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Abstract

This paper covers the methodology of a calculative model to obtain the carbon footprint for a New Zealand conference, and provides information to aid the conference organisers in choosing an appropriate emission offset program. The New Zealand Society for Sustainability Engineering and Science (NZSSES) 2008 Blueprints for Sustainable Infrastructure conference is used as a case study. Emission factors have been ascertained for transportation to and from the conference, delegate accommodation, venue energy usage, conference consumables such as food, beverages and printing, and waste produced. These are obtained from New Zealand and international sources with preference given to local factors across all areas where possible. Standards for carbon offsetting projects are discussed and a selection of offset companies is presented. It is hoped that this calculator will aid other conference organisers in quantifying their carbon footprint, and the paper will assist them with the selection of a carbon offset scheme.

1 Introduction

The NZSSES expressed a need for the development of a calculator that could determine the carbon footprint associated with their annual conference. They required a model able to calculate the carbon emissions of both assembling and accommodating the delegates, and the running of the conference. It was specified that the calculator separate the emissions produced during conference proceedings from those produced by the delegates' travel and accommodation. Accuracy was important however it was recognised the scope needed to be such that the collection and input of data would not be arduous and time consuming. The calculator also needed to be designed with the flexibility to allow its use for other conferences and events. No other papers were found on calculating the carbon emissions for a conference so comparison is not possible.

Given the required data from the conference the calculator uses emission factors to determine the associated carbon dioxide emissions which the conference is responsible for. An emission factor is per unit a measure of gas emission expressed in the number of kilograms of carbon dioxide. The calculator operates by multiplying an emission factor by the sum of the corresponding units. For example if 25 kg of lamb was consumed, the associated carbon emission would be calculated as 25 kg lamb multiplied by a factor of 10.24 kg of lamb per kg CO_2 [1]. In this case 256.0 kg of CO_2 would be emitted. The carbon emissions are divided into six categories, transport, food and beverages, waste, materials used, delegate accommodation, and energy required for the venue. Transport will be the largest contributor to the total emissions due to the air travel by delegates both nationally and internationally as the emission factors of air travel are similar to those of the cars[2] [3] considered, per kilometre. The calculator seeks to encompass most of the possible methods of assembling delegates at the conference venue with both travel from outside of Auckland and commuting with the City. Allowance is made for the varying emissions of different car sizes and different ranges of air travel[3]. The food and beverages category covers all that which shall be consumed at the conference venue during the proceedings. A range of food has been included with emission factors for both general and specific types such as vegetables[4], and beef[5] and pork[5] respectively. Beer, wine, and juice are included however tea and coffee are not, as reliable emission factors for these were unattainable. Waste from the conference is allocated an emission factor, and for ease of use the user may input the number of rubbish or wheelie bins which were filled rather than a kilogram measure. The materials used category accounts for the emissions involved with supplying packs to the delegates. The print supplier which NZSSES will be using are part of an environmental improvement program[6] which may provide benefits that not quantifiable in emission calculations. Accommodation for delegates calculates emissions based on the type of accommodation and number of guest nights. Significant variation in emission factors was found for hotels[7] [8] [9] [10] so a conservative value was adopted and justification given. Emissions related to energy used by the venue are considered to be from lighting, multimedia devices, and air conditioning. Factors have been calculated from first principles. The air-conditioning emission factor is venue specific, expressed in energy used per metre squared per hour it has been calculated using actual historical energy use data from the venue[11] [12].

The accuracy of the calculator is difficult to ascertain as it depends on both the input data and the derivation of the emission factors used. While all emission factors used are those most appropriate for the given context, each factor is the result of complex analysis and a series of assumptions. As viewing all of these assumptions is often impossible, the actual scope of the emissions calculated cannot be fully known. Without knowing the scope accuracy of the calculator accuracy is then impossible to quantify.

The NZSSES requested a discussion of practical ways of offsetting carbon emissions which would be acceptable by the international community to help them in coming to a decision on how to offset the footprint of the conference. The NZSSES specified that they were not interested in tree planting – biosequestration as a form of offsetting. The four main types of offsetting projects are discussed

Several of the standards for regulation and credibility of offset projects are then examined. Standard certification is important when purchasing offsets as they provide the customer with assurance that the carbon credits from a project are indeed valid and other factors such as benefits to the local community.[13] Finally a selection of offset providers is examined and their prices to offset one tonne of carbon dioxide are listed as a resource for NZSSES to utilise.

2 Transport

The emissions produced by assembling delegates will are calculated in the transport section. This includes both bringing delegates to Auckland before and after the conference, and commuting on a day to day basis. The emission factors for transport are all expressed as kilograms of carbon dioxide emitted per kilometre.

2.1 Air travel

Carbon emissions from air travel will make up the majority of emissions from this conference. To ensure a more accurate calculation of the emissions, separate emission factors are used for domestic, short haul, and long haul flights[3]. The separate factors take into account the large proportion of fuel which is used during takeoff and landing as opposed to cruising at altitude. This calculator does not take into account the impact of 'Radiative Forcing' as the science of Radiative Forcing is currently uncertain[3]. It must be noted that other emissions calculators do adopt a factor for Radiative Forcing and as such will give a significantly different level of emissions. Flight distances have been sourced from the Qantas website[14] or the 'Travel Happy' online calculator[15]. The emission factors are adjusted to account for indirect aircraft routing and delays. The adjustment comes as a 9.5 percent increase which is derived from a report by the International Panel on Climate Change which suggests a factor of 9 to 10 percent[16]. All flights by delegates are assumed to be return. The individual emission factors are shown in table 1.

2.1.1 Domestic

Domestic flights are those which occur in New Zealand. The furthest domestic flight to Auckland is 1177 kilometres from Invercargill[15] so the cut-off distance is 1200 kilometres, such that all flights further than 1200 kilometres become short haul or long haul.

2.1.2 Short Haul

The reference used for air travel recommends that the short haul emission factor can be used on distances up to 3700 kilometres3. Therefore short haul flights are considered as those between 1200 kilometres and 3700 kilometres.

2.1.3 Long Haul

It follows that a long haul emission factor is applied to flights which are greater than 3700 kilometres.

Table 1: Emission factors for air travel

	Initial Emission factor (kg CO_2/km)	**Adjusted Emission factor (kg CO_2/km)**
Domestic	0.158	0.173
Short Haul	0.1304	0.143
Long Haul	0.1056	0.116

2.1.4 Distances

The distances listed in the calculator attempt to best cover all likely origins of delegates given the information available. If the origin required is not specified then by selecting the origin as ‘manual’, the distance can then be entered into the 'Distance to Auckland' column in the calculator. Both the Qantas website[14] and the ‘Travel Happy’ online calculator[17] can provide distances.

2.2 Automobile

The emission factors for automobile transport are derived from New Zealand and British sources[2 3 17]. Whilst is it recognised that the composition of fuel varies slightly between the two countries, the impact this has on the actual level of emissions is assumed to be zero.

2.2.1 Taxi

The taxi emission factor was calculated using a common vehicle in an Auckland taxi company fleet, the Holden Commodore Executive 2004[17].

2.2.2 Bus

The emission factor for buses applies to all bus rides within Auckland City including to and from the airports. This factor reflects British bus sizes, models, and passenger occupancy statistics[3]. A New Zealand specific factor would be more appropriate however one was not available.

2.2.3 Car

Hybrid vehicle travel is assumed to be made in a Toyota Prius 2007[2], a popular hybrid vehicle in New Zealand. Small vehicles are considered to have an engine sized between 1.4 and 2 litres. Large vehicles are considered to have an engine sized 2 litres or greater[3].

2.2.4 Motorbike

The emission factor adopted for motorbikes uses a medium engine size of between 125cc and 500cc[3].

2.2.5 Train

The emission factor used for the commuter train in Auckland City is calculated using a British rail system[3].

2.2.6 Between Auckland Airport and the City Centre

For those arriving at the airport their return trip into town is calculated. This assumes they will be staying in the city centre which is in within close proximity to the venue. Including travel to and from the conference venue by delegates staying in the city centre is beyond the scope of the calculator when accommodation of all varieties is within walking distance of the venue. If delegates must take a taxi we recommend they use a company with low emission vehicles such as 'Green Cabs' which operate hybrid Toyota Prius vehicles.

Table 2: Transportation emission factors

	Emission factor (kg CO_2/km)
Taxi[17]	0.255
Bus[3] Car-hybrid[2]	0.089 0.106
Car-small[3]	0.191
Car-large[3] Walking	0.261 0.000
Motorbike[3]	0.094
Train[3]	0.062

2.2.6 Overland Travel

Overland travel calculates the emissions produced by delegates travelling overland to Auckland for the conference. A selection of likely origins is available which are all within 300 kilometres. For distances greater than these, or from other origins, manual entry is available.

2.2.7 Commuting

For delegates commuting to the venue from outside of the central city, return trips are calculated.

The travel distance for each delegate is required to be manually entered. Only the total vehicle emissions are calculated regardless of the number of passengers consequently each delegate is responsible for their total vehicle emissions. Allocating delegates a share of the total vehicle emissions would require the collection and input of passenger numbers for each trip and it is assumed that this level of detail is beyond the scope of the calculator.

3 Food and Beverages

New Zealand specific food and beverage emission factors, and in fact factors for foods and beverages in general are difficult to obtain due to limited amount of research available and number of emission bearing inputs which go into producing a final product. Initially there is the agriculture component of growing the raw materials with emissions produced from fertilisers and agrichemicals for plant growth, and diesel for general machinery use. Then there is a processing and production component which can involve anything from sorting raw produce to heating, cooling and mixing with inputs of energy and extra materials. Transportation is also usually involved pre and post production. Therefore developing an emission factor for a single product such as bread will require emission factors of all the materials included in the production such as wheat and sugar. Due to the position of New Zealand products which are imported must travel particularly long distances and this must also be factored in an emission factor.

NZSSES currently use De Lucas Catering which are the University in-house caterers. They will supply all food and beverages with the majority of local food purchased when possible. As the caterers and suppliers have very little information on emission factors for specific foods or products within New Zealand, most emission factors are taken from international sources such as the Danish LCA food database[5]. New Zealand emission factors are taken where possible. No consideration has been made for the energy consumed in the preparation and cooking of food. This is something for further investigation.

3.1 Food

New Zealand specific emission values were obtained from in-depth studies carried out on the energy used and CO_2 emitted by agricultural production in New Zealand. The first study was conducted on New Zealand lamb, onions and apples in 2006 for the purpose of comparing the embodied carbon emissions of the respective New Zealand and British products[1]. Inputs consisted of petrol, diesel, lubricant, electricity and contractor fuel use; indirect energy inputs of fertilisers, compost and agrichemicals and capital energy inputs from self propelled vehicles and implements such as tractors, light trucks, utilities and motor bikes and buildings. This included embodied energy of raw materials, construction and an allowance for repairs, maintenance, and international freight. The apples and lamb emission factors of 0.06 kg CO_2/ kg product and 10.24 kg CO_2/ kg product respectively were taken from this study for use in the calculator. It is assumed that this carbon emission factor for apples is representative of all fruit produced in New Zealand.

A further study was carried out on seven individual farms for the purpose of setting energy and carbon indicators that can be used for future sustainable benchmarks[4]. Using additional information carbon emission factors were calculated from the energy indicators to produce a factor of CO_2/ kg of product for wheat, barley, potatoes and onion production. The potato emission factor of 0.08 kg CO_2/ kg was the only emission factor to be used in the calculator, representing all vegetables. The resulting emission factor for onions was the same as that found in the previous carbon emission study[1] confirming data consistency and validity of both.

A wide range of food and beverage emission factors[18] developed for an Australian GHG calculator[19] are available. None of these emission factors were selected due to the lack of sources and methodology but were used for comparisons and confirmation. The remaining emissions were taken from the Danish LCA food database[5] and emissions calculated from Sima Pro software[20]. These were compared to emission factors used in various sources for validation. The selected emission factors are listed below in Table 3.

Table 3: Food emission factors

Food	**Emission factor (kg CO_2/kg)**
Beef[5]	44.80
Pork[5]	2.90
Chicken[5]	3.10
Lamb[1]	10.24
Fish[3]	7.36
Bread[5]	0.80
Cakes/muffins[5]	0.80
Vegetables[4]	0.08
Fresh Fruit[1]	0.06
Cheese[3]	11.50
Butter[3]	11.50

3.2 Beverages

Only three different choices of beverages are supplied in the calculator: wine, beer and juice. Although tea and coffee will make up a significant portion of the beverages consumed during the conference, reliable emission factors for these were unobtainable.

3.2.1 Wine

The emission factor for wine displayed in Table 4 is taken from an Australian wine study[21]. A New Zealand wine company who has quantified their carbon emission per production unit would be ideal. An excel calculator[22] has been developed for wine companies[23] for detailed quantification of emissions produced but this has yet to be carried out by Villa Maria who will be the wine supplier for the conference.

Numerous international wine emission factors were found from various studies ranging from 0.08 kg CO_2/L [24] to 3.5 kg CO_2/L[21]. This is due to the difference in scope and the inclusion of transportation to foreign countries. The selected emission factor is consistent with 1.92 kg CO_2/L[25] taken from an American study on an Australian wine.

3.2.2 Beer

In adopting an emission factor for beer a conservative value has been chosen as the information available is highly variable. Emissions are available for processes during the manufacturing of beer, or of the industry itself[24] however it is difficult to represent this information as a weight of carbon dioxide emitted per unit of product.

3.2.3 Juice

The juice emission factor is assumed to be adequate for varieties of juice regardless of the country of origin.

Table 4: Beverage emission factors

Beverages	**Emission factor (kg CO_2/L)**
Wine[20]	2.02
Beer[21]	2.40
Juice[18]	1.50

4 Waste

The waste to landfill emission factors are dependent on the waste composition and the landfill in a manner of gas recovery. The emissions are reduced if methane is captured. A factor of 0.874 kg CO_2e per kg of waste without landfill recovery as opposed to 0.529 kg CO_2e per kg with landfill recovery for the national average of mixed waste was observed[26]. The office waste composition is selected as it best reflects the large proportions of paper and food which shall be in the conference waste. The emission factor is chosen to include landfill gas recovery as this is present at the receiving Red Vale landfill, operated by Waste Management NZ Ltd[27]. The waste to landfill emission factor selected is 0.9 CO_2e per tonne of waste, as specified by the New Zealand Ministry for the Environment[26]. There is data for emission factors for waste with known composition however requiring the weighing and sorting of rubbish specifically for input data for the calculator is beyond the scope of the calculator.

Recycling is not included in the calculator. While one source allocated the different recycled material types (food and garden waste, paper, plastic or glass) a corresponding negative emission factor[9] it was assumed that the recycled material be modelled simply by diverting the material from the waste stream[26]. For the NZSSES conference surplus food will be offered to the City Mission at the end of the day. In terms of total carbon emissions this will reduce the quantity of waste to landfill as the food scraps will form a significant portion of conference waste.Table 5: Waste emission factor

Waste	**Emission factor (kg CO_2/kg)**
Office Waste[27]	0.9

For the calculator there will be three options of information input. The first is waste in kg where the user inputs the known weight of the waste. The other two options will be predetermined options of number of 6 kg bags (standard rubbish bags) or number of wheelie bins (25kg).

5 Materials

Delegate packs are usually distributed to conference attendees containing a variety of products. Emission factors for only paper and printed documents are included in the calculator as emission factors for the other products within the delegate packs were unattainable.

5.1 Paper and printed documents

The printing supplier for the NZSSES conference is SMP Solutions[28] who use Soar print[6]. Soarprint have a gold standard Enviro-Mark (New Zealand Landcare Research environmental management system) defined as "Implementation and monitoring of continuous-improvement targets and objectives". They use soya and vegetable based inks, biodegradable plastics used to print on and provide sustainably produced Forest Stewardship Council (FSC) paper stock[29]. No carbon emission calculations have been carried out for Soar printing so standard emission factors of 5.12 kg CO_2/ kg for all printed publications such as brochures and booklets. All printed documents use a factor of 4.93 kg CO_2/ kg (See table 6), taken from the World Resources Institute[30]. These are comparable to an emission factor of 4.47 kg CO_2/ kg observed[31].

Table 6: Paper and printed documents emission factors

Paper	**Emission factor (kg CO_2/kg)**	**Emission factor (kg CO_2/No. of sheets)**
Publications	5.12	0.03
Printed Paper	4.93	0.02
Plain Paper	2.72	
Recycled Paper	1.78	

Two input options in the calculator are provided, weight of paper in kilograms or number of sheets. This is based on the assumption that the paper size is A4 and weight 5 grams (For different sized paper the number of sheets can be multiplied by the size difference in relation to A4 to obtain the emission factor). Emission factors for plain paper and recycled paper[32] are also included for other paper items distributed such as pads.

5.2 CDs

An emission factor of 0.5kg CO_2/ CD[33] is provided for instances when discs (CDs or DVDs) are distributed. These are not part of the delegate package for this conference but have been included for possible future use.

6 Accommodation

Carbon emission factors for accommodation are based on an exact lodging that has had its emissions calculated or on type, rating, location and accreditation from studies or research available. The calculator accommodation selection is individually calculated for delegates over three options of accommodation: hotel, motel and hostel/backpackers. Table 7 displays the emission factors selected for the specific accommodation types.

Table 7: Emission factors per room and guest night for different accommodation type.

Accommodation Type	**Emission factor (kg CO_2/ room and guest night)**
Hotel[34]	11.63
Motel[34]	2.30
Backpackers[34]	3.05

The selected emission factors are based on calculations from research of accommodation energy use in New Zealand[34]. This is conservatively calculated based on the assumption that energy is only from an electricity source which is 75% for hotels and 85-90% for backpackers and motels. The purchased electricity emission factor was used with the inclusion of transmission and distribution line losses[26].

6.1 Hotels

A range of carbon emissions for hotels were observed ranging from 1.4 kg CO_2/ per room per night [35] to 50 kg CO_2/ per room per night[36]. The selected emission factor is above the 8.01 kg CO_2/ per room per night, used by New Zealand Land Research program Carbonzero[25] and US sources[37] which is based on the average energy consumption and average occupancy rates from survey data[38].

7 Venue Energy

7.1 Power

The conference requires electrical power for lighting, and multimedia devices along with natural gas for air conditioning. Emission factors for power are expressed as kilograms of carbon dioxide produced per kilowatt hour of energy used. The electricity emission factor used is calculated by the New Zealand Government[26] and accounts for the fuel combustion and fugitive emissions associated with power generation. An additional emission factor takes into account the transmission and distribution line losses caused by inefficiencies in the system. The natural gas emission factor used is also calculated by the New Zealand Government[26] for the transmission and distribution.

7.1.1 Lighting

The method used to find the power required for lighting was chosen such that it could be easily recalculated for another conference. It uses an average lighting intensity per square metre multiplied by the floor area utilised by the conference. The average lighting intensity of 18 watts per square metre was derived in a report on the lighting conditions of offices in Central Auckland.[39] It is thus assumed that the conference will be lit to this level. It is recognised that lighting configurations during presentations are readily changed and may become significantly darker than assumed, however the actual monitoring of this is beyond the scope of the calculator. Instead it is considered as part of a conservative approach.

7.1.2 Multimedia Devices

The electrical power used during the conference by multimedia devices is calculated by using an approximate rate of power consumption (wattage rating) for each electronic device multiplied by the time for which the device is used. The multimedia facilities which will be used during a presentation in each lecture theatre consist of the sound system, data projector, lectern computer, and room controller. The projectors and audiovisual equipment used across the lecture theatres will very similar[40]. It is possible that a presenter may use the additional devices available such as a document camera or DVD player however it is assumed they will not. The increased power consumption resulting from extra devices would not be significant. Presentations may be run from the lectern computer or a laptop connected to the system. In the case of laptops the period use of each laptop must be summed and inputted into the spreadsheet. It is acknowledged that the wattage ratings of the multimedia equipment are taken from the manufacturer's figure for maximum power usage. To find the exact power consumption it would have been necessary to test each individual device under typical conditions which is beyond the scope of the calculator. This is also considered part of a conservative approach.

7.1.3 Air-conditioning

The electricity and gas used by the air conditioning was analysed to give an average kilowatt per hour rate per square metre of floor space in the Engineering School complex. The methodology used is as follows. The inputs required are:

- The most recent total annual usage of electricity and gas for the air conditioning in the School of Engineering complex.[41]

- The rate of energy usage of the air conditioning for the duration of the conference. This was derived by making an assumption of the number of days in the year, and the number of hours in each day during which the air conditioning was not fully operating. The data analysed for this was obtained from the 'Time of Use' (TOU) metering service[42] which is available to the University of Auckland Property Services. This service continuously monitors and records the electricity consumption every 30 minutes for the engineering school.

- The proportion of the School of Engineering complex utilised by the conference. This was found by obtaining the gross floor area of School of Engineering complex[41], and the floor area which the conference shall be using. The area of the lecture theatres are exact values obtained from the University[43] however conference organisers will need to make a judgement on the amount of space used in the Engineering School Atrium and Business School Foyer.
A provisional area has been allocated for other facilities used which require lighting and air conditioning such as toilets, corridors, and entrances. The usage for these facilities should be the duration of the conference.

The energy consumption of the air conditioning in the Business School is assumed to be the same as the School of Engineering complex. This is due to the relatively small proportion of time and space which the conference requires of the Business School facilities, and the similar nature of the two buildings. The calculation steps are shown in table 8.

Table 8: Air-conditioning Energy usage calculation steps

Air-conditioning Energy Usage		**Units**
Effective days per annum	356	d/a
Effective hours per day	10	h/d
Effective hours per annum	3560	h/a
Total floor area[43]	26,129	m^2
Electricity		
Total energy usage 2007[41]	3,239,710	kWh/a
Usage rate for total area per hour	910.03	kWh/h
Electricity usage rate per m^2	0.0348	$kWh/m^2/h$
Gas		
Total energy usage 2007[41]	659,474	kWh/a
Rate of usage for total area per hour	185.25	kWh/h
Gas usage rate per m2	0.007089652	$kWh/m^2/h$

8 Offsetting and carbon credits

Once the emissions have been quantified carbon credits for offset projects can be purchased to counterbalance the emissions produced from the conference. Basic details on the different types of offset projects and accreditation standards and covered. This is to establish a background so evaluation can be made by conference organisers on the available offset options investigated, and appropriate offset choices made.

8.1 Offset Projects

There are four main categories of greenhouse gas offset projects: biosequestration, renewable energy, energy efficiency and greenhouse gas capture projects.

8.1.1 Biosequestration projects

Biosequestration covers forestation and land management projects that reduce the CO_2 existing in the atmosphere by enhancing biological CO_2 uptake and capturing and storing it in plants and soil.

Even though tree planting has great advantages (improving ecosystems, providing food, shelter and medicine) as well as making up for the global extent of forestation (producing up to 75% of the global GHG[44]), there is an associated controversial issue of permanence and leakage. Permanence refers to the unreliable insurance that a planted tree will survive and remain intact, providing a permanent carbon sink with protection from future logging. Leakage is the indirect cause of clearing and logging occurring in other areas as a result of one area being protected[45]. There is also a lack of biodiversity with reforestation and afforestation projects as they are usually monoculture, and issues such as how the level of carbon adsorption varies with plant type, age, location and climate/weather conditions all play an important factor when determining the offset potential and validity.

8.1.2 Renewable Energy

Renewable energy offsets involve projects using wind power, hydro power (usually small scale), solar power, and power generation from biomass. These projects ultimately reduce our reliance on fossil fuels and thus lower the carbon intensity of energy generation. As a result emissions from fossil fuel energy generation that would otherwise occur are displaced. This is an advantage over forestry offsets which seek to mitigate emissions already generated instead of targeting the source. The money generated from selling carbon credits also helps to make the renewable energy projects more commercially viable. These projects are very applicable to the concept of additionality (discussed below), and strict offset standards are necessary.

8.1.3 Energy Efficiency

Energy efficiency acts to reduce the amount of energy required which lowers total carbon emissions regardless of the source of generation. Energy efficiency can be achieved by fuel efficiency, cogeneration, and refitting existing buildings. Cogeneration plants use the same source to produce heat and electricity. The refitting of existing buildings involves increasing the efficiency of the lighting, heating, and cooling systems, particularly the replacement of incandescent light bulbs with new generation compact fluorescent bulbs.

8.1.4 Greenhouse Gas Capture

Greenhouse gas capture is the capture and retention of greenhouse gases such as methane (CH4), sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs), methane nitrous oxide (N2O) and perfluorocarbons (PFCs) from agricultural and industrial processes. A commonly used method is the capture of methane released from landfills or agriculture with the captured gas then used as an energy source.

8.2 Standards for the Regulation and Credibility of Offset Projects

Verification standards are issued for offset projects to ensure the validity of the project and its organisation. Offsets are sold within two different markets, voluntary by individuals and businesses, and mandatory /compliance or regulated to meet emission regulations under the Kyoto Protocol.

Additionality is an important concept in regulating carbon offset projects. Essentially 'if a project is additional, it means that it would not have gone ahead in the absence of carbon funding'[46]. Ensuring a project is additional allows capital raised from the sale of carbon credits issued to provides finance for the project, enabling it to occur when otherwise it would not.

8.2.1 Clean Development Mechanism

Clean Development Mechanism (CDM) projects come under the Kyoto Protocol provision and are part of the United Nations Framework Convention on Climate Change (UNFCCC). They are designed for developed countries to offset their carbon emissions by projects in developing countries. The credits within this are Certified Emission Reduction (CERs) and undergo vigorous analysis to ensure the projects validity. CDM advantages are that the projects are usually basic life requirements that developing countries benefit greatly from, reducing poverty while improving the global environment. Developing countries are also highly vulnerable to climate change and have the least ability to deal and adapt with global warming issues. Another advantage of CDM projects is the issue of double counting of the project in developed Annex 1 countries. The credits are counted once by the purchaser and then also included in the countries GHG Inventory instead of being retired after purchasing, as offsets should be. This can be easily solved but so far no mechanisms have been implemented to do so[53]. CDM require an additionality assessment.

8.2.2 Gold Standard

The Gold Standard (GS) was founded in 2003 by a number of prominent non-governmental organizations such as the World Wide Fund for nature. The organisation is based in Basel, Switzerland. The purpose of the Gold Standard is to encourage sustainable development at a local level and ensure carbon markets are working towards a lasting climate change solution. The standard only covers energy efficiency and renewable energy projects[47]. The Gold Standard operates by an initial evaluation of the project to ensure that it meets the requirement of energy efficiency or renewable energy. The project must also be assessed for additionality. Next consultations are undertaken involving the local policy makers, community, and organisations. The purpose of these is to identify and address stakeholder issues which may affect the project. The project is then validated and verified by a UN approved third party organisation. After certification the Gold Standard credits are issued[13].

8.2.3 Verified Emission Reductions and Certified Emission Reductions

One Certified Emission Reduction (CER) is equal to one tonne of CO_2 produced and can be purchased before the actual reduction and for trade within the mandatory market. These are developed to help countries meet their Kyoto targets which result in high accreditation costs, and therefore are generally used for large industrial scale projects.

Verified Emission Reductions (VERs) are a range of voluntary standards lower than the CERs which cannot be used in the mandatory market. They are cheaper and easier to gain accreditation and are generally used for smaller community projects with more social and environmental benefits. VERs also provide the flexibility to utilise methodology and innovative technologies that have not been yet approved for the CDM. There is no additionality compliance for VERs

8.3 Offset Companies

Most carbon offsetting companies provide offsets but require an input of information for their specific calculator to determine the total emissions. Some offer packages such as Offset the Rest which have pre-calculated conference packages of a set tonnage of CO_2 predetermined from an assumed number of attendees, transportation, flights and heating, cooking, waste, and other factors[48] [49]. Three main offset companies have been outlined below and table 9 presents a comparison of major offset companies detailing their projects, standards, and the price in New Zealand dollars to offset 1 tonne of carbon.

8.3.1 Offset the Rest

Offset the Rest are a New Zealand company based in Nelson. Founded and run by two mothers their focus is shifting our usage of fossil fuels to renewable energy and encouraging overall efficiency.

Offset the Rest trade exclusively in carbon credits generated from renewable energy projects both within New Zealand and abroad. Carbon credits currently for sale are sourced from the Te Apiti Wind Farm, located north of the Manawatu Gorge in New Zealand, and the Sri Balaji Power Project in Andhra, India. The Te Apiti Wind Farm consists of 55 turbines, generating 90 MW which provides enough power for approximately 45,000 households.[50] Sri Balaji is a 7.5 MW biomass power plant which is fuelled by agricultural waste.[51] Offset the Rest's carbon credits are of the highest quality as all projects are independently validated and meet the Gold Standard.

8.3.2 Climate Friendly

Climate Friendly is an Australian based company. Their goal is to increase demand for new power generation projects which produce renewable and sustainable energy. Climate Friendly trades only in credits from renewable energy projects sourced from around the world. At present Climate Friendly is sourcing carbon credits from the Jaisalmer wind project, India, and a limited number from Te Apiti in New Zealand. The Jaisalmer wind farm consists of 75 turbines each producing 0.8 MW[52]. Previously credits were taken from a wind farm in Turkey. Climate Friendly's carbon credits are also of the highest quality as all projects are independently validated, meet the Gold Standard, and are consistent with the Kyoto Protocol[53].

Table 9: Comparison of Offset providers

Offset Provider	Country	Projects	Standards	1 Tonne CO^2 (NZ$) (as of 30/05/08)
Offset the Rest[49]	NZ	Renewable Energy Wind Farm – New Zealand Biomass Power Plant – India	GS	$39.28
Climate Friendly[53]	Australia	Renewable Energy Wind Farm – India and New Zealand	GS, VERs	$29.60
Carbon Reduction Institute[54]	Australia	Landfill Gas Capture	Greenhouse Friendly	$19.30
Climate Care[55]	UK	Renewable Energy, Energy Efficiency	CDM (CERs), GS, VGS(voluntary GS)	$22.05
Terrapass[48]	USA	Renewable Energy, Landfill Gas Capture, Biodigester	VCS, GS, ISO 14064-2	$13.20

8 Relative Levels of Emissions

An assessment of the relative levels of carbon emissions from elements of the conference allows the organisers to ascertain which sources are highest producers and prioritise their efforts in addressing these. For the purpose of this section data was put into the calculator based on information from both the previous and upcoming NZSSES conferences to obtain an estimate of the relative emission levels. Assumptions were made where necessary data was not available and consequently this analysis is very approximate. Delegate transportation forms a large proportion of the emissions from the conference however the organisers have expressed that transportation as well as delegate accommodation tend to be relatively inflexible at this stage. Accordingly the results are presented in the following two figures where the second shows a more detailed breakdown of power and consumables, being the areas which the organisers are better able to control.

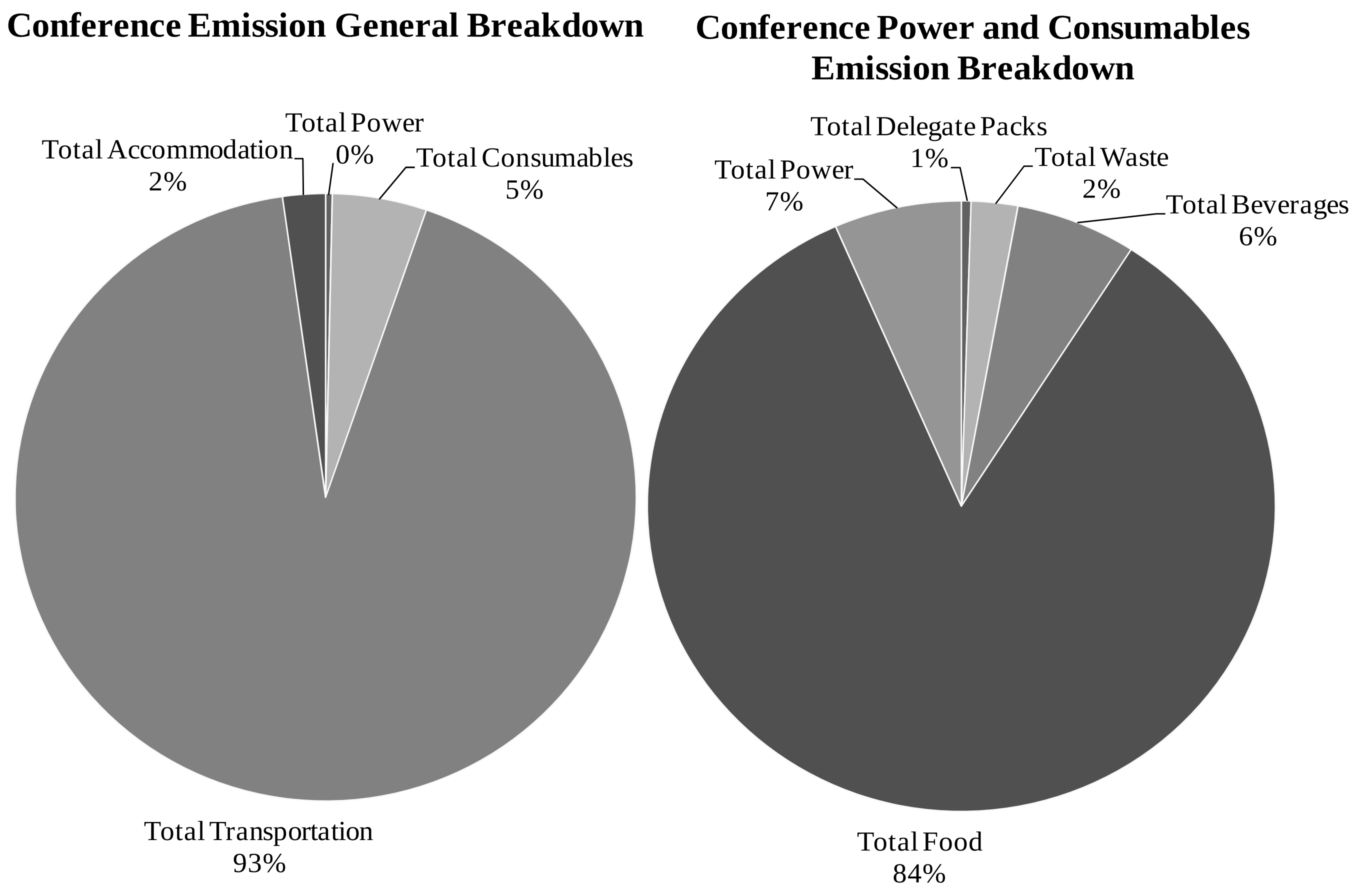

Figure 1: Relative Levels of Emissions

It is evident in figure 1 that delegate transportation is the main source of emissions from the conference and consquently emissions from power and consumables make up a relatively small proportion overall. Total power related emissions make up an insignificant proportion of the total emissions and are still relatively small when compared with consumables. Delegate packs are the smallest source of emissions. Of the consumables the main source of emissions are those from food. This is significant as the conference organisers are able to address this by choosing to provide foods which have low emission factors in place of those with high factors. For example beef has a factor which is 4.4 times higher than lamb and 14.5 times that of chicken, and all types of meat have factors significantly higher than vegetables. Beverages make up a small proportion of consumables and with little variation in the available emission factors the organisers may only reduce these emissions significantly by utilising water instead.

9 Conclusion

It is difficult to summarise the outcome of the calculator without having any actual results produced from it as the conference is not held until December except as discussed in section 8. An ideal comparison would be achieved by taking the data from a previous conference in New Zealand which used another carbon calculator, and put it through this one. Unfortunately this information was not available. Use of the calculator in retrospect to find the footprint of last years NZSSES conference is also not possible as the volume of data required is fairly substantial and would not be available historically.

Many of the emission factors which are used have been quoted to a the nearest gram of carbon dioxide emitted per unit. It is recognised that this gives an artificial sense of accuracy in an inaccurate science, however this data is simply presented as provided by the sources. To account for the inherent inaccuracy of the results the final total values from the calculator may be suitably rounded. The food and beverages category will need to be improved in the future and emission factors should be found for tea and coffee. Current development was hampered by several factors; a general lack of related research which has been undertaken, large variability in the information available, limited applicability of foreign emission factors to New Zealand, and little financial resource. Analysis using the Sima Pro software for the purpose of this project would be ideal however the software is very expensive. These factors are indications of the very complex nature of determining emission factors for food. The accommodation section requires further research to investigate the significant difference between the hotel and motel emission factors. The materials section would also benefit from being enlarged to include more items which may be distributed or used during the conference. The current selection is limited by the availability of information. Other data in the calculator will need to be updated as the sources are updated. This includes the emission factors for electricity and gas usage, and waste to landfill which are calculated by the New Zealand Ministry for the Environment on a yearly basis.

The calculator in its current state is deemed to be applicable to other conferences and events only within New Zealand. This is due to the New Zealand specific information such as emissions associated with electricity. It would be easily possible to adapt the calculator for use internationally by changing emission factors and travel distances.

The discussion of offset projects is intended to give the conference organisers some information to help decide on which type or types of projects they intend to use in offsetting the carbon footprint of the conference. The information provided here is by no means exhaustive; this paper could have been written on the types of offset projects alone. Information is readily available on all the topics covered in the offsetting and carbon credits section and the conference organisers are advised to supplement this with their own personal reading.

The discussion on standards for the regulation and credibility of offset projects outlines some clear advantages to purchasing certified carbon credits to offset emissions, both in terms of environmental and socials aspects. One may assume that certification comes at a premium price however significant variation and comparatively low prices amongst those listed in table 8 is evidence suggesting that certified credits are an affordable and viable option for the conference organisers.

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