UBC CENTRE FOR SPORT & SUSTAINABILITY

UBC Athletics & Recreation Sustainability Project

Measuring the Climate Change Impacts of a UBC Thunderbirds Men's Basketball Game

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DATE: July 6, 2011

Executive Summary

As part of its commitment towards engaging in sustainability best practices, UBC Athletics & Recreation commissioned the UBC Centre for Sport and Sustainability to carry out a pilot study of the climate change impacts of a varsity 'Thunderbirds' basketball event. The UBC Life Cycle Assessment Alliance, a cross-faculty collaboration of UBC grad students applying LCA in a variety of fields, measured impacts for the most significant event organizational sectors: travel, accommodation, food, materials and waste, venue operation and infrastructure. A key aim of this study was to apply rigorous evaluation methods in a resource-efficient manner that estimated major impacts by using easily obtainable activity data.

A hybrid LCA method combining both input-output and unit process data was applied to measure climate change potential. The unit of analysis was all services that went into providing an entertainment experience for participants over the four-hour period of the event (food, warmth, transport, safety, etc.).

The results showed a total of approximately 5 tonnes of carbon dioxide equivalents from the five event sectors under study. The major impact came from travel (73%), followed by food & beverage (12%), accommodation (11%), venue operation and infrastructure (3%), and materials & waste (1%). A sensitivity analysis showed that the travel impacts of this event were actually significantly lower than an average UBC basketball event since the visiting team came by bus whereas most events require travel by air. This report includes recommendations for GHG mitigation opportunities for future editions of this event. It also recommends that a robust baseline for all UBC A&R events be developed to set specific targets and measure performance. A more comprehensive sustainability management system that addresses other environmental, social and economic issues is also recommended.

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Abbreviations

A&R - UBC Athletics & Recreation Department

CCP – Climate Change Potential

CO2 - Carbon Dioxide

CO2e - Carbon Dioxide Equivalents

CSS - UBC Centre for Sport & Sustainability

EF - Emission Factor

EIO LCA - Economic Input-Output LCA

EPA – (U.S.) Environmental Protection Agency

GHG – Greenhouse Gas

IPCC - Intergovernmental Panel on Climate Change

ISO - International Standards Organization

LCA - Life Cycle Assessment

UBC - University of British Columbia

1 - INTRODUCTION

1.1 Background

UBC Athletics & Recreation (A&R) is looking for ways to mitigate the environmental impacts of their activities in line with UBC's overall mission of sustainability. A&R is composed of approximately 100 employees and operates 7 venues on campus. They manage the activities of the UBC varsity teams inclusive of on-campus varsity events. A UBC Thunderbirds Men's Basketball game was selected as the subject of a pilot life cycle assessment (LCA) study as it is one of the largest recurring athletics events held by A&R on campus, with 500 - 1,000 spectators attending each game. A&R's intent in mandating and participating in this LCA pilot study is to find ways to reduce their environmental footprint and contribute to the development of a benchmark to be used as a relative measure for future events. A&R aims to use the results of this study to exemplify a model Athletics and Recreation Department engaging in environmental responsibility by implementing activities that would positively influence the behaviour of spectators, athletes, staff, and sponsors.

1.2 Aim

To complete an LCA pilot study on key areas of a UBC A&R basketball event to quantify impacts relative to their climate change potential - also known as a carbon footprint or global warming potential - in order to develop future initiatives to manage and reduce these impacts.

1.3 Objectives

1. To calculate the climate change potential of 5 key sectors (travel, accommodation, food, materials / waste, and venues) frequently considered to be major environmental impacts of sports events.
2. To develop a baseline inventory of environmental impact data in these sectors using LCA methods from ISO standards.
3. To recommend environmental impact reduction strategies for future events and A&R activities.
4. To communicate results that can be transparently and effectively used for decision making by key stakeholders in the event planning processes at UBC.

1.4 Event

The event under investigation is the UBC Thunderbird Men's Basketball Game that took place on Saturday, February 12th, 2011. The event was located in the UBC War Memorial Gym. Approximately 665 people were in attendance, including: 560 spectators, a home and a visiting team of 25 members each, and 55 staff. The visiting team came from Thompson Rivers University in Kamloops, BC.

1.5 Life Cycle Assessment

Life cycle assessment methods were applied to develop quantified estimates of the impacts caused by the game. LCA is gaining broad acceptance as a transparent and robust method for developing complete and valid claims regarding the environmental performance of products and services. LCA is also increasingly being integrated into a growing list of applications including strategic business management, product and process design, environmental labeling, and product declarations.

LCA sets out a method for measuring impacts of products and services across all stages of their life cycle from 'cradle to grave', including resource extraction > processing > distribution > use > disposal (see Figure 1 next page). In order to carry out a peer reviewed LCA as set out by ISO 14044 and ISO 14040, four key steps are applied (ISO, 2006): 1) Goal and Scope Definition, 2) Inventory Analysis, 3) Impact Assessment, 4) Interpretation.

We took a hybrid LCA approach to analyze data, using both unit process and environmental input-output data. Impact categories are used to characterize the respective potential environmental damages including climate change potential, ozone layer depletion, acidification, smog formation, eco-toxicity, land use, water use, eutrophication, and human toxicity potential among others.

Climate change potential (CCP) over a 100-year horizon, measured in greenhouse gas (GHG) emissions, was selected to describe the impacts of this event for the following reasons:

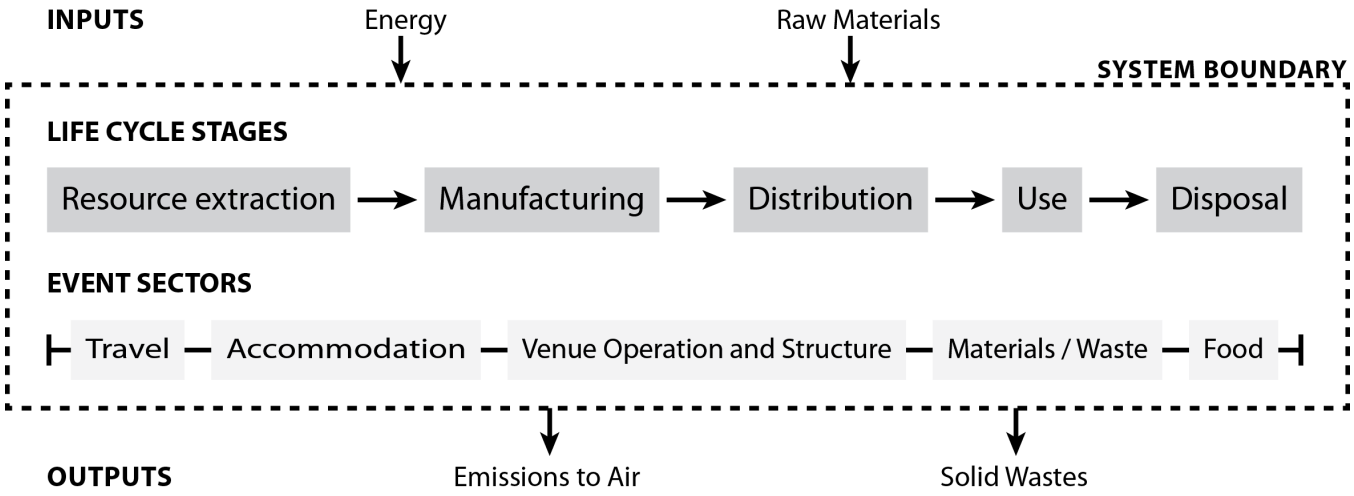
- UBC campus primarily uses GHG emissions to measure environmental performance and set targets. Of note the UBC campus aims to reduce GHGs: to 33 per cent below 2007 levels by 2015, to 67 per cent below 2007 levels by 2020, and to 100 per cent below 2007 levels by 2050[1].
- Widely available data and emission factors exist for CCP. Therefore this was the most effective impact assessment category to apply given limited time and resources.
- Simplicity of communication, people have a growing awareness of carbon footprints, which are synonymous with climate change potential.
- GHG emissions create global impacts and therefore can include off-site impacts such as long distance travel. Water or biodiversity impacts for example have more local specificity.

As this study describes only the potential damages caused to climate change and not other impacts such as water use or land use, it is unable to provide insight into the potential tradeoffs that can be created between impact categories through decision-making.

1.6 Approach

In coordination with A&R, the project team divided the UBC Thunderbirds men's basketball game into 5 main event organizational sectors and developed life cycle data collection strategies for each: travel, food, accommodation, materials/waste, and venue operation and structure (Figure 1).

FIGURE 1: SYSTEM BOUNDARY OF LIFE CYCLE STAGES APPLIED TO EVENT ORGANIZATIONAL SECTORS



Activity data was collected first-hand where possible and estimated where it was either not available or too resource intensive to gather. Activity data was translated into CCP impacts using emission factors from a combination of unit processes and input-output data sources.

Section 3 provides the results for each event category with detailed methodology and data sources provided in Appendix 1.

[1] Source: UBC Climate Action Plan. 2010. http://www.sustain.ubc.ca/climate-action

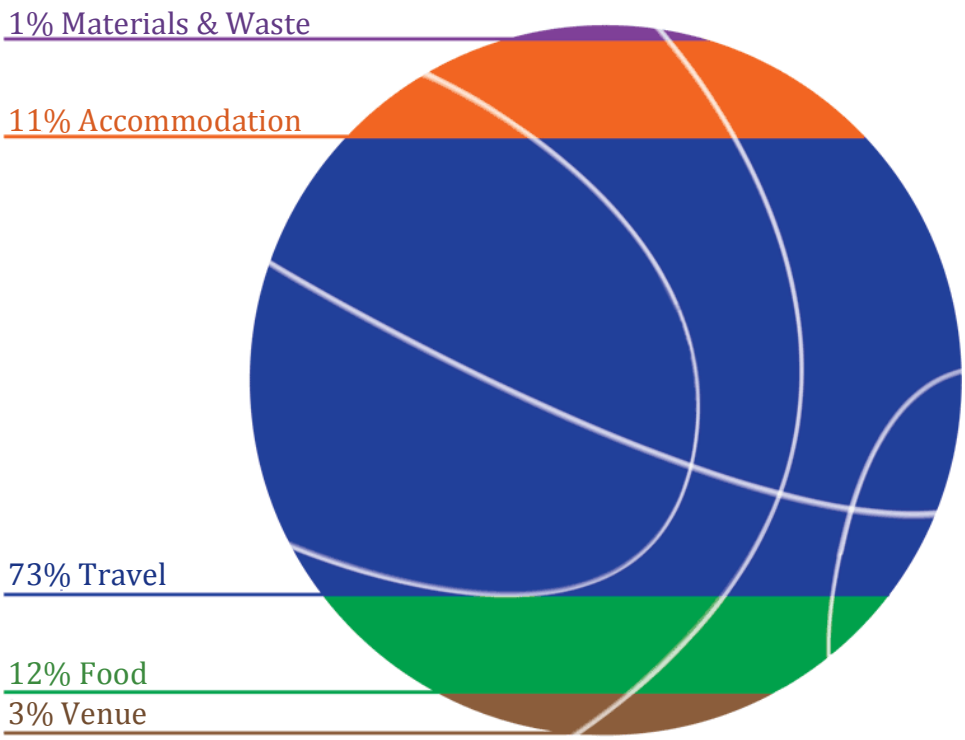
The category indicator for climate change potential is kilograms of carbon dioxide equivalents per unit (kg CO2e / unit). The general formulas used to convert activity data into GHG emissions were:

- Materials: GHG emissions = Data (kg) * EF (kg CO2e / kg)
- Waste: GHG emissions = Waste audit value (kg) * % categories (wt%) * EF (kg CO2e / kg)
- Travel by car: GHG emissions per **vehicle** km = {Travel distance (km) * Fuel efficiency (l/km) * EF (kg CO2e/l)} / Occupancy (# passengers)
- Travel by bus: GHG emissions per **passenger** km = Travel distance (psg-km) * EF (kg CO2e/psg-km)
- Food: GHG emissions = EF (kg CO2e / 2002 US $) * exchange rate (US $ to CAN $) * inflation rate ($) * Sales (2011 CAN $)
- Venue energy: GHG emissions = Allocated electricity usage (MW.hr) * EF (kg CO2e / MW.hr) & GHG emissions = Allocated steam usage (lbs) * EF (kg CO2e / lbs)
- Venue water: GHG emissions = Allocated water usage (m3) * EF (kg CO2e / m3)
- Venue wastewater: GHG emissions = Allocated wastewater emissions (m3) * EF (kg CO2e / m3)

2 - RESULTS

The results of this pilot LCA study on a UBC Thunderbirds men's basketball event showed total CCP of 5 tonnes CO2e). Table 1 shows a breakdown of the total event impacts by percentage (by vertical distance). Clearly travel, at 73%, as well as accommodation (11%) and food (12%), are the major impacts of the event. The venue operation, and materials and waste sectors are relatively minor in terms of this event.

TABLE 1: GHG EMISSIONS BY EVENT ORGANIZATION SECTOR OF THE BASKETBALL EVENT



Impacts have been further broken down by participant type, as seen in Table 2. Of the 665 total participants, 560 were spectators, 55 were staff (including volunteers), and 50 were team members. The teams were further broken down into 'home' and 'visiting' since travel impacts significantly different.

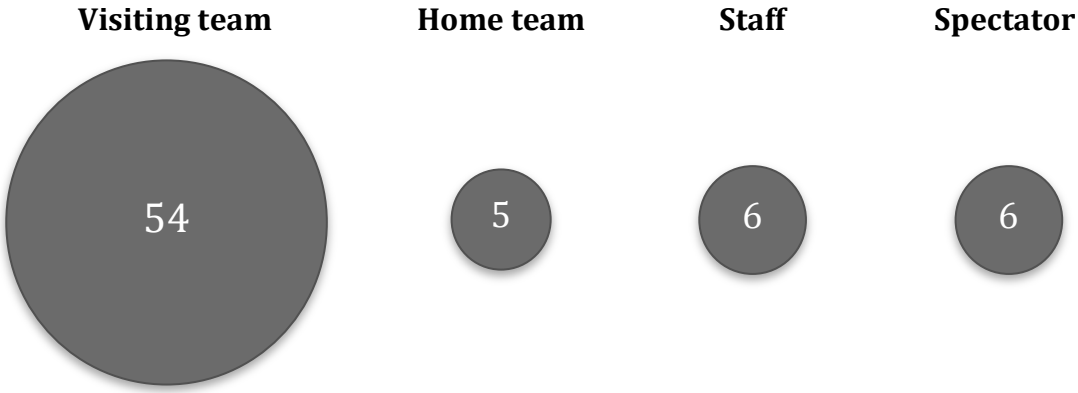
TABLE 2: TOTAL GHG EMISSIONS (KG CO2E) BY EVENT SECTOR AND PARTICIPANT TYPE

	Spectators	Staff	Home team	Visiting team	Total by sector
Travel	2,600	310	120	760	3,780 (73%)
Accommodation	0	0	0	580	580 (11%)
Food	590	1	0	0	590 (12%)
Venue	130	10	6	6	150 (3%)
Materials/Waste	55	-2	-1	-1	50 (1%)
Total by participant type	**3,380**	**320**	**110**	**1,340**	**5,150**

**Note: Figures rounded to nearest significant figure (sums may show rounding errors)*

Table 3 shows the impacts per person for each type of participant. Although the visiting team was made up of only 25 individuals, their impacts were much larger (54 kg CO2e per person) than other participant types due to their long distance travel and accommodation impacts. The impacts of the staff, spectators and home team were essentially the same since they followed similar travel and consumption patterns.

TABLE 3: CCP PER PERSON BY PARTICIPANT TYPE



The WBCSD/WRI Greenhouse Gas Protocol Corporate Accounting and Reporting Standard defines three scopes of responsibility. Scope 1 covers direct or owned GHG emissions (e.g. fuel used by company vehicles), scope 2 emissions are from purchased electricity, and Scope 3 includes all other indirect emissions from sources not owned or controlled by the entity (e.g. spectator travel). As shown in Figure 2, no impacts fell under scope 1. Purchased energy for venue operation came under scope 2 and accounted for 3% of total event impacts. The remaining impacts fell under scope 3 and made up 97% of the total. Many organizations only report on scopes 1 and 2. This study included scope 3 to represent all impacts considered to be significantly caused or influenced by this event. It was considered important to take an inclusive approach to associated impacts in order to develop a comprehensive sustainability strategy.

FIGURE 2: % EVENT GHG EMISSIONS BY SCOPE

2.1 Travel

Travel included all GHG emissions caused by participants travelling to and from the game venue at UBC (War Memorial Gym). This travel data was collected from participants through an onsite survey conducted during the game. A breakdown of the methods, calculations and assumptions are available in Appendix I.

Travel was by far the major source of impacts for the event, accounting for approximately ⅔ of the total. The primary contributors were cars and buses since walking and cycling were considered to be zero impact and no one travelled by motorbike or plane. Table 4 shows the break down of travel impacts by distance and GHG emissions of the event.

TABLE 4: TRAVEL DISTANCES AND CCP IMPACTS BY TRAVEL MODE

Mode	Total distance (km)	Total CCP (kg CO2e)
Walking	110	0
Cycling	1	0
Car	9,400	2,600
Motorbike	0	0
Bus - city	2,900	420
Bus - intercity	10,000	760
Plane	0	0
Total	**22,400**	**3,780**

**Note: Figures rounded to nearest significant figure (sums may show rounding errors)*

The bus impact is relatively high because the visiting team drove 400 kilometers from Kamloops to Vancouver. It should be noted however that this pilot study does not capture the fact that most UBC Thunderbirds games would involve at least one team flying in. In order to better represent the average travel impact of this event, CCP was calculated for the whole regular season schedule and divided by the number of games requiring travel. There were approximately 34 games across Canada and the USA. Table 5 shows that the average travel distance and CCP impact are approximately 7 times higher than this event.

TABLE 5: COMPARISON OF TRAVELING TEAM DISTANCES AND IMPACTS OF FEB 11 EVENT WITH AN AVERAGE UBC THUNDERBIRDS EVENT

	Total distance (km)	Total CCP (kg CO2e)
Feb 11 Event	400	770
Average Event	1,950	5,600[2]

**Note: Figures rounded to nearest significant figure*

Furthermore, a significant number of spectators (89%) that travelled by car were in high occupancy vehicles (HOVs) as opposed to single occupancy vehicles (SOVs) (Table 6). This is well above the UBC commuting average of 35% HOV and is likely explained by the fact that people tend to go to events with friends or family. It is also interesting that only one person reported cycling to the event, although it should be noted that this game took place on a rainy and cold February evening.

TABLE 6: SPECTATOR TRAVEL MODES BY PERCENTAGE AND AVERAGE DISTANCE (ROUND TRIP)

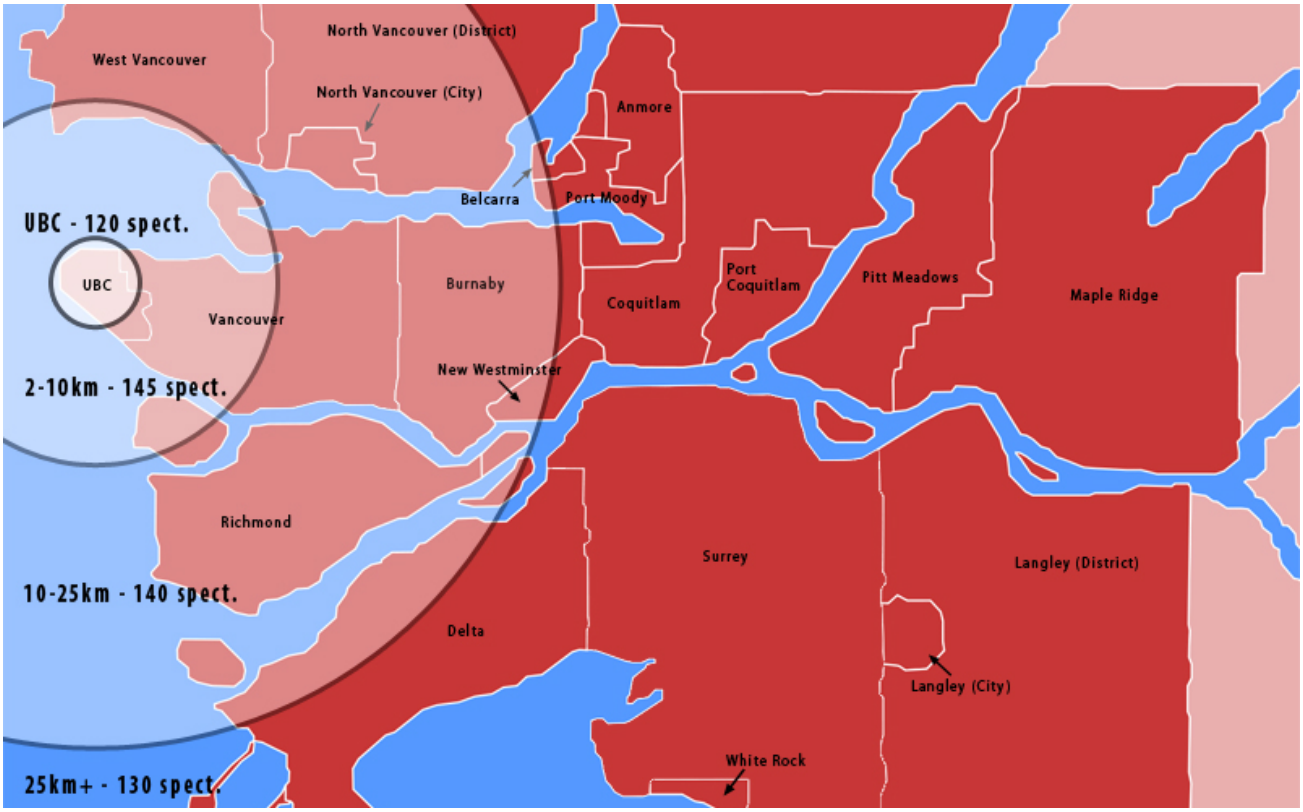
Mode	Spectators (#)	%	Average travel distance
Walking	86	15%	1 km
Cycling	1	<0%	1 km
Car – SOV[a]	42	7%	85 km
Car - HOV[a]	340	61%	54 km
Motorbike	0	0%	0 km
City bus	91	16%	24 km
Plane	0	0%	0 km
Total	**560**	**100%**	

a. SOV (single occupancy vehicle) = 1 person, HOV (high occupancy vehicle) = 2 or more people

[2] Flight GHG emissions estimations derived using http://www.myclimate.org flight calculator.

Table 6 also shows that spectators attended the game by bus and car from across the GVRD (Greater Vancouver Regional District). This is highlighted in Figure 3 by the even distribution of spectators travelling from zones of 0-1 km (UBC), 10 km, 25 km, and 25-100 km. Somewhat surprisingly, only one fifth of spectators came from UBC even though there are approximately 16,500 residents, 47,00 students, and 40,000 staff.

FIGURE 3: SPECTATOR TRAVEL DISTANCES ACROSS THE GREATER VANCOUVER REGIONAL DISTRICT



RECOMMENDATIONS

1. Promote a 'bike to the event' initiative. Only one person travelled by bike so there is significant room for improvement. Perhaps the home team athletes could all lead by example on this.
2. Promote the use of public transportation. An example would be a free bus ticket with each game ticket. This strategy is widely used in European events.
3. More local UBC participants should be encouraged to come. Approximately 20% of spectators polled came from UBC campus. More local spectators would promote more people walking and biking to the event and would at the same time engage more students and UBC community members in the events.
4. Although none of the teams flew into this particular event, flight impacts could be optimized for the season through strategies such as:
    - cluster events to limit the number of trips by plane required
    - encourage the regionalization of events to promote competition with local cities
    - prioritize direct rather than indirect flights
    - travel by bus rather than plane for shorter distances
    - fly second class instead of first class where possible

2.2 Accommodation

Accommodation impacts were measured for the 25 visiting team members of the UBC men's basketball event who traveled from Kamloops, BC to participate. Impacts took into account both energy impacts of accommodation at the hotel and travel to the venue by city bus. The visiting team stayed for 2 nights (50 person nights total) to play 2 games however only 1 night per person was allocated since only one game is being measured. The travel impacts accounted for the 25 km return trip between the Coast Plaza Hotel and UBC War Memorial Gym for the 25 team members on a city bus.

TABLE 7: ACCOMMODATION CCP IMPACTS OF THE VISITING TEAM

Impact Areas	Total CCP impact (kg CO2e)
Hotel Accommodation	490
Travel from hotel to venue	90
Total	**580**

**Note: Figures rounded to nearest significant figure (sums may show rounding errors)*

RECOMMENDATIONS

1. Reduce the travel distance between the hotel and the venue. Note that 19% of the accommodation impact was due to travel.
2. Ensure that hotels with eco-certification programs are prioritized to host visiting teams and when travelling to other cities. Note that Coast Plaza Hotel in Vancouver is already eco-certified by GreenKey.
3. Encourage the use of walking, bikes, buses or public transit for transportation from hotel to venue.

2.3 Food

Food and beverage impacts were estimated for all items sold at the game to spectators. Food and non-alcoholic beverages were sold by a snack bar contracted to a catering company. Alcoholic beverages (primarily beer) were sold at two A&R managed beer gardens. The food sold by on-site vending machines was not included.

In order to estimate the food and beverage GHG emissions, the US National Purchaser 2002 economic input-output database was used based on the total dollar amount of items sold. It was not considered feasible to perform a full LCA on individual food items since there was not a large volume of goods sold and data of the supply chain are difficult to obtain. Impacts include estimations for food and food packaging resource extraction, manufacture, and distribution. The energy impacts relevant to the use phase (or preparation) of the food were allocated to venue energy. Waste processing impacts for food items have been allocated to the general waste category. Appendix III shows the calculations used to determine the food GHG emissions.

ITEMS SOLD

- Cold drinks: soft drinks, bottled water, juice, beer
- Hot drinks: coffee, tea, hot chocolate
- Snacks: nachos & cheese, popcorn, pretzels, churros, chocolate bars, candy, peanuts
- Ice cream & popsicles
- Pizza

TABLE 8: FOOD & BEVERAGE CCP IMPACTS

Impact Areas	Total sales	Total CCP impact (kg CO2e)
Food & beverage	$2,300	590

**Note: Figures rounded to nearest significant figure.*

RECOMMENDATIONS

Approaches to reducing the CCP impact of food and beverage activities are difficult to generalize since aspects such as travel mode, travel distance, pesticide use, water use, change of seasons, etc. vary significantly and can show contrary results. However we recommend the following general approaches:

1. Purchase seasonal and local as well as organic where possible. Avoid products that are air-transported. [3]
2. Reduce food waste impacts by limiting food packaging (e.g. bottled water) and composting organic waste.
3. The majority of options were processed and high fat/sugar foods. Going beyond global warming impacts, there would also be an opportunity to use the event to provide healthy and fresh food to tie in with the positive health associations of sport.

2.4 Materials and Waste

All materials used and waste[4] created at the event were measured (see Table 9). Materials included all merchandise and paper products used at the event. Food packaging was not measured in this category as they were accounted for in the food section. Permanent communication materials such as Thunderbird banners were not included as their impact was distributed across a significant number of events, making their impacts in a single event insignificantly small. The total CCP impacts from materials were 75 kg CO2e (**Error! Reference source not found.**). Only a small amount of paper and merchandise were used/sold and therefore this is an extremely small impact in comparison with other event sectors.

TABLE 9: TOTAL MATERIALS CCP IMPACTS

Categories	Value	CCP Impacts (kg CO2e)
Event programs (paper)	5 kg	15
Merchandise (T-shirts, caps & jackets)	$75	23
Give-aways (e.g. mini-basketballs)	$100	36
Total		**75**

A waste audit was also carried out on-site for the event. All recycling and trash bins were emptied by staff prior to the game. After the game, staff and volunteers collected the contents of the garbage and recycling bins in the stadium. Contents were weighed using a "bathroom" mechanical scale to obtain two categories of data: trash and recycling weights (

Table 10). 4 bags were sampled, corresponding to 20% of the total trash weight, and sorted 4 waste types: recyclable plastic & metals, recyclable paper, compostable and non-recyclable/non-compostable (trash).

[3] Jungbluth, N., Tietje, O., & Scholz, R. W. (2000). Food purchases: Impacts from the consumers' point of view investigated with a modular LCA. *The International Journal of Life Cycle Assessment*, 5(3), 134-142.

[4] Definitions: Waste **-** solid materials that the holder discards, including materials to landfill, incinerator and recycling center. Trash **-** waste going to landfill or incinerator. Recycling **-** waste going to a recycling center. Materials - communication and marketing materials distributed and merchandise sold during the game.

The total waste produced by the event was 44 kg with a diversion rate of 16% to recycling. Total CCP impacts for waste processing were -22 kg CO2e. Negatives emissions come from the fact that by recycling, emissions can be avoided by reducing the extraction of additional natural resources.

TABLE 10: WASTE AUDIT RESULTS

Categories	Mass (kg)	CCP Impacts (kg CO2e)	Notes
Trash	37	4	
Recycling	7	-26	
Total waste	**44**	**-22**	
Diversion rate (wt%)	**16 wt%**		**Recycling / total waste**

**Note: Figures rounded to nearest significant figure (sums may show rounding errors)*

RECOMMENDATIONS

Although waste had a comparatively small environmental impact relative to the other event sectors. It is however an aspect that is highly visible. An action plan that does not directly address waste reduction will likely not be seen as credible by the public. The diversion rate of 16% of waste to recycling during the event was much lower than the UBC[5] (44%) and Metro Vancouver[6] (55%) averages. From our waste audit (see Table 17 in Appendix IV), 79% of the waste could be recycled. Here are some suggestions to reduce the impacts of waste:

1. Establish a composting program that is championed by the food caterer.
2. Create waste stations. Trash bins should always be paired with recycling and composting bins.
3. Provide cleanup crew training about what is recyclable and what is compostable at UBC and provide them with equipment to separate the waste.
4. To reduce the volume of waste, implement a discount or deposit system to collect/reuse cups for drinks. Many UBC food outlets give discounts to customers who bring their own coffee mug for instance. In Europe, the cup deposit system is widely used for events.
5. Use kegs and reusable cups instead of cans for beer in order to reduce waste.

Typically, waste action plans focus on addressing waste treatment of products and materials since they are most visible; more significant are the embodied impacts from resource extraction, production, distribution, and use (e.g. electricity requirements) phases. Purchase decisions of less and low-life cycle impact materials are therefore the best way to reduce impacts.

Although communication materials and merchandise had a small impact for this event, they could be significant in larger sporting events with broader marketing and communication strategies. Here are some suggestions:

1. Print material should make use of lower impact materials such as those that are 100% recycled and FSC certified.
2. Avoid paper by using electronic technological solutions. E.g. Give electronic program with smart phone code bars on the ticket.
3. Weigh the benefit of giving away promotional items. Reducing is always better. Choose low impact gift and promotional materials when necessary.

2.5 Venue Operation and Structure

The UBC men's basketball game took place at the War Memorial gymnasium venue. In order to capture the CCP impacts associated with this venue, three main areas were considered. These included accounting for

[5] UBC Waste Action Plan - Discussion Paper 2011.
[6] Metro Vancouver Recycling and Solid Waste Management 2008 Report.

impacts associated with energy usage, water usage and the construction of the building itself. Table 11 shows the final results.

Sensitivity to the most influential assumptions was tested. The most sensitive assumption was the building utilization factor. If the factor is lowered to 1/2 from 2/3, then this results in a 21.2% decrease in total associated emissions. This shows that the model is susceptible to small changes in the percentage of the building used during the event. If less of the building is used during the event, then the total venue impacts are considerably smaller.

TABLE 11: TOTAL VENUE CCP IMPACT

Venue Operation Area	Total CCP impact (kg CO2e)	Total Impact %
Thermal heating	130	89.7%
Electricity	10	6.9%
Water delivery	0.7	0.5%
Water treatment	0.5	0.4%
Embodied in structure	3.7	2.5%
Total	**140**	**100%**

**Note: Figures rounded to nearest significant figure (sums may show rounding errors)*

IMPACTS FROM ENERGY USE

The assessment of energy use included all the electricity used by the building operating systems, including air handling, lighting systems, water heating and plug loads. We also included energy delivered by steam to provide thermal heating of the building during the game.

Calculations were averaged from 3 years worth of metered steam and electricity usage. We assumed the venue was used for 4 hours, and that 2/3 of its square footage was dedicated to hosting the game. This gave us respective results of CO_2 equivalent emissions resulting from electricity (10 $kgCO_2e$) and steam (130 $kgCO_2e$) usage per UBC men's basketball game.

IMPACTS FROM WATER DELIVERY AND TREATMENT

Water impact estimates took into account all hot and cold water coming into, and all wastewater leaving, the War Memorial building.

The same methodology used to calculate energy use CCP impacts was used to calculate water use (ie. impact of pumping to site) and waste water emission (ie. impacts of treatment at waste water treatment facility) impacts. We allocated 4 hours of building use for water and that 2/3 of the building's water usage was used during the game. This gave us respective results of CO_2 equivalent emissions resulting from water usage (0.7 $kgCO_2e$) and wastewater emitted (0.5 $kgCO_2e$) usage per UBC men's basketball game. These impacts are small enough to be negligible.

IMPACTS OF VENUE STRUCTURE

The CCP impacts of the venue structure took into account the resource extraction, manufacturing of construction materials and construction of the War Memorial building's structure and envelope, as well as related transportation. This scope of the life cycle is commonly referred to as cradle-to-gate. An estimate of this scope for the venue was derived from the average CCP impact of UBC academic buildings from the UBC-LCA database (24.4 kg CO2 e/ ft^2). This average impact was extrapolated using War Memorial's square footage (18,730 ft^2) and assumptions regarding the building life (50 years) and game length (4 hours). The resulting CCP impact of the War Memorial venue was subsequently estimated to be 3.7 kg CO_2e per UBC men's basketball game.

RECOMMENDATIONS:

Clearly, the energy impacts dominate the water and embodied impacts. Reducing venue impacts involves improving the general energy efficiency strategies employed by the building.

1. For winter events, the greatest gains can be made by reducing the maximum temperature set point.
2. For the remainder of the year, ensuring low plug loading and using efficient lighting systems will reduce carbon emissions.

3 - DISCUSSION & RECOMMENDATIONS

3.1 CCP Impact Reductions

The total climate change impacts of the UBC men's basketball event organizational sectors measured was estimated to be approximately 5 tonnes of carbon dioxide equivalents. To put this in context, the average Canadian emits 22 tonnes of GHGs per year. While 5 tonnes for one event may seem small, the GHG emissions of all UBC A&R sport events and activities could be significant. The men's basketball team travel impacts alone for the 34 games in a season are estimated to be 190 tonnes of kg CO2e. In this event, the majority of the CCP impacts came from travel at 72%, food and accommodation contributed 12% each, and venue operations and materials & waste were each minor contributors under 5%.

Opportunities exist to reduce the amount of energy and resources consumed in each of the sectors. In order to achieve net zero GHG impacts in the short term however, UBC A&R would need to 'offset' their unavoidable impacts by bringing about net GHG emission reductions elsewhere. This could be done by using its profile as an agent of change to encourage a wider adoption of sustainable behaviours locally and, if necessary, by purchasing voluntary carbon offsets. An example would be to use the profile of UBC athletes to encourage event participants to make a behaviour change. As a general strategy, we recommend that A&R put in place ongoing data collection strategies and applying LCA methods to track key aspects such as travel patterns and energy use. A summary of specific GHG reduction opportunities for each sector is provided below.

TRAVEL

Spectator and staff travel impacts could be reduced through initiatives to increase walking, biking, public transit, and car share modes of transport. For most basketball events, long distance team travel by air would be the largest single impact and strategies to reduce this could include increased clustering of events, traveling by bus for moderate distances, and adapting the league schedule to increase the number of local events.

ACCOMMODATION

Accommodation CCP impacts could most significantly reduced by using energy efficient hotels and reducing travel distances to the venue.

FOOD

We recommend reducing overall CCP impacts of food and beverages by promoting seasonal and local foods, low-meat diets, and organic produce where possible. A more detailed examination of individual food items impacts were outside the scope of this pilot study but this would certainly merit further investigation.

MATERIALS & WASTE

Materials and waste represented less than 1% of the total event CCP impacts and were not an important CCP impact contributor in this event. We recommend a two-fold strategy of continuing to reduce the amount of materials purchased and increasing the percentage of waste reused and recycled.

VENUE OPERATION AND STRUCTURE

The biggest impact reductions from the venue would come by reducing thermal heating needs of the building (90% of venue CCP impacts). A thorough review of this has already been done in the A&R Strategic Energy Management Plan (2010) undertaken by the Campus Sustainability Office.

3.2 Sustainability Management Plan

It should be reiterated that this study only considered climate change related environmental impacts and that a comprehensive sustainability strategy is needed to address a wider spectrum of environmental, social and economic issues such as health, accessibility, equity, and ethical practices. Addressing this spectrum more holistically would enable UBC A&R to be a leader among Canadian and North American athletics departments by showcasing a broad commitment to sustainability. Applying the latest research methods being developed at UBC to sports events would also be in line with the University Sustainability Initiative's two major themes: 'campus as a living laboratory' and 'the university as an agent of change'.

DEVELOP A GLOBAL WARMING IMPACT ASSESSMENT FRAMEWORK FOR ALL A&R ATHLETIC EVENTS USING LCA

Beyond implementing the specific recommendations listed for this basketball event, we suggest commissioning impact studies using LCA on a number of UBC varsity sports events to develop:

1. An estimate of impacts for each sport, venue, and event type.
2. A benchmark for A&R to measure the sustainability performance of its activities against.
3. An internal A&R impact assessment tool that can be used for decision-making.
4. A standardized Goal and Scope document to ensure a rigorous standard is maintained for all A&R LCA studies.

To elaborate on point 2, this study contributes to the development of a benchmark to be followed by future events, but it is not in itself a benchmark. However, the methods developed in this study could be applied to a number of events and used to develop event benchmarks.

CREATE A SUSTAINABILITY MANAGEMENT PLAN FOR A&R ACTIVITIES COMPLIANT WITH CSA Z2010

Launch a strategy for 'Sustainability at Athletics & Recreation' to follow a road map such as the one offered by the Canadian Standards Association (CSA) Z2010 Sustainable Management of Events standard. CSA Z2010 was published in 2010 as a part of a legacy of the Vancouver 2010 Olympics and supports public claims of contributions to sustainability by event organizers. Broadly, it asks event organizers to:

1. Make a public commitment to sustainability.
2. Define the scope of commitment and responsibilities.
3. Designate a sustainability team with the necessary authority to implement sustainability commitments.
4. Engage important partners (e.g. sponsors or the UBC Campus Sustainability Office).
5. Identify major sustainability issues with the planned event.
6. Set and track key objectives and performance measures.
7. Ensure compliance with applicable legal requirements.

CSA Z2010 also applies principles from the ISO 14001 Environmental Management System. A cornerstone of this system is its Plan-Do-Check-Act approach, which can be applied to events as follows:

1. **Plan**: Set clear sustainability objectives, strategies, and targets.
2. **Do**: Implement actions, assign responsibility, and record progress.
3. **Check**: Measure how well you did and share this with others.
4. **Act**: Incorporate learning into future plans.

Developing this plan should be an ongoing process that involves key individuals from within A&R and relevant experts and stakeholders. Initially the scope of this plan could focus on a few key areas that are resource efficient, effective, and with few barriers to implementation.

As part of its mission to provide educational opportunities with core research activities focused around sport and sustainability, the Centre for Sport and Sustainability would be pleased to continue to support Athletics & Recreation in its sustainability endeavors.

4 - APPENDIX

4.1 Background Information - Travel

METHODS

Travel activity data collected through an on-site survey. Of the estimated 665 people in attendance, 390 were polled: a sample size of 59%. Survey participants were asked the following:

1. Which mode of travel they used - walking, cycling, motorbike, car, public transport, or flight.
2. If they came by car, how many passengers there were. Car impacts were then divided by the number of passengers.
3. The first 3 digits of their postal code. Google maps was used to obtain approximate travel distances to the venue. This approach was generally accurate within 1-2 square kilometers. Requesting full postal codes was avoided to allow for home address confidentiality.
4. Whether their primary reason for travel to UBC was to watch the game. This question allowed us to subtract those that travelled to UBC for work and may not otherwise have stayed to watch the game. 93% said they travelled primarily to UBC to watch the game.

TABLE 12: TRAVEL IMPACTS FOR EACH MODE OF TRANSPORT IN GHG EMISSIONS

Mode	EF (kg CO2e / km person)	Notes
Walking	0	No GHG impacts allocated to walking
Cycling	0	No GHG impacts allocated to cycling
Car	0.2772	EF for an average car derived using: - % vehicle types (57% light duty vehicle & 43% vans, pickups, SUVs). - % vehicle fuel types (98.3% gas light duty vehicle and 98% diesel vans, pickups, SUVs. 1.7% diesel light duty vehicle and 2% diesel vans, pickups, SUVs). - Average fuel extraction and production impacts (0.2749 kg CO2e) added to average tailpipe emission factor (2.2448 kg CO2e).
Motorbike	0.2772	Car EF used due to insufficient data for motorbikes and lack of event participants who used this mode.
Bus - city	0.1445	Tailpipe EF for city buses (0.1302 kg CO2e/km) multiplied by 11% (assumed the same increase that was added to cars).
Bus - intercity	0.0760	Tailpipe EF for intercity buses (0.0685 kg CO2e/km) multiplied by 11% (assumed the same increase that was added to cars).
Plane - short haul	0.2236	0 – 463 km
Plane - med. haul	0.1264	463 – 1108 km
Plane - long haul	0.1475	> 1108 km

LIMITATIONS

- Different emission factors can be derived based on information specific to UBC, Vancouver, BC, Canada, or internationally. Which EFs were used depended on information availability, accuracy, completeness, and the future usefulness for other events. It should be noted that while it is more accurate to take into account more regionalized information (e.g. bus types on UBC routes), this specificity reduces the ability to compare impacts with events in other locations.

DATA SOURCES

- Travel emission factors & fuel efficiencies for cars, buses, and planes - BC Ministry of Environment, 2011. *Methodology for Reporting B.C. Public Sector Greenhouse Gas Emissions.*
- Flight emission factors - Canadian GHG Challenge Registry Guide to Entity and Facility-Based Reporting-Emission Vectors, Version 5, 2007.
- Global warming characterization factors - IPCC 4th Assessment Report (2007)
- Vehicle fuel type % - Vancouver City, 2007. Community Energy and Emissions Inventory Percentages
- Vehicle type % - Transport in Canada, 2009. Table RO3: Provincial Light Vehicle Fleet Statistics
- Fuel extraction and production impacts - NREL, 2008. Crude oil, in refinery. Data Years 1997e2003. U.S. LCI Database. Golden, CO: National Renewable Energy Laboratory. www.nrel.gov/lci (accessed July 2008).

4.2 Background Information - Accommodation

TABLE 13: EMISSION FACTORS FOR HOTEL AND TRAVEL

Impact Area	Emission Factor	Notes
Hotel	19.42 kg CO2e / night	25 nights allocated. Although visiting team stayed for 2 nights to play 2 games, only 1 night was allocated per person since only one game is being measured.
Travel[a]	0.1445 kg CO2e / psg-km	12.5 km each way (25km) between Coast Plaza Hotel and UBC War Memorial Gym for 25 team members on a city bus.

a. see travel appendix for city bus emission factor derivation

ASSUMPTIONS

- It was assumed that all spectators, staff, and home team members stayed at their usual residence and therefore no additional impact occurred.

DATA SOURCES

- Emission factor for hotel accommodation - sourced from the BC Ministry of Environment (2011) *Methodology for Reporting B.C. Public Sector Greenhouse Gas Emissions*. It should be noted that this emission factor is based on an average impact for a sample of hotels across Canada calculated by CHIP Hospitality (2004). Only energy use of the hotel was factored in, avoiding impacts from food, water, etc. at the hotel. It is recommended that in future a regional specific or hotel specific emission factor be used that includes a more complete LCA of environmental impacts.
- Team hotel and travel arrangements - sourced from UBC Athletics & Recreation
- Travel emission factors - sourced from BC Ministry of Environment (2011) *Methodology for Reporting B.C. Public Sector Greenhouse Gas Emissions.*

4.3 Background Information – Food

Food impacts took into account all food and beverages sold at the event to spectators excluding on-site vending machines. An input-output LCA approach was taken to estimate food impacts by using the total event food sales budget. Table 14 shows the approach taken to calculate the result.

TABLE 14: DERIVATION OF FOOD GHG EMISSIONS WITH AN ECONOMIC INPUT-OUTPUT APPROACH

	Results	Units	Notes
Emission factor	0.321	kg CO2e / US $ 2002	Economic Input-Output model applied using US National Purchases 2002 model 'Arts, Entertainment, Hotels and Food Services - Food services and drinking places'
Inflation '02-'11	1.24	US $	Used http://www.bls.gov/data/inflation_calculator.htm
Exchange rate	1	US $ / CAN $	Assumed exchange rate of 1 CAN $ = 1 US $
Event food sold	2,295	CAN $	Sales estimation supplied by A&R food caterer
Total impact	594.1	kg CO2e	

DATA SOURCES

- Emission factor for food - Carnegie Mellon Input-Output Estimator - US 2002 National Purchaser Model. http://www.eiolca.net/
- Food sales data - A&R staff and A&R food caterer

4.4 Background Information - Materials/Waste

TABLE 15: MATERIALS INVENTORY

Categories	Value	Unit	Notes
Event programs (paper)	3.9	Kg	300 printed (UBC A&R) weighing 13 g each (direct measurement of one sample)
Player programs (paper)	1.3	Kg	Assumed 25 printed (average told by vendor), assuming weight of 50 g each
Merchandise (T-shirts, caps & jackets)	75	$	Assumed 5 items sold (average told by vendor) at $15 average price
Give-aways (e.g. mini-basketballs)	100	$	Assumed 20 items (LCA alliance team visual count) at $5 each

TABLE 16: MATERIALS EMISSION FACTORS

Categories	EF	Unit	Notes
Paper	2.9	kg CO2e / kg	Assumed 0% recycled fiber[a]
Merchandise (t-shirt, caps, jackets)	0.31	kg CO2e / 2011 CAN $[c]	Applied "Men's and boy's cut and sew apparel manufacturing"[b]
Give-aways	0.36	kg CO2e / 2011 CAN $[c]	Applied "Athletics and sporting goods manufacturing"[b]

a. BC Ministry of Environment - Methodology for Reporting B.C. Public Sector Greenhouse Gas Emissions, Version 1.0, Victoria, February 2011.

b. Carnegie Mellon University Green Design Institute. (2008) Economic Input-Output Life Cycle Assessment (EIO-LCA), US 2002 Purchaser Model, Available from: <http://www.eiolca.net> Accessed March 2011.

c. To convert from 2002 US$ to 2011 CAN $, we used a conversion factor of 1:1.24 to take in account inflation (retrieved from (www.bls.gov/data/inflation_calculator.htm), and 1:1 for the exchange rate.

TABLE 17: TRASH SAMPLE AUDIT DATA

Categories	Weight (kg)	wt% sample
Mixed plastic & metals (recyclable)	5.4	63%
Mixed paper (recyclable)	0.5	5%
Mixed organics (compostable)	0.9	11%
Non-recyclable & non-compostable	1.8	21%
Total	**7.5**	**100%**

TABLE 18: RECYCLING AUDIT DATA

Categories	Weight (kg)	Wt%	Notes
Paper & cardboard	5	79%	
Plastics & metals	2	29%	Mostly aluminum cans
Total	**7**	**100%**	

TABLE 19: TRASH IMPACTS IN GHG EMISSIONS

Categories	Emissions (kg CO2e)	Notes
Mixed plastics and metals (recyclable)	0.94	Assumed 100% to landfill facilities
Mixed paper (recyclable)	0.70	Assumed 100% to landfill facilities
Mixed organic	0.94	Assumed 100% to landfill facilities
Non-recyclable & non-compostable	1.25	Assumed as mixed recyclables
Total	**3.83**	

TABLE 20: RECYCLING IMPACTS IN GHG EMISSIONS

Categories	Emissions (kg CO2e)	Notes
Mixed plastics and metals (recyclable)	-6.5	Assumed 100% going as mixed recyclables
Mixed paper (recyclable)	-19.4	
Mixed organic	0	No composting for this event
Total	**-25.9**	

TABLE 21: WASTE EMISSION FACTORS[A]

Categories	Recycling EF (kg CO2e / kg waste)	Landfill EF (kg Co2e / kg waste)	Notes
Mixed metals	-5.780	0.0404	
Mixed plastics	-1.657	0.0404	
Mixed paper	-3.880	0.3638	
Mixed recyclables	-3.193	0.1617	
Mixed organics	-2.202	0.2425	
Mixed solid waste		0.4850	

a. Adapted from US Environmental Protection Agency - Solid Waste Management and Greenhouse Gases, A Life-Cycle Assessment of Emissions and Sinks - 3rd edition, September 2006. Landfill EF values reflect estimated US national average CH_4 recovery in year 2003.

LIMITATIONS

- Garbage bins from the bathrooms were not measured
- Plastic bottles were not emptied of liquids
- Percentage of non-recyclable material in the recycling bins (contamination) was not measured

4.5 Background Information - Venue

ENERGY USAGE

TABLE 22: VENUE INVENTORY DATA

Categories	Value	Unit	Notes
Annual Electricity Usage	298,500	kWh/year	Averaged from 2007 to 2010 consumption metered data[a]
Annual Steam Usage	5,027,350	lbs/year	Averaged from 2007 to 2010 consumption metered data[b]
Annual Water Usage	10.605	m^3/year	Averaged from 2007 to 2010 consumption metered data[c]
Annual Wastewater Emitted	10.605	m^3/year	Assumed all water used is treated
War Memorial floor area	18,730	ft^2	Reported online[e]

a. 2010 Athletics and Recreation Utility Report, which was put together by UBC Infrastructure and Development

b. 2010 Athletics and Recreation Utility Report, which was put together by UBC Infrastructure and Development

c. 2010 UBC Campus Operations A&R Energy and Water Metering Analysis

e. http://www.hostingbc.ca/content/ubc-war-memorial-gymnasium

TABLE 23: VENUE EMISSION FACTORS

Categories	EF	Unit	Notes
Electricity	84	t CO2e / GW·hr	Assume same energy sources contributing to grid mix as 2006[a]
Steam	0.0658	t CO2e / klb	Based on amount of steam generated per GJ of gas and oil burned at the plant between 2007 and 2010[b]
Water delivered	0.158	kg $CO2e/m^3$	Based on EU conditions [c]
Water treated	0.119	kg $CO2/m^3$	Based on EU conditions for grey and black water treatment [d]
Embodied in structure	24.4	kg $CO2/ft^2$	Based on kg CO2e embodied in average UBC academic buildings [e]

a. UBC 2006 Greenhouse Gas Inventory Report, v4, January, 2009

b. Personal communication with Lilian Zaremba. UBC Sustainability Office on February 4th, 2011.

c. Crettaz, Jolliet, Cuanillon, & Orlando. (1999). Life cycle assessment of drinking water and rain water for toilets flushing. Aqua, 48(3), 73-83.

d. Monteith, Sahely, MacLean, & Bagley, (2005). A rational procedure for estimation of greenhouse-gas emissions from municipal wastewater treatment plants. Water Environment Research: A Research Publication of the Water Environment Federation, 77(4), 390-403.

e. Sianchuk, R. (2010). 'LCA in Green Building: Complying with the new paradigm set out by ISO 21931-1'. Conference Presentation, LCA X, Portland. http://www.lcacenter.org/LCAX/abstracts/abstract.php?id=200

ASSUMPTIONS

- Allocation – The venue inventory data is representative of the entire building. For our study, we assume that only 2/3 of the building is used for the event. We define this as the building utilization factor set to 0.67.
- Operating Hours – The number of functional hours for building usage is set to 18 hours. The building is assumed to be idle for the remaining 6 hours of the day.
- Basketball Game Length – Only the length of the event is considered – ie. 4 hours. This includes 3 hours of game time and 1 hour of logistical support time (e.g. site cleaning).
- Energy Consumption per Hour – In the absence hourly data for utilities, annual average electrical and steam usage are assumed. The event will likely have a high utility demand than for average data.
- Electricity Use - BC Hydro energy is predominantly hydroelectric but some disagreement exists with regards to the emission factor for electricity production. The figures reported in the 2006 UBC GHG inventory vary from between 24-84 tCO2e/GW·hr, the latter including GHG impacts for imported electricity. For our analysis, the most conservative figure of 84 tCO2e/GW·hr is used because BC currently requires imported power during night-time use.
- Water Consumption per Hour – In the absence hourly data for utilities, annual average water usage are assumed. The event will likely have a high utility demand than the average data.
- Water Treatment – Every drop of water coming used in the building will be treated as waste black and grey water at a treatment plant.
- Building Structure Emission Factor – The emission factor per square foot sourced from the UBC-LCA Database was developed from the study of the cradle-to-gate effects of constructing academic buildings at the UBC Vancouver campus. The War Memorial building is not an academic building, however, the UBC-LCA Database average was considered sufficient given the minor contribution of the structure within the UBC men's basketball game LCA study. Furthermore, the carbon impacts embodied in the structure are only measured cradle-to-gate. Future impacts of building maintenance and demolition are not included.

4.6 Climate Change Potentials Used

Name	Abbreviation	Climate change potential for 100-yr horizon
Carbon dioxide	CO2	1
Methane	CH4	25
Nitrous oxide	N20	298

DATA SOURCE:

- Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 2007.