Centre universitaire de santé McGill
McGill University Health Centre
Les meilleurs soins pour la vie
The Best Care for Life

McGill University Health Centre's energy efficiency measures for GHG Emissions Reduction Project

Greenhouse Gas Project Report
Reporting period: January 1st 2011 – December 31st 2011

Project proponent: *McGill University Health Centre*
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ABBREVIATIONS

BS:	Baseline Scenario (GHG Emission Source)
CDM:	Clean Development Mechanism
CH_4:	Methane
CO_2:	Carbon dioxide
CO_2e:	Carbon dioxide equivalent (usually expressed in metric tons)
CSA:	Canadian Standards Association
CUSM :	Centre universitaire de santé McGill
EF:	Emission Factor
EPA :	Environmental Protection Agency (USEPA)
HDD:	Heating degree day
GHG:	Greenhouse gases
ISO:	International Organization for Standardization
IPCC:	Intergovernmental Panel on Climate Change
kWh :	Kilowatt hour
MUHC :	McGill University Health Centre
N_2O:	Nitrous oxide
PS:	Project Scenario (GHG emission source)
SSR :	Source, Sink and Reservoir
t :	Ton (metric)
VER :	Verified Emission Reduction

SOMMAIRE EXÉCUTIF

(*Please note that the remainder of the document is in English*)

Le Centre Universitaire de Santé McGill a mis en œuvre un projet d'amélioration de l'efficacité énergétique des édifices dont il a la responsabilité. Le projet du Centre Universitaire de Santé McGill inclut plusieurs édifices situés à Montréal, dans la province de Québec. Il s'agit par conséquent d'un projet groupé. Les mesures mises en place dès 2002 font en sorte que les quantités d'électricité, de gaz et d'huile utilisées ont été réduites, ce qui se traduit par des réductions des émissions de gaz à effet de serre.

L'implantation des mesures a débuté en 2002 et la quantification de ces dernières débute en 2002. La période de 10 ans du projet a pris fin en décembre 2011. La reconduction de la période créditrice pur une période additionnelle de dix ans (ou moins) est à considérer. En 2008, le campus de Lachine a été intégré au Centre Universitaire de Santé McGill, cependant aucun projet n'a été implanté pour la présente période créditrice. Des futurs projets sont planifiés pour cet établissement.

Les édifices pris en considération lors de cette étude sont l'Hôpital général de Montréal (1650 Avenue Cedar), l'Hôpital de Montréal pour enfants (2300 rue Tupper), Hôpital Royal Victoria (687 Avenue des Pins ouest), l'Institut thoracique de Montréal (3650 St-Urbain) et l'Hôpital neurologique de Montréal (3801 University).

Les réductions d'émission de GES pour la période 2011 ainsi que pour la totalité du projet depuis 2002 sont ici présentées :

Année	Réductions (t CO2e)
2011	11 116
TOTAL	**76 155**

1. INTRODUCTION

As a high level educational and health services provider and an important player in the Montreal community, McGill Universiy is committed to demonstrate its social responsibility in every aspect of its operations. As part of this commitment the McGill University Health Centre (MUHC) has decided to take action to reduce its impact on the environment. Among other measures, several energy efficiency improvements have been implemented resulting in both reduction of energy usage and GHG emissions mitigation. The present document gives explanation about how the project is implemented and reports factual outcomes regarding GHG emissions reduction.

This GHG report is presented in a format that meets the requirements of CSA CleanProjects™ registry and the ISO 14064-2 guidelines and principles:

- Relevance:

All relevant GHG sources related to energy usage at MUHC are meticulously selected and presented in section 4. A precise methodology is used along with project specific parameters values.

- Completeness:

A complete assessment of GHG sources is made and all GHG types are considered in the applied quantification methodology. Complete information regarding project implementation, continuing activities, new building improvements over time and GHG quantification is given through this GHG report.

- Consistency:

Chosen quantification methodology is appropriate for McGill University Health Centre's specific project. Established baseline scenario is consistent with the project level of activity related to the heating needs of the buildings.

- Accuracy:

Calculation uncertainties are kept as small as possible. Energy data are precise and calculations are well documented.

- Transparency:

Project related information is transparently communicated through this document so that the intended user knows what the important data are, how they are collected and how the project actually leads to GHG emissions reduction. Data monitoring and GHG emission reductions calculation are clearly detailed in order to provide the reader sufficient information to confidently make decisions.

- Conservativeness:

GHG emission reductions are not overestimated. When accuracy is jeopardized because of assumptions, conservative choices are made.

This report will be made available for public consultation.

2. PROJECT DESCRIPTION

2.1. Project title

McGill University Health Centre’s energy efficiency measures for GHG Emissions Reduction Project

2.2. Objectives

The main objective of the project is to reduce the GHG emissions resulting from the use of different energies in the MUHC’s buildings.

2.3. Project lifetime and crediting period

McGill University Health Centre’s energy efficiency grouped project was gradually implemented from January 2003, except for the MCH which started the efficiency measures’ implementation in 2002. The project crediting period start date is January 1st 2002. The project activities are planned to be ongoing for at least a crediting period of 10 years. Renewal of the crediting period will be assessed.

2.4. Type of GHG project

This project is an energy efficiency grouped project.

2.5. Location

McGill University Health Centre (The buildings are located on the island of Montreal)
Montreal (Quebec) Canada

McGill University Health Centre’s Energy Efficiency Projects are located at:

Montreal General Hospital (MGH)
1650 Cedar Avenue
Montreal, Quebec
H3G 1A4
Latitude: 45° 29’ 51.32’’ N
Longitude: 73° 35’ 18.78’’ W

The Montreal Children’s Hospital (MCH)
2300 Tupper Street
Montreal, Quebec
H3H 1P3
Latitude: 45° 29’ 23.68’’ N
Longitude: 73° 34’ 56.24’’ W

The Royal Victoria Hospital (RVH)
687 Pine Avenue West
Montreal, Quebec
H3A 1A1
Latitude: 45° 30’ 49.97’’ N
Longitude: 73° 34’ 33.46’’ W

The Montreal Chest Institute (MCI)
3650 St-Urbain
Montreal, Quebec
H2X 2P4
Latitude: 45° 30’ 47.70’’ N
Longitude: 73° 34’ 29.64’’ W

The Montreal Neurological Hospital (MNH)
3801 University Street
Montreal, Quebec
H3A 2B4
Latitude: 45° 30’ 32.83’’ N
Longitude: 73° 34’ 52.97’’ W

2.6. Conditions prior to project initiation

The conditions in place before implementation of the project were status quo on energy efficiency technologies. The conditions were also status quo on energy utilization, switching and on the steam heating systems.

2.7. Description of how the project will achieve GHG emission reductions or removal enhancements

The project contributes to GHG emissions reduction since it makes it possible to consume less energy than it would otherwise consume in the baseline scenario. The significant GHG reductions projects in this report are:

1) The replacement of inefficient boilers by new and efficient ones, changing the overall piping system (thermo insulation) and installing centralized command centers;

2) Change of air cooling equipment;

3) Energy switches for heating systems from steam to hot water.

The other projects will have a small overall impact on the total GHG emissions reduction. However it is important to mention the substantial environmental efforts carried out by McGill University Health Centre.

The project achieves GHG emissions reduction by the installation of energy efficient technologies and thus the reduction of energy consumption (natural gas, oil and electricity) than what would have happened with the baseline scenario: status quo on energy efficiency projects, on switch of energy (steam to hot water) and status quo on the inefficient boilers within the heating system.

2.8. Project technologies, products, services and expected level of activity

Created in 1997, the McGill University Health Center (MUHC) is the first and most important University Hospital voluntary fusion in Canada. In 2008, Campus Lachine was added to the MUCH and is referred in this report as Lachine Health Centre (LAC). With around forty buildings on six locations, MUHC is responsible for the management of approximately 380,000 m^2.

The following pictures represent each Hospital Center.

Figure 2.1 Montreal General Hospital

Figure 2.2 Royal Victoria Hospital

Figure 2.3 Montreal Children Hospital

Figure 2.4 Montreal Children Hospital

Figure 2.5 Montreal Chest Institute

Figure 2.6 Lachine Hospital Centre

The following table presents the abbreviation, year of foundation, and the total area for each of the six Hospital Centers.

Table 2.1: Summary of MUHC's hospital centers

Hospital Center	Abbreviation	Year of foundation	Total Area
Montreal General Hospital	MGH	1955	102,016 m^2
Royal Victoria Hospital	RVH	1893	131,195 m^2
Montreal Children's Hospital	MCH	1956	57,683 m^2
Montreal Chest Institute	MCI	1954	13,948 m^2
Montreal Neurological Hospital	MNH	1934	27,904 m^2
Lachine Health Centre	LAC	1939	23,330 m^2

As one can observe, MUHC's Hospital Centers are composed of buildings that are more than 100 years old, some dating from the 1800s. In 2002, MUHC started the implementation of its Energy Optimization Plan in order to increase the energy efficiency of its installations through the modernization and optimization of its operations and maintenance. In the years to come, planned projects will be implemented for LAC.

2.8.1. Royal Victoria Hospital (RVH)

The Royal Victoria Hospital project, as a whole, cost over $4.7 million. One of the main measures implemented, was the installation of a central computer controlled heating system allowing for an automatic modulation based on the heating needs. A resistance element boiler was also installed. It ensures the main heating needs in the summer and it works only if the electrical demand is below high peak. Furthermore, a specific effort was made for the recovery of the energy generated by the pipe purges and the combustion fumes. The following table summarizes the different measures implemented at RVH.

Table 2.2: Measures implemented at RVH

Measures
Installation of six (6) high performance boilers
Installation of a hot exhaust gas recovery system
Installation of a central computer controlled heating system allowing for an automatic modulation based on the heating needs
Installation of a Resistance Element Boiler (electrical)
Thermal insulation of the piping network
Heat recovery during the stripping phase
New Multistack heat pump

2.8.2. The Montreal Children's Hospital (MCH)

The Montreal Children's Hospital project has a whole cost over $2.5 million. Two high efficiency centrifuge chillers condition the MCH. A frequency variable speed drive unit was added to one of the chillers allowing to adjust the energy consumption more efficiently and to correspond to the current norms of HCFC elimination. Furthermore, the elimination of the absorption chillers significantly reduced the vapor consumption. Finally, the frequency variable speed drive units optimize ventilation in the building outside of traffic high hours.

Table 2.3: Measures implemented at MCH

Measures
Installation of high efficiency centrifuge chillers
Installation of a more efficient boiler
Optimization of vapor distribution network
Optimization of control panels
Installation of frequency variable speed drive units
Heat recovery from the medical air compressors

2.8.3. Montreal Chest Institute (MCI)

The Montreal Chest Institute project as a whole cost over $695,000. In this case, the MUHC focused on limiting the utilization of vapor to the laundry room, the kitchen and the sterilization. Projects implemented at MCI are listed in the following table.

Table 2.4: Measures implemented at MCI

Measures
Conversion of the heating network at Pavilion J
Optimization of vapor production
Conversion of sanitary hot water production systems
Installation of a heating facility at Pavilion D
Weatherstripping of windows at Pavilion D

2.8.4. Montreal Neurological Hospital (MNH)

The Montreal Neurological Hospital project as a whole cost over $6.2 million. In order to reduce its environmental impact, MUHC has chosen to convert its heating system to a hot water system and to divide the different vapor applications in the building (sterilization, labs, and humidification). Also, vapor coils were changed for hot water coils, which have more capacity. Measures implemented at MNH are listed in the table below.

Table 2.5: Measures implemented at MNH

Measures
Conversion of heating system
Installation of a heat recovery system
Replacement of a sanitary hot water production system
Installation of a variable speed drive unit
Installation of a central control system

2.8.5. Montreal General Hospital (MGH)

The Montreal General Hospital project as a whole cost over $9.8 million. It was done in two phases. Projects implemented at MGH are shown in the table below.

Table 2.6: Measures implemented at MGH, first phase

Measures : First phase
Replacement of a vapor boiler
Installation of two off-peak electric boilers

Table 2.7: Measures implemented at MGH, second phase

Measures : Second Phase
Unification of water heating networks
Conversion of ventilation heating to water
Replacement of boilers
New Multistack heat pump
Installation of a recuperator with heat pump
Installation of a heat recuperator with glycol coils
Installation of heat recuperator on the chimney

2.9. Aggregate GHG emission reductions and removal enhancements likely to occur from the GHG project

The crediting period is now over. A total of about 60 000 t CO_2e of GHG emissions reduction was expected for the 10-year period and the project results in a reduction of over 75 000 t CO_2e of GHG emissions. The reductions are shown per year in the following table.

Table 2.8: GHG Emission Reductions Summary

Year	Expected Emission Reductions (t CO2e)	Achieved Emission Reductions (t CO_2e)
2002	6252	431
2003	6252	3216
2004	6252	6370
2005	6252	6641
2006	6252	5723
2007	6252	7592
2008	6252	8138
2009	6252	12883
2010	6252	14045
2011	6256	11116
TOTAL	**62524**	**76155**

2.10. Identification of risks

This emission reductions report was written according to ISO 14064-2 Specifications Requirements for quantification, monitoring and reporting of greenhouse gas emission reductions and removal enhancements assertions. In order to minimize risks, the methodology was selected based on its completeness and its international recognition. It was developed by the UNFCCC and published in 2007 for small scale projects.[1] No serious potential risks which could alter this GHG emissions reduction project were identified.

2.11. Roles and Responsibilities

2.11.1. Project proponent and representative

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2.11.2. Monitoring and data collection

The McGill University Health Centre is responsible for the project implementation, emissions reduction and data monitoring. Mr. Khouchane is a manager in charge of collecting the energy data and the follow up of the process of the quantification and verification of the saved GHG emissions and monitoring the entire environmental footprint as well in the MUHC.

2.11.3. Quantification and reporting responsible entity

L2I Financial Solutions is a firm specialized in non-traditional corporate financing. An expertise has been developed in the quantification of GHG emissions. Services are offered for GHG inventory, GHG emissions reduction project implementation, GHG markets advising, regulatory requirements and much more.

Joséanne Bélanger-Gravel works at L2I as a carbon credits advisor. She has a mechanical engineering degree from Université de Sherbrooke and EPF-École d'ingénieurs de Sceaux in France. She also owns an engineering master degree on renewable energies and she is about to complete a second master in environment with specialisation in sustainable development. She is responsible for the update of the quantification.

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[1] CDM, (2007). CDM methodology II.E/Version 10: Energy efficiency and fuel switching measures for buildings, Internet link: http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_LAVBAV8STPGYPWVKGQJLBCNEC8APNP

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Mr. David Beaudoin works at L2I as director of environment and climate change services. He holds a Bachelor's Degree in Biotechnological Engineering from the University of Sherbrooke. During his career, Mr. Beaudoin has occupied several positions such as Process Engineering Consultant, Project Manager in R&D and research assistant for different environmental firms. He is responsible for the project report update based on the previous versions. He also performs reviews of the monitored data and the GHG emission reductions calculation.

David Beaudoin, B.Ing.

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Report Use and Users

The target users are the potential offset VER (Verified Emission Reductions) buyers on the voluntary carbon market.

Verification Notification

Initially quantified by L2I Financial Solutions, the verification of the VERs will be conducted by an external verification entity according to ISO 14064 part 3.

2.11.4. Authorized project contact

Christine Lagacé is shareholder and vice-president of financial relations at L2I Financial Solutions and has the signing authority for L2I. She is authorized by the project proponent to perform requests and administrative tasks regarding the project registration.

Christine Lagacé, Adm.A.

Vice-president, Corporative Development

L2I Financial Solutions

clagace@solutionsl2i.com

2.12. Project eligibility under the GHG program

The project is eligible under the GHG CleanProject™ registry. It is implemented following the ISO 14064-2 guidelines and principles, is not attempted to be registered under another GHG program and does not create any other environmental credit.

2.13. Environmental impact assessment

The nature of the project does not involve a required environmental impact assessment as the impact on the environment is limited to the GHG emissions.

2.14. Stakeholder consultations and mechanisms for on-going communication

Mr. Mohamed Khouchane, Manager, Quality and Performance Advisor at MUHC, is responsible for the communications with the quantifier, the verifier and the MUHC's board. Results are to be communicated to the MUHC Board and the CSA organization as well, for the publication of the available credits units.

2.15. Detailed chronological plan

The project's crediting period began on January 1st 2002 and ended on December 31st, 2011. This is the fourth GHG report. The first was for the period from 2002 to 2008, a second followed in 2009, and a third in 2010. Renewal of the crediting period will be assessed.

3. SELECTION OF THE BASELINE SCENARIO AND ASSESMENT OF ADDITIONALITY

The baseline scenario was selected among alternative scenarios representing what would have happened without this project. If this grouped project had not been implemented, the consumption of natural gas, oil and electricity would have been equivalent to what existed in 2001 or subsequent baseline years. This assumption is conservative since the electricity demand is currently increasing significantly during the summer with the increased demand for air conditioning.

Potential Baseline Scenarios:

1. Status quo or keeping the current boilers, not changing the piping system and not installing central controls, no thermal collectors, no wastewater heat recovery, and no energy switch;

2. Another scenario would be to replace the existing boilers, but not changing the piping system and not installing a central control system. No changes for the other technologies mentioned above;

3. The project scenario includes the replacement of the less efficient boilers in place by new efficient ones, physical modification of the piping system, installation of a central control system and the implementation of energy efficiency measures.

The first option was considered realistic since, before the project started the boilers were working and usual maintenance work was necessary. The second scenario was evaluated to be different from the first one in terms of efficiency, but there is still some energy loss with the old piping system in place and no central control to optimize the system. The third scenario has a financial barrier compared to the status quo, required for the analysis of the system, the modifications and the subsequent tasks. Finally, the financial barriers are significant for the third scenario and thus, this scenario is rejected as a baseline and is proposed as the project scenario.

The emission reductions achieved by the project are additional to what would have occurred in the absence of the GHG project since it is voluntary and faces significant investment barriers. Its implementation is highly motivated by the GHG emission reductions potential.

<u>In summary, baseline scenario:</u>

- Using the inefficient boilers in place until their end-of-life utility, no physical modification of the piping system and no central command;

- No switch of energy (steam to hot water) for heating mostly;

- No implementation of energy efficiency measures: i.e. Heat recovery from domestic waste water.

4. IDENTIFICATION AND SELECTION OF GHG SOURCES, SINKS AND RESERVOIRS

The SSRs for the baseline and the project scenario are identified in the table below and it is stated whether they are included or excluded from the quantification.

Table 4.1: SSR inventory

	Source	Incl/Excl? Type ?	Explanation
Baseline	Fuel extraction, processing and transport	Excluded Related	This emission source is assumed to be negligible compared to the combustion.
	Emissions from electricity production	Included Related	May be a significant source of greenhouse gases depending on the production means.
	Fossil fuel combustion	Included Controlled	An important source of greenhouse gases.
Project	Fuel extraction, and processing	Excluded Related	This emission source is assumed to be negligible compared to the combustion.
	Developing and installation of new technologies	Excluded Related	Installed equipments and technologies do not require significant amount of energy and do not create significant emissions
	Emissions from electricity production	Included Related	May be a significant source of greenhouse gases depending on the production means.
	Fossil fuel combustion	Included Controlled	An important source of greenhouse gases.
	Decommissioning of Equipments	Excluded	Decommissioning of equipments activities of the project are assumed to be negligible

5. QUANTIFICATION OF GHG EMISSIONS AND REMOVALS

The clean development mechanism (CDM) provides an approved methodology: II.E version 10 – *Energy efficiency and fuel switching measures for buildings*[2]. This methodology is used as a guiding tool for the quantification.

The quantification method consists essentially of multiplying appropriate emission factors to the total consumption of different types of energy namely electricity, natural gas and light fuel oil. However, the energy consumption is closely related to the heating needs and therefore to the weather conditions of a given year particularly in temperate regions like the province of Quebec. For accuracy purposes, it is therefore important to evaluate the effect of the weather conditions on the energy consumption and its related GHG emissions and emission reductions. The normalization procedure is intended to do so and is applied for this quantification. The normalization equations are outlined in the following subsections.

Another element which might greatly influence the energy consumption is the size of the buildings. Changes in buildings dimensions must be monitored and the impact on the energy demand must be assessed. Once normalized for weather impact, the consumption is then multiplied by the ratio of the buildings' areas in baseline year to buildings' areas in the year for which emissions are quantified. For the duration of this project, no changes in the area of the buildings are registered so the area parameter is not taken into account.

5.1. Baseline GHG emissions/removals

$$BS_{i,} = E_{elec,i,b} + E_{ng,i,b} + E_{fo,i,b}$$

$BS_{i,}$= Baseline Scenario emissions from building "i" (t CO_2e)

$E_{elec,i,b}$ = Emissions associated with electricity use at building "i" in baseline year (t CO_2e)

$E_{ng,i,b}$= Emissions associated with natural gas combustion at building "i" in baseline year (t CO_2e)

$E_{fo,i,b}$= Emissions associated with light fuel oil combustion at building "i" in baseline year (t CO_2e)

$$E_{elec,i,b} = [EE_{CO2} + (EE_{CH4} * GWP_{CH4}) + (EE_{N2O} *GWP_{N2O})] * AQE_{i,b}$$

$$E_{ng,i,b}= [ENG_{CO2} + (ENG_{CH4} * GWP_{CH4}) + (ENG_{N2O} *GWP_{N2O})] * AQNG_{i,b}$$

[2] CDM, (2007). CDM methodology II.E/Version 10: *Energy efficiency and fuel switching measures for buildings*, p.1. Internet link: http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_LAVBAV8STPGYPWVKGQJLBCNEC8APNP

$$E_{fo,i,b} = [EFO_{CO2} + (EFO_{CH4} * GWP_{CH4}) + (EFO_{N2O} * GWP_{N2O})] * AQFO_{i,b}$$

$AQE_{i,b}$ = Adjusted (normalized) quantity of electricity consumed at building "i" in baseline year (kWh)

$AQNG_{i,b}$ = Adjusted (normalized) quantity of fossil fuel consumed at building "i" in baseline year (m^3)

$AQFO_{i,b}$ = Adjusted (normalized) quantity of fossil fuel consumed at building "i" in baseline year (litres)

EE_{CO2}, EE_{CH4}, EE_{N2O} = GHG emission factors for electricity (2g CO_2/kWh; 0,0002g CH_4/kWh; 0,0001g N_2O/kWh)[3]

ENG_{CO2}, ENG_{CH4}, ENG_{N2O} = GHG emission factors for fossil fuel combustion (Natural Gas: 1878 g CO_2/m^3, 0.037 g CH_4/m^3, 0.035 g N_2O/m^3)[4]

EFO_{CO2}, EFO_{CH4}, EFO_{N2O} = GHG emission factors for fossil fuel combustion (Light Fuel Oil: 2725 g CO_2/L, 0.026 g CH_4/L, 0.031 g N_2O/L)[5]

GWP_{CH4} = Global Warning Potential of methane (21)

GWP_{N2O} = Global Warning Potential of nitrous oxide (310)

$$AQE_{i,b} = [0.3 + 0.7 *(HDD_r/HDD_b)] * QE_{i,b}$$

$$AQNG_{i,b} = [0.3 + 0.7 *(HDD_r/HDD_b)] * QNG_{i,b}$$

$$AQFO_{i,b} = [0.3 + 0.7 *(HDD_r/HDD_b)] * QFO_{i,b}$$

$QE_{i,b}$= Quantity of electricity consumed at building "i" in baseline year (kWh)

$QNG_{i,b}$= Quantity of natural gas consumed at building "i" in baseline year (m^3)

$QFO_{i,b}$= Quantity of fossil fuel consumed at building "i" in baseline year (litres)

HDD_r= Heating Degree-day of a 30 years reference period[6]

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[3] National Inventory Report 1990-2010, Greenhouse Gas Sources and Sinks in Canada, Part 3, Table A13-6, p.41

[4] National Inventory Report 1990-2010, Greenhouse Gas Sources and Sinks in Canada, Part 2, pp.194-195

[5] National Inventory Report 1990-2010, Greenhouse Gas Sources and Sinks in Canada, Part 2, p.196

HDD_b= Heating Degree-day of the baseline year “b”

The above equation for weather-adjustment is the same wherever the weather-adjusted consumption of energy is required and is taken from the VCS methodology[7]. In this case, degree-days data are from the Montreal Trudeau Airport weather station.

5.2. Project GHG emissions/removals

$$PS_{i,y} = PS_{Elec,i,y} + PS_{ng,i,y} + PS_{fo,i,y}$$

$PS_{i,y}$= Project Scenario emissions for building “i” in year “y” (t CO_2e)

$PS_{Elec,i,y}$ = Project Scenario emissions associated with electricity use for building “i” in year “y” (t CO_2e)

$PS_{NG,i,y}$ = Project Scenario emissions associated with natural gas combustion for building “i” in year “y” (t CO_2e)

$PS_{FO,i,y}$ = Project Scenario emissions associated with light fuel oil combustion for building “i” in year “y” (t CO_2e)

$$PS_{Elec,i,y} = [EE_{CO2} + (EE_{CH4} * GWP_{CH4}) + (EE_{N2O} *GWP_{N2O})] * APQE_{i,y}$$

$$PS_{NG,i,y} = [ENG_{CO2} + (ENG_{CH4} * GWP_{CH4}) + (ENG_{N2O} *GWP_{N2O})] * APQNG_{i,y}$$

$$PS_{FO,i,y} = [EFO_{CO2} + (EFO_{CH4} * GWP_{CH4}) + (EFO_{N2O} *GWP_{N2O})] *APQFO_{i,y}$$

$APQE_{i,y}$ = Project scenario adjusted (normalized) quantity of electricity consumed for building “i” in year “y” (kWh)

$APQNG_{i,y}$ = Project scenario adjusted (normalized) quantity of natural gas consumed for building “i” in year “y” (m^3)

$APQFO_{i,y}$ = Project scenario adjusted (normalized) quantity of light fuel oil consumed for building “i” in year “y” (litres)

$$APQE_{i,p} = [0.3 + 0.7 *(HDD_r/HDD_b)] * QE_{i,y}$$

$$APQNG_{i,p} = [0.3 + 0.7 *(HDD_r/HDD_b)] * QNG_{i,y}$$

$$APQFO_{i,p} = [0.3 + 0.7 *(HDD_r/HDD_b)] * QFO_{i,y}$$

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[6] Heating degree-days of each region are taken from Environment Canada weather office : http://climate.weatheroffice.gc.ca/climate_normals/stnselect_f.html?pageid=1&lang=f&province=QUE&provBut=Recherche

[7] VM0008 Methodology for Weatherization of Single and Multi-Family Buildings, p16; Internet link: http://www.v-c-s.org/VM0008.html

$QE_{i,y}$= Quantity of electricity consumed for project scenario at building “i” in year “y” (kWh)

$QNG_{i,y}$= Quantity of natural gas consumed for project scenario at building “i” in year “y” (m^3)

$QFO_{i,y}$= Quantity of light fuel oil consumed for project scenario at building “i” in year “y” (litres)

HDD_r= Heating Degree-day of a 30 years reference period[8]

HDD_y= Heating Degree-day of the year “y”

5.3. Emission reductions

These following equations illustrate the GHG emissions reduction quantification.

$$TPER_y = \Sigma ER_{i,y}$$

$TPER_y$ = Total Project Emission Reductions in year “y” (t CO_2e)

$ER_{i,y}$ = Emission reductions for building “i” in year “y” (t CO_2e)

$$ER_{i,y} = BS_{i,} – PS_{i,y}$$

[8] Idem 5.

6. DATA MONITORING AND CONTROL

Table 6.1: Monitored data

Data / Parameters	**QE**
Data unit :	kWh
Description :	Electricity consumption
Source of data to be used :	Power supplier invoices
Description of measurement methods and procedures to be applied :	Collection from energy bills and input into a database
QA/QC procedures to be applied :	Supplier invoices are judged sufficiently accurate so other QA or QC procedures are not required
Any comment :	

Data / Parameters	**QNG**
Data unit :	m^3
Description :	Natural gas consumption
Source of data to be used :	Natural gas supplier invoices
Description of measurement methods and procedures to be applied :	Collection from energy bills and input into a database
QA/QC procedures to be applied :	Supplier invoices are judged sufficiently accurate so other QA or QC procedures are not required
Any comment :	

Data / Parameters	**QFO**
Data unit :	litres
Description :	Fuel oil consumption
Source of data to be used :	Oil suppliers invoices
Description of measurement methods and procedures to be applied :	Collection from energy bills and input into a database
QA/QC procedures to be applied :	Supplier invoices are judged sufficiently accurate so other QA or QC procedures are not required
Any comment :	

Data / Parameters	Heating Degree-days (HDD)
Data unit :	^oC
Description :	Number of degrees (^oC) below 18^oC between this threshold of 18 and the average temperature of the day. It serves as a representation of the need for heating of a given year.
Source of data to be used :	Taken from the closest weather station. This information is available from Environment Canada Weather Office.
Description of measurement methods and procedures to be applied :	
QA/QC procedures to be applied :	Official data from Environment Canada are considered the most accurate available.
Any comment :	

Data / Parameters	$ENG_{CO2, CH4, N2O}$
Data unit :	g/m^3 of Natural gas
Description :	Emission factor of CO_2, CH_4, N_2O for the combustion of Natural gas.
Source of data to be used :	Most recent version of the Canada's National Inventory Report. Value updated yearly.
Description of measurement methods and procedures to be applied :	
QA/QC procedures to be applied :	Official data from Environment Canada are considered the most accurate available.
Any comment :	

Data / Parameters	$EFO_{CO2, CH4, N2O}$
Data unit :	g/L of light fuel oil
Description :	Emission factor of CO_2, CH_4, N_2O for the combustion of light fuel oil.
Source of data to be used :	Most recent version of the Canada's National Inventory Report. Value updated yearly.
Description of measurement methods and procedures to be applied :	
QA/QC procedures to be applied :	Official data from Environment Canada are considered the most accurate available.
Any comment :	

Data / Parameters	**EE $_{CO2, CH4, N2O}$**
Data unit :	g/kWh
Description :	Emission factor of CO_2, CH_4, N_2O for use of electricity
Source of data to be used :	Most recent version of the Canada's National Inventory Report. Value updated yearly.
Description of measurement methods and procedures to be applied :	
QA/QC procedures to be applied :	Official data from Environment Canada are considered the most accurate available.
Any comment :	

7. REPORTING AND VERIFICATION DETAILS

The project plan and report is prepared in accordance with ISO 14064-2 standard and the GHG CleanProject™ program requirements. The methodology that is used, the choice of region specific emission factors and a rigorous monitoring plan allow for a reasonably low level of uncertainty. L2I Solutions is confident that the emission reductions are not overestimated and that the numbers of emission reductions that are reported here are real and reflect the actual impacts of the project.

The GHG report is prepared in accordance with ISO 14064-2 and GHG CleanProjects™ requirements. Emission reductions will be verified by an independent third party to a reasonable level of assurance. Raymond Chabot Grant Thornton will be the verifying firm for this reporting period and will verify in conformance with ISO 14064-3. Emission reductions are reported here for the year 2011.

Table 7.1: Baseline scenario GHG emissions in 2011 (t CO_2e)

		RVH+MNH	MCH	MGH	MCI	TOTAL
Natural gas	CO2	17 433	7 644	9 548	1 507	
	CH4	7	3	3	0	
	N2O	100	44	55	8	
	Total	17 540	7 691	9 606	1 515	36 352
Electricity	CO2	76	27	62	5	
	CH4	0	0	0	0	
	N2O	0	0	0	0	
	Total	76	27	62	5	170
Light fuel oil	CO2	332	219	964	0	
	CH4	0	0	0	0	
	N2O	1	0	3	0	
	Total	333	219	967	0	1 519
TOTAL		17 949	7 937	10 635	1 520	38 041

Table 7.2: Project scenario GHG emissions in 2012 (t CO_2e)

		RVH+MNH	MCH	MGH	MCI	TOTAL
Natural gas	CO2	14 374	5 345	5 807	1 033	
	CH4	6	3	3	1	
	N2O	84	31	34	6	
	Total	14 464	5 379	5 844	1 040	26 727
Electricity	CO2	68	32	79	9	
	CH4	1	1	1	1	
	N2O	2	1	2	1	
	Total	71	34	82	11	198
Light fuel oil	CO2	0	0	0	0	
	CH4	0	0	0	0	
	N2O	0	0	0	0	
	Total	0	0	0	0	0
TOTAL		14 535	5 413	5 926	1 051	26 925

Table 7.3: GHG emission reductions in 2011 (t CO_2e)

	RVH+MNH	MCH	MGH	MCI	TOTAL
Baseline emissions	17 949	7 937	10 635	1 520	38 041
Project emissions	14 535	5 413	5 926	1 051	26 925
Emission reductions	3 414	2 524	4 709	469	11 116