads University, British Columbia
17. Ryerson Polytechnical Institute, Toronto, Ontario

18. Saint Francis Xavier University, Antigonish, Nova Scotia
19. Saint Mary's University, Halifax, Nova Scotia
20. Saint Thomas University, Fredericton, New Brunswick
21. Simon Fraser University, Burnaby, British Columbia
22. Université de Montréal, Montréal, QC; Guy Breton, Rector; 1 February 2011
23. University College of Cape Breton, Sydney, Nova Scotia
24. University of British Columbia, Vancouver, British Columbia
25. University of Calgary, Calgary, Alberta
26. University of Guelph, Guelph, Ontario
27. University of Lethbridge, Lethbridge, Alberta
28. University of Manitoba, Winnipeg, Manitoba
29. University of Northern British Columbia, Prince George, British Columbia
30. University of Ottawa, Ottawa, Ontario
31. University of Saskatchewan, Saskatoon, Saskatchewan
32. University of Victoria, British Columbia
33. University of Western Ontario, London, Ontario
34. University of Windsor, Windsor, Ontario
35. University of Winnipeg, Manitoba
36. Vancouver Island University, Nanaimo, BC
37. York University, Toronto, Ontario

Appendix B: The University and College Presidents' Climate Change Statement of Action for Canada

University and College Presidents' CLIMATE CHANGE STATEMENT OF ACTION for Canada

We, the undersigned university and college presidents, are concerned about global climate change and its potential for adverse health, social, economic and ecological effects. We recognize our responsibility to advance knowledge for society and our obligation to demonstrate leadership in areas of community, national and global importance. We believe universities and colleges can fulfill these expectations by sharing knowledge, research and best practices about climate change with our students and the public.

We are proud of our record on climate action to date, but we must do more to accelerate our impact. Accordingly, our institutions will pursue responsible solutions to address the climate change challenge. Therefore, we commit to the following actions:

- We will exercise leadership by reducing emissions of greenhouse gases in collaboration with our communities.
- We will develop measurable targets using research and science.
- We will develop achievable and practical plans to achieve reduction targets.
- We will put in place rigorous assessment and measurement procedures.
- We will fully disclose and be accountable for our actions.

In pursuit of these actions, each institution will:

1. Initiate the development of a comprehensive plan to reduce greenhouse gases by creating a planning body that includes students, staff, faculty, researchers, administrators and other partners to set emission reduction targets in accordance with each institution's jurisdiction.

2. Within one year of signing this document, complete a comprehensive inventory of all greenhouse gas emissions on each campus.

3. Within two years of signing this document, set targets and develop an institutional climate action plan that engages each institution's research, education and operations into a comprehensive strategy that catalyzes solutions for climate change.

4. While the comprehensive plan is being created, immediately implement selected tangible actions to reduce greenhouse gas emissions.

5. Make action plans, inventories and periodic progress reports publicly available for review and comment.

6. Work cooperatively with governments, civil society, the business community and other institutions of higher learning to contribute to global climate change actions in recognition of our responsibility for equitable solutions.

In recognition of the importance of climate change to all Canadians, indeed to all the inhabitants of the earth, the undersigned Presidents will encourage universities, colleges and other post-secondary institutions to become signatories to this or similar climate change commitments.

Harvey P. Weingarten, President and Vice-Chancellor
University of Calgary, Calgary, Alberta

Ron Burnett, President and Vice-Chancellor
Emily Carr University of Art and Design, Vancouver, British Columbia

Harold (Skip) Bassford, President and Vice-Chancellor
University of the Fraser Valley, Abbotsford, British Columbia

Ralph Nilson, President and Vice-Chancellor
Vancouver Island University, Nanaimo, British Columbia

David W. Atkinson, President and Vice-Chancellor
Kwantlen Polytechnic University, Surrey, British Columbia

Greg Lee, President and Vice-Chancellor
Capilano University, North Vancouver, British Columbia

William Alfred Samuel (Sam) Shaw, President and CEO
Northern Alberta Institute of Technology, Edmonton, Alberta

Ron Woodward, President and CEO
Red Deer College, Red Deer, Alberta

Sharon Carry, President and CEO
Bow Valley College, Calgary, Alberta

David T. Barnard, President and Vice-Chancellor
University of Manitoba, Winnipeg, Manitoba

Terrence Downey, President
St. Mary's University College, Calgary, Alberta

Lance Carlson, President and CEO
Alberta College of Art and Design, Calgary, Alberta

Bruno-Marie Béchard, President
The University of Sherbrooke, Sherbrooke, Quebec

Frits Pannekoek, President
Athabasca University, Athababasca, Alberta

Andy Orchard, Provost
Trinity College, Toronto, Ontario

Paul J. Byrne, President and CEO
Grant MacEwan University, Edmonton, Alberta

Tom Traves, President
Dalhousie University, Halifax, Nova Scotia

Daniel Woolf, Principal and Vice-Chancellor
Queen's University, Kingston, Ontario

Dr. Lloyd Axworthy, President and Vice-Chancellor
The University of Winnipeg, Winnipeg, Manitoba

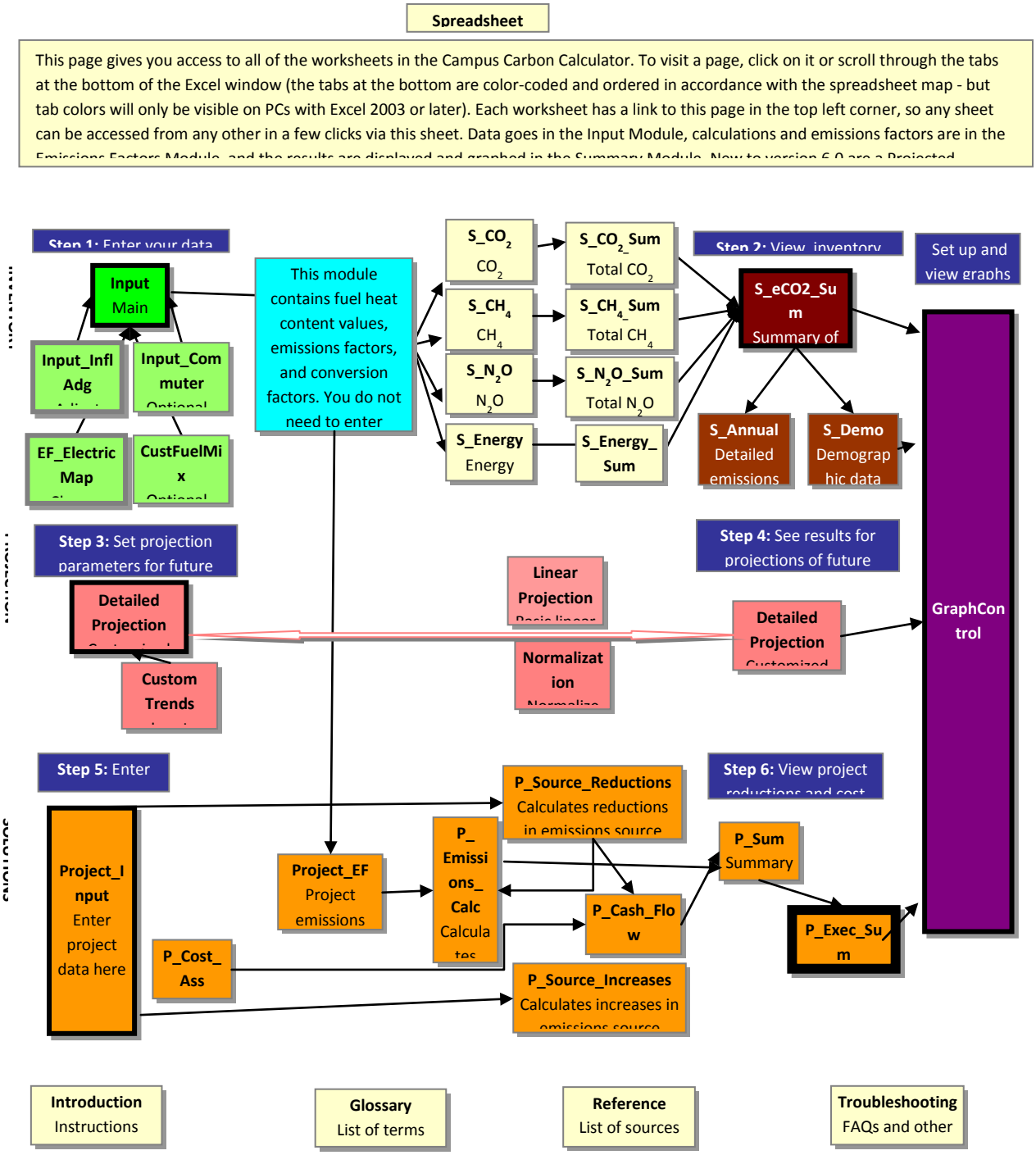
Dr. J. Harry Fernhout, President
The King's University College, Edmonton, Alberta

Peter MacKinnon, President
University of Saskatchewan, Saskatoon, Saskatchewan

Patrick Deane, President and Vice-Chancellor
McMaster University, Hamilton, Ontario

Appendix C: Campus Carbon Calculator, Clean Air-Cool Planet

Retrieved from: http://www.cleanair-coolplanet.org/toolkit/inv-calculator.php



Appendix D: CarbonCounted Information

Andrew Conway, P.Eng.

Co-Founder CarbonCounted

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Steve Cox

Co-Founder, CarbonCounted

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Website: www.carboncounted.com

Carbon Counted User Guide:

https://www.carbonconnect.carboncounted.com/Resources/CarbonConnectUserGuide.pdf#page=1

Carbon Counted Standard Pricing:

http://www.carboncounted.com/wp-content/uploads/2010/10/CarbonCounted-Standard-Pricing.pdf

Appendix E: Data Tables

Table 1: Summary of emission sources and contact information, Grenfell Campus, Memorial University

Scope	Grenfell emission source	Data obtained	Contact
1 **Direct emissions**	Vehicle fleet Site maintenance equipment	• Kilometers driven/year • Type of fuel • Quantity of fuel purchased from gas card summaries	Nora Lundrigan, Administration and Finance nlundrigan@grenfell.mun.ca 709-637-6200 x 6393 Javis Hulan, Manager, Facilities Management, Physical Plant jmhulan@grenfell.mun.ca 709-637-6224 Gary Pennell and Grant Kelly, Facilities Management
	Propane	• Lab use • Food vendors	Wanda Ellsworth, Chemistry/Environmental Science wellswor@grenfell.mun.ca 709-637-6200 x 6488 Superior Propane Account #: 1575412 709-686-2001
	Diesel	• Generator in Fine Arts Building	Javis Hulan jmhulan@grenfell.mun.ca 709-637-6224
	Refrigerant losses from cooling	• Type and quantity (lbs) of refrigerants used on	Wayne Tiller, Honeywell

	units on campus	campus • Type and quantity of refrigerants (lbs) added during 2010-2011 fiscal year • Converted to kgs	Wayne.tiller@honeywell.com Rod Sheppard, Refrigeration technician, Honeywell, Corner Brook roddy_66@live.com
2 **Indirect emissions**	Electricity	The number of kilowatt hours (KWH) consumed per month	Javis Hulan, Facilities Management Brian Duffy, Admin and Finance Carl Bishop, NL Power
3 **Other indirect emissions**	Solid waste management	Size of disposal bins and frequency of disposal	Javis Hulan, Edward Young, and Gary Pennell, Facilities Management Edward Young, Supervisor, Facilities Management 709-637-6200 x 6510 eyoung@grenfell.mun.ca

Table 2: Vehicle Fleet Fuel Consumption

VEHICLE	**J146**		**J 147**		**J 151**		**J157**			**J101**
DATE	**Quantity (L)**	**Total Cost**	**Quantity (L)**	**Total Cost**	**Quantity**	**Total Cost**	**Quantity (L)**	**Total Cost**	**Quantity**	**Total Cost**
4-May-10	100.6	110.06	306.8	340.76	52.9	57.91	265.7	292.71	184.8	204.69
2-Jun-10	112.2	122.26	379.2	411.55	50.3	55.46	326.1	351.95	219.9	238.79

5-Jul-10	379.7	404.53	338.1	355.84	122.2	130.18	533.6	564.26	359.1	377.79
4-Aug-10	161.3	170.76	206.5	216.76	147.8	155.76	283.8	300.09	178.7	188.43
1-Sep-10	268.42	392.6	178.5	123.86	171.3	116.92	217.1	145.01	117.7	81.55
1-Oct-10	242.5	256.87	254.5	271.3	103.9	109.77	257.6	275.37	237.5	249.68
1-Nov-10	125.4	138.35	532.3	581.29	52.7	58.99	407.9	441.23	250.2	272.31
1-Dec-10	45.1	51.66	364	409.31	100.5	111.03	263.1	292.95	237	265.76
31-Dec-10	59.2	66.59	65.4	75.34	56.7	63.69	191.1	218.21	137.2	158.87
31-Jan-11	57.4	66.67	108.5	126.76	108.7	126.57	203.7	238.72	322.1	377.38
28-Feb-11	63.8	74.42	146.6	172.63	59.4	69.58	153.7	179.24	212.3	249.36
31-Mar-11	174.2	219	77.3	97.15	223.4	276.99	531.6	666.74	211.6	266.22
TOTAL:	1789.82	2073.77	2957.7	3182.55	1249.8	1332.85	3635	3966.48	2668.1	2930.83
TOTAL Quantity of fuel consumed by fleet:	12300.42									
Fuel consumption by vehicle (%)	14.55089		24.04552		10.16063		29.55184		21.69113	
TOTAL Cost	10,555.65									

Table 3: Site Maintenance Equipment Fuel Consumption Data

SITE MAINTENANCE EQUIPMENT	J006 Kubota Tractors – Diesel		J006 Other - Regular Gasoline	
DATE	**Quantity (L)**	**Total Cost**	**Quantity (L)**	**Total Cost**
4-May-10	0	0	0	0
2-Jun-10	52.5	58.38	0	0
5-Jul-10	28.9	30.3	36	37.56
4-Aug-10	0	0	0	0
1-Sep-10	0	0	65.9	69.68
1-Oct-10	0	0	0	0
1-Nov-10	0	0	0	0
1-Dec-10	0	0	97.4	109.53
31-Dec-10	0	0	0	0
31-Jan-11	0	0	0	0
28-Feb-11	0	0	0	0
31-Mar-11	0	0	0	0
TOTAL:	81.4	88.68	199.3	216.77