SWI
systemware innovation

## INTRODUCTION

This document provides the greenhouse gas (GHG) inventory for Systemware Innovation Corporation for the year ending January 31, 2008.

Founded in 1978, Systemware Innovation Corporation is celebrating 30 years of offering unsurpassed engineering services for the creation of mission critical applications.

## INVENTORY TEAM AND CONTACT INFORMATION

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## REPORTING PERIOD

This report covers the 2007-2008 fiscal year beginning February 1, 2007 and ending January 31, 2008.

## ORGANIZATIONAL BOUNDARIES

During the reporting period, Systemware Innovation Corporation (SWI) had offices in Toronto and Vancouver. The company's consultants worked with clients in Canada, the United States, and Europe.

The company counts its share of emissions from facilities; i.e. Systemware Innovation Corporation uses the equity share approach. (Section 4.1 of the CSA/ISO 14064-1 standard.) SWI shares office space and vehicles with several related companies.

- Emissions generated by shared vehicles were mainly (80%) assigned to SWI. It is not possible to accurately split the vehicle usage in this period among the companies, but it is known that SWI used the vehicles the most.
- Scope-2 (energy indirect) emissions were apportioned among the companies on the basis of the employee headcount relevant to the location.

- Emissions generated by SWI consultants while working at client sites are within the boundaries of the client organization, and are therefore not included.

## OPERATIONAL BOUNDARIES

The relevant sources of GHG emissions within the organization boundaries were:

- Company vehicles
- Energy indirect emissions
- Employee business travel

The sources were classified according to the ISO 14064-1 method as follows:

| Emission Source | Classification |
|---|---|
| Company vehicles | Direct |
| Energy indirect emissions | Energy indirect |
| Business travel | Other indirect |

Some sources of emissions were excluded:

- Travel by local public transit. The available data do not permit reliable estimation of the number and the length of trips on the TTC in Toronto or TransLink in Vancouver.
- Paper consumption. Available data do not permit reliable estimation of paper consumption. The company has changed its standard paper stock to 100% recycled, making paper a negligible source of emissions.

The company surveyed employees to estimate emissions generated by commuting to work. These emissions are outside the organizational boundary and are not reported.

There are no sinks or reservoirs relevant to Systemware's operations, nor is there any combustion of biomass.

## BASE YEAR

The GHG inventory for this period (the year ending January 31, 2008) will be used as a historical base year.

## METHODS USED TO QUANTIFY EMISSIONS

Emissions are quantified by calculating activity levels and then translating this into a $CO_2$-equivalent measure using an emission factor. Activity levels were estimated using data from purchasing records and data obtained from suppliers. Emission factors were taken from calculator tools provided by reputable organizations and published reports from Canadian government agencies. Procedures to translate financial measures of activity into physical estimates were carefully documented for future reference.

## EMISSIONS FROM VEHICLE USAGE

1. Methodology

*a) Activity data*

- Records of fuel purchases were used to obtain the total expenditure on fuel in leased vehicles and rental vehicles.
- The average retail price of gasoline in Toronto during this period was used to convert expenditures into an estimate of litres of gasoline consumed.
- The weekly average price data was obtained from the Natural Resources Canada's website under Energy – Energy Sources – Petroleum Products and Crude Oil Prices.[1]
- The average price for the fiscal year was obtained by combining the relevant weeks from 2007 and 2008. Matching weekly purchases to weekly prices was judged not worth the time or effort because: price variation throughout the year was low (cents per litre: mean 99.7, standard deviation 5), and purchases were made steadily throughout the year.
    - The fuel consumption data for the leased vehicles are consistent with the 24,000 annual kilometres of travel included in the lease cost.
- Records of employee expense claims were used to obtain kilometres of car travel in employee vehicles.
- An employee survey was used to estimate the fuel efficiency of employee vehicles.

*b) Emission factors*

The WRI/WBCSD *Mobile Combustion $CO_2$ Emissions Calculation Tool. January 2005. Version 1.3*, of the WRI/WBCSD GHG Protocol Initiative, was used to convert estimates of fuel consumption into tonnes of $CO_2$-equivalent emissions.[2]

The emission factors used to convert litres of fuel were compared to the figures from *National Inventory Report, 1990-2006 - Greenhouse Gas Sources and Sinks in Canada.*[3]

Employee vehicles were assumed to be in the Tier 1 category. (Vehicles built since 1994 must meet Tier 1 standards.)

1 http://www2.nrcan.gc.ca/eneene/sources/pripri/prices_bycity_e.cfm, Retrieved March 9, 2009.
2 http://www.ghgprotocol.org/calculation-tools/all-tools. Retrieved November 11, 2008.
3 http://www.ec.gc.ca/pdb/ghg/inventory_report/2005_report/a12_eng.cfm#a12_1_4. Retrieved March 9, 2009.

| *Emission Factors for Energy Mobile Combustion Sources* | | | | |
|---|---|---|---|---|
| | | Emission Factors (g/L fuel) | | |
| Mode | | $CO_2$ | $CH_4$ | $N_2O$ |
| **Light-Duty Gasoline Vehicles (LDGVs)** | **Tier 1** | 2360 | 0.12 | 0.16 |
| 100-year GWP | | 1 | 23 | 296 |
| $CO_2$-equivalent units | | 2360 | 2.76 | 47.36 |
| Total $CO_2$-equivalent emission factor | | 2410.12 | | |

The factors for converting to $CO_2$-equivalent units are from *Table 6.7* of *Climate Change 2001: Working Group I: The Scientific Basis,* International Panel on Climate Change.[4]

There is a 1.2% difference in the emissions factors. The emission factors from the WRI/WBCSD calculation tool were used in the computation of SWI's emissions.

*c) Calculations of total emissions*

For emissions where there were records of fuel purchases, the average price of gasoline in Toronto during the 2008 fiscal year was used to convert fuel purchase dollars into litres of fuel. This quantity was then multiplied by the emission factor.

For emissions where there were records of distance travelled, estimates of vehicle fuel efficiency were used to calculate fuel consumption. A survey of employees was used to estimate the fuel efficiency of employee vehicles. Participation in this survey was voluntary, and the sample was from the population of employees who drive to work, not the population of employees who used their vehicle for business travel. Despite these limitations, this is likely to provide a better estimate than an arbitrary estimate of fuel efficiency. The resulting figure of 8.99 L / 100 km is consistent with about half the employees driving small cars, and half the employees driving medium-sized cars, which is a reasonable result. This was then multiplied by the emission factor.

*d) Verification of accuracy of results*

Sample calculation:

For litres of gasoline, the following formula is used:

emissions $CO_2$ = fuel volume (litres) x GJ per litre of fuel x emissions factor (kg $CO_2$ / GJ)
= 6911.28 x 0.0344 x 69.25
= 6911.28 x 2.3822
= 16464.05 kg $CO_2$-equivalent
= 16.5 tonnes $CO_2$-equivalent

4 http://www.ipcc.ch/ipccreports/tar/wg1/248.htm. Retrieved November 12, 2008.

For distance, the following formula is used:

emissions $CO_2$ = distance (km) / 100 x fuel eff. (L/100 km) x GJ per L of fuel x emiss. factor (kg $CO_2$ / GJ)
= 153,410 / 100 x 8.99 x 0.0344 x 69.25
= 13,792 x 2.3822
= 32.9 tonnes $CO_2$-equivalent

2. Estimation of Uncertainty

There are several potential sources of error. These include:

a) The accounting system was not designed to track fuel purchases separately. It is possible that some fuel purchases were combined with other purchases on the expense report, and therefore could not be identified without inspecting paper records. However, it is standard practice to enter descriptions that are sufficiently detailed to identify fuel and mileage.
b) Some fuel purchases or mileage for company purposes may not have been claimed by employees. These amounts are likely to be very small, as the employees have a financial incentive to make a claim.
c) Fuel purchases and mileage claims were counted based on the date of the claim, not on the date of the purchase or the journey. Some emissions prior to the base year will therefore be included in the base year estimates, and some of the base year emissions will be included in the estimates for 2008-09 instead. If emissions from these sources are growing over time, this method will underestimate each year's emissions slightly.
d) Precise fuel economy figures for individual consultant's vehicles are not matched to mileage claims. Consultants were surveyed to determine typical vehicle size, but the population sampled was not an exact match of the population of vehicles used for business travel. The results were in accord with anecdotal knowledge of employee vehicles.
e) Some vehicle mileage is incurred by employees working for related companies. This mileage was included in the 2008 estimates. This will lead to an overestimate of emissions.

To reduce these sources of error, in future

- The accounting system will track GHG-generating activities in greater detail. This change will not be fully implemented until the 2009-2010 fiscal year.
- Log books are now used to track mileage in the leased vehicles. This makes it possible to separate SWI usage from other usage, and permits fuel consumption volume and distance measures to be compared.

Overall, the level of uncertainty of this quantification methodology is considered to be low. The limitations of the data should not introduce substantial error.

## Energy Indirect Emissions: Energy Usage in Buildings

1. Methodology

*a) Compilation of leased space occupied by SWI.*

SWI operates from two locations, one in Vancouver, and one in Toronto.

*b) Compilation of activity data for the buildings:*

- The square footage of space was determined from the lease documents.
- The Toronto space is shared with related companies. The internal methods used to allocate the cost of the space were used to allocate the share of emissions.
- The landlords provided aggregate energy consumption figures.
- Metered electricity data became available in mid-2009

*c) Determination of appropriate emission factors:*

For the Vancouver office, the landlord and the energy supplier, Central District Heating Limited, were able to provide the data needed to estimate the emissions for the building as a whole. An emission factor for steam (59.67 kg $CO_2$-equivalent per 1000 lbs of steam) was provided by Central District Heating. The emission factor for electricity (23 tonnes $CO_2$-equivalent per GWh) is from BC Hydro.[5] (23 tonnes $CO_2$-equivalent per GWh equals 0.023 kg $CO_2$-equivalent per kWh.) The Vancouver office's share of the building's energy consumption was allocated on the basis of square footage, with an adjustment for the higher energy consumption profile of the ground floor tenant. Multiplying the emission factor by the estimated consumption gives the $CO_2$-equivalent emissions. Note that factors were only available for $CO_2$-equivalent emissions, not for individual greenhouse gases.

| ***Emission Factors for BC Energy Consumption*** | |
|---|---|
| Steam (kg $CO_2$-equivalent / 1000 lbs) | 59.67 |
| Electricity (kg $CO_2$-equivalent / GWh) | 0.023 |

For the Toronto office, the landlord was able to provide the natural gas consumption data for the building as a whole. Beginning in mid-2009, metered electrical consumption was available for one floor. This was used as a proxy for 2007 consumption.

The emissions attributable to the use of electrical energy were calculated using emission factors derived from Ontario Power Generation's *Sustainable Development Report 2007*.[6]

5 *F2009 BC Hydro/GRI Comparative Index.* Retrieved from http://www.bchydro.com/about/company_information/reports/gri_index/f2009_environmental_EN16_2.html

6 *Sustainable Development Report, 2007.* Appendix B, p. 44. Retrieved from http://www.opg.com/pdf/Sustainable%20Development%20Reports/Sustainable%20Development%20Report%202007.pdf

| Emission Factor for Ontario Electricity | | |
|---|---|---|
| | $CO_2$ | NOx |
| Emissions (tonnes / GWh) | 270 | 0.34 |
| 100-year GWP | 1 | 296 |
| $CO_2$-equivalent units | 270 | 100.64 |
| Total $CO_2$-equivalent emission factor (tonnes / GWh) | 370.64 | |
| Total $CO_2$-equivalent emission factor (kg / kWh) | 0.371 | |

Multiplying the emission factor by the estimated kWh gives the $CO_2$-equivalent emissions.

For natural gas emissions, the factor for Residential, Commercial, Agriculture from Table A13-1: Emission Factors for Natural Gas and NGLs from Annex 13: Emission Factors of the *National Inventory Report, 1990-2004 - Greenhouse Gas Sources and Sinks in Canada* was multiplied by the estimated cubic metres of natural gas.[7]

| Emission Factor for Natural Gas | | | |
|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ |
| Emissions (g / $m^3$) | 1891 | 0.037 | 0.035 |
| 100-year GWP | 1 | 23 | 296 |
| $CO_2$-equivalent units | 1891 | 0.85 | 10.36 |
| Total $CO_2$-equivalent emission factor (g / $m^3$) | 1902.21 | | |
| Total $CO_2$-equivalent emission factor (kg / $m^3$) | 1.90221 | | |

The estimate of total energy indirect emissions for Vancouver and Toronto is 93.3 tonnes $CO_2$-equivalent.

*d) Verification of accuracy of results*

Sample calculation:

Area x Consumption per unit area x Emission factor = Total emissions

100 $m^2$ x 156 kWh / $m^2$ x 0.023 kg $CO_2e$ / kWh = 359 kg $CO_2$-equivalent

2. Estimation of Uncertainty

The estimates for Vancouver are not direct measures of energy consumption. A number of assumptions are made to estimate the organization's share of overall building energy consumption. These methods are not able to provide precise measurements of energy consumption. The organization's energy consumption might be significantly different from that of other tenants. However, there is no reason to believe this is the case.

7 *National Inventory Report, 1990-2004 - Greenhouse Gas Sources and Sinks in Canada*. Retrieved from http://www.ec.gc.ca/pdb/GHG/inventory_report/2004_report/ann13_e.cfm.

At the Toronto location, electricity meters were installed on each floor in mid-2009. The significant retail component in the Toronto building complex made it difficult to construct reasonable estimates of SWI's energy consumption from the aggregate electrical energy consumption data. Therefore, the available metered data from 2009 was used to estimate consumption in 2007. As an entire year's worth of data is not available, seasonal variation may be a source of error in the estimate. Overall, these estimates are reasonably certain.

For natural gas consumption at the Toronto location, aggregate data were used. These were the best data available. The emissions due to natural gas consumption are a small percentage of overall emissions, so any error is unlikely to have a substantial effect on the estimate of total emissions.

Overall, most of the estimates are based on direct measures of energy consumption and therefore there is little uncertainty about the quality of the estimates. Also, the results are comparable to estimates made by other organizations for similar locations.

## BUSINESS TRAVEL

1. Methodology

*a) Activity Data*

Accounting records were used to identify flights taken since February, 2007. From these records, the following information was extracted for each flight leg:

1. Passenger name
2. Departure City
3. Arrival City
4. Date of Travel

To determine the flight distance, the departure and arrival cities were entered at the World Airport Codes website. (http://www.world-airport-codes.com/) The distance in kilometres was recorded. The reasonableness of the distances was checked by comparing to known distances and by comparing the distances of similar pairs of departure and arrival cities.[8]

*b) Aggregation of flights and estimate of total kilometres flown:*

Each flight was categorized as short, medium or long, using the guidelines from *The Greenhouse Gas Protocol Initiative*, World Resources Institute (WRI)[9].

*c) Calculation of total $CO_2$-equivalent emissions from employee business flights:*

8 Aircraft typically fly a greater distance than the great circle distance used by World Airport Codes. This means that emissions will be somewhat underestimated.

9 http://www.ghgprotocol.org/calculation-tools/all-tools. *For Air, Rail, Bus and Car Travel, Business Travel, Service Sector, Version 2.0*, GHG Protocol Initiative, August 2005. Retrieved November 11, 2008.

| *Emission factors used for air travel*[10] | | |
|---|---|---|
| Category | Flight distance | Emissions (kg $CO_2$) / km |
| Short | < 452 km | 0.180 |
| Medium | 452 to 1,600 km | 0.126 |
| Long | > 1,600 km | 0.110 |

*d) Computation of the amount of each specific gas type emitted:*

The data above give total $CO_2$ emissions. By assuming jet fuel is used on all flights, and using the data on the emissions of each greenhouse gas from jet fuel, the emission of each gas can be determined. (This will overestimate emissions, as aviation gasoline has lower emissions of GHG than jet fuel.)

| *Emission Factor for Jet Aircraft Fuel and GHG Global Warming Potential*[11] | | | |
|---|---|---|---|
| Greenhouse Gas | Jet Aircraft Emission Factor (g/L fuel) | Global Warming Potential (GWP) | $CO_2$-equivalent emissions (g/L fuel) |
| $CO_2$ | 2550.00 | 1 | 2550 |
| $CH_4$ | 0.08 | 21 | 1.68 |
| $N_2O$ | 0.25 | 310 | 77.5 |
| | | Total | 2629.18 |

The $CO_2$-equivalent emissions are 3.11% higher than the $CO_2$ emissions alone. Therefore the overall total emissions from air travel were increased by 3.11%.

The estimated total emissions from business air travel is 54.9 tonnes $CO_2$-equivalent emissions.

e) Verification of accuracy of results

Results for one flight were checked using two websites:
http://www.aircanada.com/en/travelinfo/traveller/zfp.html and https://www.less.ca/
The air distance from Toronto to Frankfurt is 6348.6 km according to "less.ca" which is 10.6 km more than the 6338 km estimate from World Airport Codes.

The estimated emissions are 0.7 tonnes (700 kg) from Air Canada's site, and 862.8 kg from "less.ca". This compares with 697.8 kg following the GHG Protocol Initiative's calculation tool. (6338 x 0.11). After adding 3.11%, the result is 719 kg. The GHG Protocol estimates are based on data from DEFRA, the UK Department of Environment, Food, and Rural Affairs.

10 Ibid.

11 Taken from *Emission Factors for Energy Mobile Combustion Sources, Canadian National Inventory Report*, published April 2006, Table A13-5, p. 435. Global Warming Potentials from ISO 14064-1 standard, Annex C.

As a further check on these figures, data on fuel consumption per passenger kilometre from the U.S. Bureau of Transportation Statistics were used to estimate greenhouse gas emissions per passenger kilometre for U.S. carriers.

| ***U.S. Bureau of Transportation Statistics Data***[12] | |
|---|---|
| **Passenger-kilometres (millions)** | |
| Domestic operations | 952,465 |
| International operations | 354,277 |
| **Fuel consumed (million litres)** | |
| Domestic operations | 50,944 |
| International operations | 22,059 |
| | |
| **Calculated values** | |
| Passenger-kilometres per litre | |
| Domestic operations | 19 |
| International operations | 16 |
| GHG emissions per litre of kerosene | 2.629 |
| GHG emissions per km (domestic) (kg $CO_2$-equivalent) | 0.141 |
| GHG emissions per km (international) (kg $CO_2$-equivalent) | 0.164 |

For a 6338 km flight, the emissions based on the U.S. Bureau of Transportation data is:

6338 km x 0.164 kg/km = 1039 kg

2) Estimation of Uncertainty

The level of uncertainty linked to the estimate of activity levels is low. The accounting system records transportation expense data, and individual flights are sufficiently expensive that it is easy to identify individual transactions that might contain flight costs. This ensures that it is very unlikely any flights were not counted.

There is greater uncertainty attached to the emissions factors. The US data result in an estimate that is 45% higher than the GHG Protocol Initiative estimate. It is beyond the scope of this report to examine the reasons for these differences.

## *GHG INVENTORY DATA QUALITY MANAGEMENT*

All data files concerning the completion of this GHG Inventory have been saved and filed in a secure location at SWI's Toronto office. Documentation has been developed to provide guidance for the completion of future inventories. The documentation includes specific and detailed information about data collection, computation, and reporting for the inventory.

12 United States Bureau of Transportation Statistics, *National Transportation Statistics*, Internet edition. Table 4-21M - Energy Intensity of Certificated Air Carriers, All Services (Updated July 2007). Retrieved from http://www.bts.gov/publications/national_transportation_statistics/html/table_04_21_m.html, December 15, 2008.

Future reports will investigate any improvements in data availability and data quality that may be possible. Some measures have been taken to make the data-gathering part of routine business processes.

## *EMISSIONS SUMMARY*

**Emissions by Source**

| | *Emissions (tonnes)* | | | |
|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $NO_x$ | Total $CO_2e$ |
| Air Travel | 53.3 | 0.0017 | 0.0052 | 54.9 |
| Rail Travel | n/a | n/a | n/a | 0.3 |
| Automobile Travel | 45.6 | 0.0023 | 0.0031 | 46.3 |
| Building - Electricity | n/a | n/a | n/a | 58.1 |
| Building - Other | n/a | n/a | n/a | 14.6 |
| Total | 98.9 | 0.0040 | 0.0083 | 174.3 |

**Emissions by Gas**

| Gas | $CO_2$ | $CH_4$ | $NO_x$ | $CO_2e^*$ |
|---|---|---|---|---|
| Tonnes | 98.9 | 0.0040 | 0.0083 | 73.1 |

| **Emissions by Class** | $CO_2$ | $CH_4$ | $NO_x$ | $CO_2e^*$ |
|---|---|---|---|---|
| Direct | 13.0 | 0.0007 | 0.0009 | |
| Energy indirect | n/a | n/a | n/a | 72.7 |
| Other indirect | n/a | n/a | n/a | 55.3 |

**Where a breakdown by individual gas was not available the $CO_2$-equivalent figure is shown.*

## *GHG ASSERTIONS*

1. Systemware Innovation Corporation's GHG Inventory for fiscal year 2007-08 report was prepared in conformance with the CSA/ISO 14064-1 standard entitled *Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals*.

2. Emissions from SWI's GHG inventory covering all buildings, employee business travel, and emissions from company vehicles for the fiscal year 2007-08 were 174.3 tonnes $CO_2e$.

## *REFERENCES*


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