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Title of the Paper: **Carbon Emission Offsetting for Conferences**

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Abstract
Conferences are held at locations all around the world and have delegates travelling from far distances to attend. Due to the large transportation factor, high quantities of carbon emissions are produced from conference events. A Conference Carbon Emission Model (CCEM) has been developed to assist with quantifying the carbon emissions produced in relation to holding conferences, so that carbon credits can be purchased for emission offset. This paper covers the methodology used to create the Conference Carbon Emission Model (CCEM), and carbon offsetting options for conference organisers to consider when selecting an appropriate emission offset program. The New Zealand Society for Sustainability Engineering and Science (NZSSES) 2008 Blueprints for Sustainable Infrastructure conference was used as a case study. The CCEM requires quantity inputs of products and activities associated with the conference event, and uses specific embedded emission factors to calculate total carbon emissions. The emission factors were ascertained for delegate transportation and accommodation, venue energy usage and conference consumables such as food, beverages, printing, and waste produced. The calculator separates the emissions produced during conference proceedings, to those produced from delegate travel and accommodation. Carbon emission offsetting programs currently available comply with regulations based on the offset credit's accreditation and its offsetting mechanisms, both which are outlined in this paper. Presently Gold Standard and the Kyoto Protocol Clean Development Mechanism are the highest accreditation standards available. Renewable energy, energy efficiency, bio-sequestration and greenhouse gas capture are the common emission reduction projects. It is hoped that this paper and the CCEM will aid conference organisers in quantifying conference carbon emissions, and assist them with the selection of an apposite carbon offset scheme.

Introduction
International conferences regularly occur and due to the extent of transportation can produce large quantities of greenhouse gases. Carbon offsetting is a method of balancing the emissions produced from international conferences while still allowing physical attendance. Many organisations use carbon offsets to reduce their conferences environmental impact by developing their own models to quantify emissions and then purchasing offset credits, or employing the services of a carbon offset company to carry out measuring and monitoring assessments[1]. For developing models, software programs such as SoFi EM[2] and Sima Pro[3] are available for purchase that generate carbon footprints, emission data and manage and report on the emissions produced from company inputs. An emission factor for a product can be determined by building a production process model with quantities of each particular input. Each input has an associated emission factor which can be selected from the programs database of emission factors. The total process's emissions are then automatically computed.

Internet carbon credit event packages can be purchased for a set carbon emission quantity, based on a pre-determined number of attendees and various assumptions of travel and energy uses[1]. Some require inputs of duration and travel information but are very basic with little supply of background information, emission factor sources and calculator basis. Most internet emission calculators use emission factors from the Intergovernmental Panel on Climate Change (IPCC) or government published factors. The inputs offered are usually only for transportation and energy use in which emission factors are publically available. Very few offer inputs for food and beverage quantities or materials use (paper etc.) as these have minimal emission factor information available. Some conferences have been offering carbon neutral trips to the conference by offsetting the transportation emissions[4]. This coincides with the fact that transportation to the conference is a major source of conference emissions and is easy to quantify.

Carbon offsetting is a financial means of representing a reduction in greenhouse gases entering the atmosphere. The process of carbon offsetting involves quantifying emissions produced and purchasing offset 'credits' from carbon emission reducing projects[5]. Measured in carbon dioxide equivalents ($CO_{2\text{-}e}$), one carbon offset symbolises a reduction of one tonne of carbon. $CO_{2\text{-}e}$ represents the equivalent of a greenhouse gases global warming potential (GWP) in terms of CO_2, for example, methane has a GWP 21 times that of CO_2 (one metric tonne of methane is the equivalent of 21 metric tones of $CO_{2\text{-}e}$).

The CCEM and advised offset methods will be primarily developed for the NZ Society for Sustainability Engineering and Science (NZSSES) 2008 conference: Blueprints of Sustainability Infrastructure to be held at The University of Auckland, New Zealand[6]. The objective of the CCEM is to provide a simple generic model that quantifies conference emissions which can be easily updated with new emission factor data and adapted to suit particular organisations. Therefore presenting a free tool for companies to utilise without having to produce their own model or employ offset company services. This paper aims to supply the technical background for the Conference Carbon Emission Model (CCEM), specifically the emission factors and calculations embedded in the program that enable the simple computation of carbon emissions. CCEM parameter inputs are specified with the selected emission factors for each parameter stated and sources and reasons defined. For offsetting emissions, carbon offset standards and projects that are the basis for the offset credit accreditation are outlined with major offset providers presented for comparison.

CCEM Inputs and their emission factors

To produce the calculator, conference infrastructure, equipment and consumables were identified so that the emission factors required could be acquired. Research of current emission factors was carried out to ascertain representative factors for products to be used for the conference. New Zealand (NZ) emission factors are used where applicable with international sources used otherwise. The CCEM is divided into sub-sections of conference consumables (food, beverages, materials, waste) and venue energy use; and delegate transportation and accommodation. It calculates emissions associated specifically with the conference separate to delegate individual emissions from their transportation and accommodation. This enables easy division of emissions as NZSSES indicated they will cover the cost of offsetting the conference emissions (conference consumables and venue energy), and then charge participants the cost of offsetting their personally accumulated transport and accommodation emissions[7].

The carbon emissions are calculated for each product used by multiplying the quantity of each product (various units of kilograms of weight, kilowatts of energy, kilometres travelled etc) by its specific emission factor (EF, in kilograms of CO_2 per product unit). The total of all product carbon emissions are then summed for the final total.

$$Product\ carbon\ emission = \ product\ quantity\ (unit)\ x\ product\ EF$$

Food & Beverages

To quantify the emissions associated with food and beverages consumed at the conference, the CCEM requires quantity inputs of different food and beverage categories. Specific food and beverage emission factors were hard to obtain due to the little research that has been carried out and the numerous activities and combination of different inputs that go into producing the final product. Many products have emission factors for individual processes, such as fertilisers and diesel from an agricultural component or energy from heating, mixing or cooling processes. This can vary widely, making a total product emission factor hard to quantify. This may also be for only one ingredient when multiple ingredients are required.

NZ specific emission values were obtained from in-depth studies carried out on the energy used and CO_2 emissions from producing NZ products. The first study compared NZ and UK dairy, lamb, onions and apples to give an insight into the basis of food miles and the creditability of its representation[8]. Inputs consisted of direct energy inputs 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, utilities and buildings. (This included the embodied energy of raw materials, construction and an allowance for repairs and maintenance and international freight.) The lamb and apples carbon emission results of 10.24 and 0.06 kg CO_2/ kg product respectively, were used in the CCEM with apples representing all fruit.

Seven case studies were carried out to set energy and carbon indicators for use as future sustainable benchmarks[9]. CO_2 emission factors were used with calculated energy indicators to produce carbon emissions per kilogram of product. Emission factors were calculated for irrigated and dry land arable (wheat and barley), potato and onion productions. The potato emission factor of 0.08 kg CO_2/ kg was the only emission factor used in the CCEM, representing vegetables. The resulting onion emission factor was similar to that found in the previous food miles study confirming data consistency and validity of the methods and NZ emissions.

The remaining food emission factors were taken from the Danish LCA food database[10] and emissions calculated from Sima Pro[3] software. These were compared to emission factors used in various sources for validation[11]. The IPCC Emission Factor Database (EMDB)[12] was consulted but presented very low emissions signifying only sections of processes were included in the analysis. The selected emission factors with respective sources are listed below in

Table 1.

Table 1: Food emission factors

Food	Emission factor (kg CO_2/kg)	Reference
Beef	44.80	Danish LCA[10]
Pork	2.90	Danish LCA[10]
Chicken	3.10	Danish LCA[10]
Lamb	10.24	Foodmiles[8]
Fish	7.36	Sima Pro[3]
Bread	0.80	Danish LCA[10]
Cakes/muffins	0.80	Danish LCA[10]
Vegetables	0.08	Seven Studies[9]
Fresh Fruit	0.06	Foodmiles[8]
Cheese	11.50	Sima Pro[3]
Butter	11.50	Sima Pro[3]

Only three different choices of beverages are supplied in the calculator: wine, beer and juice (Table 3). Though tea and coffee will be a significant portion, reliable emission factors for these were unattainable. The emission factor for wine is taken from an Australian wine study[13]. A NZ wine company who has quantified their carbon emission per production unit would be ideal but currently only total winery annual emissions are available[14]. An excel calculator that quantifies emissions produced[15] has been developed for wine companies but is yet to be implemented. The selected emission factor is consistent with 1.92 kg CO_2/L taken from an American study on an Australian wine[16]. The juice emission factor is assumed to be adequate for all beverages other than wine, beer, tea and coffee.

Table 3: Beverage emission factors

Beverages	Emission factor (kg CO_2/L)	Reference
Wine	2.02	Garnett[13]
Beer	2.40	Rose[11]
Juice	1.50	Sima Pro[3]

Materials

Delegate packs are usually distributed to conference attendees containing a variety of products. Emission factors for only paper, printed documents and compact discs are included in the CCEM, as emission factors for other products were unattainable. NZSSES contract a local printing supplier SMP Solutions[17] who use the company Soarprint[18]. Soarprint have a gold standard Enviro-mark (NZ Landcare Research environmental management system). They use soya and vegetable based inks, biodegradable plastics to print on and provide sustainably produced Forest Stewardship Council (FSC) paper stock[19]. As no carbon emission calculations have been carried out for Soarprint, standard emission factors for publications and printed paper (Table 4) were taken from the World Resources Institute (WRI)[20]. Emission factors for plain paper and recycled paper[21] are also included for distributed pads etc.

Two input options in the CCEM are provided, weight of paper in kilograms or number of sheets. This is based on the assumption that an A4 paper size weighs 5 grams. (For different sized paper the number of sheets can be multiplied by the size difference in relation to A4.)

Table 4: Paper and printed documents emission factors

Paper type	Emission factor (kg CO_2/kg)	Emission factor (kg CO_2/No. of sheets)	Reference
Publications	5.12	0.03	WRI[20]
Printed paper	4.93	0.02	WRI[20]
Plain paper	2.72	0.01	EPA[21]
Recycled paper	1.78	0.01	EPA[21]

An emission factor of 0.5kg CO_2/disc[22] is provided for instances when discs (CDs or DVDs) are distributed. These are not included in the NZSSES delegate package but have been included for possible future use.

Waste

The waste to landfill emission factor selected is 0.9 CO_2e per tonne, representing office waste of an unknown composition with landfill gas recovery[23]. The University of Auckland waste is disposed to the Redvale, Dairy Flat landfill which captures methane gas and redistributes it back into the national power grid[24]. Recycling plastics, tin, glass and organic waste will be the main method for minimising waste emissions by reducing the quantity of waste to landfill. The CCEM provides three options of information input. The first is 'waste in kilograms' where the user inputs the known waste weight, and the other two options are predetermined options of 'number of 6kg bags' (standard rubbish bag) or 'number of wheelie bins' (25kg).

Venue Energy Use

The conference requires energy for lighting, multimedia devices and air conditioning. Lighting and multimedia are powered by electricity, and air-conditioning by both electricity and natural gas. Emission factors selected for electricity and gas are those used by the New Zealand Government[23]. Additional emission factors for electricity and gas are included which account for the transmission and distribution line losses caused by inefficiencies in the system**Error! Bookmark not defined.**, as seen in Table 5.

Table 5: Electricity and Gas Emission Factors**Error! Bookmark not defined.**

Energy type	Emission factor (kg CO_2/kWh)
Electricity	**0.229**
Generation	0.209
Transmission and distribution line losses	0.020
Gas	**0.215**
Generation	0.190

Transmission and distribution line losses	0.025

The methodology used to find the conference venue energy is based on an average energy usage per square metre for lighting, multimedia and air-conditioning. The CCEM requires inputs of hours or usage and floor area (square metres) utilised by the conference to calculate the total energy emissions. Within the CCEM, hours and area used are automatically multiplied by an equipment factor for lighting, multimedia and air-conditioning, as seen in Table 6. The equipment factor is a predetermined figure of the devices energy use per square metre per hour. The lighting power is assumed to be an average lighting intensity of 18 watts per square metre, derived from a report on office lighting conditions in Central Auckland[25]. For multimedia devices, power usage is taken as an approximate rate of power consumption (wattage rating) for each electronic device obtained from manufacturer's figures. The multimedia facilities included in the CCEM consist of a sound system, data projector, lectern computer, laptops and room controller[26]. Additional devices may be used however the increased power consumption resulting from these will be insignificant. The electricity and gas quantities for air conditioning were obtained from the annual usage of electricity and gas for air conditioning in the School of Engineering complex[27], approximate annual usage hours and the respective floor area. This provided units of an average kilowatt per hour rate per square metre of floor space in the Engineering School complex. The data analysed for annual usage hours was obtained from the 'Time of Use' (TOU) metering service[28] 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 CCEM requires yearly updates of the annual electricity and gas usages for the complex.

Table 6: Venue equipment power usage

Power usage	Equipment factor	Unit
Lighting intensity	0.018	kW/m^2
Multimedia	2.707	kW
Air-conditioning electricity	0.035	$kWh/m^2/h$
Air-conditioning gas	0.007	$kWh/m^2/h$

The proportion of the School of Engineering complex utilised by the conference was found by obtaining the gross floor area of School of Engineering complex[27] and the floor area for which the conference shall be using. The area of the lecture theatres are exact values obtained from the University[29], 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.

Conference Transport

Delegate transportation to and from conferences (specifically air travel), will make up the majority of emissions associated with international conference events. The CCEM transportation emission factors are provided for air travel and overland travel.

For air travel, separate emission factors are used for domestic, short haul, and long haul flights based on flight distance. This is to account for the large proportion of fuel used during takeoff and landing as opposed to cruising at altitude. Table 7 specifies the distance range of each flight type and their respective emission factors with a domestic flight length based on the furthest domestic flight being 1177km, Auckland to Invercargill[30]. The CCEM does not account for the impact of 'Radiative Forcing' (non-CO_2 climate change impacts) due to the current uncertainty of Radiative Forcing science[33]. The emission factors include a 9.5 percent increase that accounts for indirect aircraft routing and delays recommended by the IPCC[31]. Selection of flight origin is required for the CCEM to automatically compute flight emissions based on predetermined flight distances from the origin to Auckland (conference location)[32,30] with the assumption that all flights are return. A range of likely origins is provided for air and overland travel, with the option of manually entering a distance if the origin required is not specified.

Table 7: Emission factors for air transport[33]

	Emission factor (kg CO_2/km)	Flight distance (km)
Domestic	0.173	< 1200
Short Haul	0.143	1200 - 3700
Long Haul	0.116	> 3700

For overland travel, the CCEM requires inputs of a selected origin and mode of transport. For delegates carpooling, the travel distance can be adjusted to represent the individual's contribution to the travel emissions. The various transportation modes provided in the CCEM and their assigned emission factors are listed in

Table 9, where it can be seen that train transportation has the lowest emission factor, closely followed by bus and motorbike. The bus emission factor for buses applies to regular buses taken from a British source[33] (as a NZ specific factor was not available), which reflects British bus sizes, models, and passenger occupancy statistics. For car transportation there is the option of small, large or hybrid vehicle travel. Small and large vehicles are based on engine size with small vehicles considered to have an engine sized between 1.4 - 2 litres and large vehicles sized 2 litres or greater[33]. A hybrid vehicle is assumed to be similar to a hybrid Toyota Pirius 2007[34] as this has a quantified emission factor. For taxis, an emission factor quantified for a common vehicle in an Auckland taxi company fleet, the Holden Commodore Executive 2004[35] was adopted. The motorbike emission factor is based on a medium engine size of between 125cc and 500cc[33].

Table 9: Transportation emission factors

Transport	Emission factor (kg CO_2/km)	Reference
Bus	0.089	DEFRA[33]
Car-hybrid	0.106	Toyota[34]
Car-small	0.191	DEFRA[33]
Car-large	0.261	DEFRA[33]
Motorbike	0.094	DEFRA[33]
Taxi-regular	0.255	Rightcar[35]
Train	0.060	DEFRA[33]

Accommodation

Carbon emission factors for accommodation are based on type, rating, location and accreditation from studies or research available. The CCEM accommodation selection is individually calculated for delegates over three options of accommodation: hotel, motel and hostel/backpackers. Table 11 displays the emission factors selected for the specific accommodation types which are based on calculations from NZ accommodation energy data[36]. This is conservatively calculated based on the energy only being from an electricity source (neglecting gas, where gas has a lower emission factor) which is 75% for hotels and 85-90% for backpackers and motels. The purchased NZ electricity emission factor was used with the inclusion of transmission and distribution line losses[Error! Bookmark not defined.].

Table 11: Emission factors per guest night room for different accommodation type[36].

Accommodation type	Emission factor (kg CO_2/ room and guest night)
Hotel	11.63
Motel	2.30
Backpackers	3.05

A range of carbon emissions for hotels were observed ranging from 1.4 kg CO_2/ per room per night [37] – 50 kg CO_2/ per room per night[38]. The selected emission factor is comparable to that quantified for a five star Auckland hotel[39] which would have a high energy use. It is also above the 8.01 kg CO_2/ per room per night, used by NZ Land Research program carbonzero[1] and US sources[40] which is based on the average energy consumption and average occupancy rates from survey data[41]. The emission factor for hotel accommodation is far greater than that for motels due to hotels high energy consumption for the various services such as restaurants, lifts, conference rooms and communal areas such as the lobby, a swimming pool and gym. Also continuous lighting for all the corridors is provided.

As carbon emission factors for accommodation within the model are only approximates based on estimates, recommendations are made on accommodation within Auckland for hotels with green initiatives and accreditation. Green Globe provides a company benchmarking system against specific Sector Benchmarking Indicators (SBI)[42] which focuses on carbon emission reduction instead of carbon offsetting. Green globe accredited accommodation in Auckland includes the Langham hotel, Heritage hotel and Citylife[43]. Auckland City Hotel also announced a green clean environment stance early this year with energy saving initiatives, recycling and other emission saving schemes.

Offsetting and carbon credits

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

Offset Projects

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

Bio-sequestration projects cover forestation and land management projects that reduce 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 many great advantages (ecosystem improvement and food, shelter and medicine provision) as well as making up for the global extent of deforestation (produces 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. Leakage is the indirect cause of emissions (clearing and logging) occurring elsewhere as a result of areas being protected[45]. A lack of biodiversity with reforestation and afforestation projects results from the general monoculture approach, 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. Therefore forestation projects tend to be relatively unreliable for carbon offsets.

Renewable energy offsets involve projects using wind power, hydro power (usually small scale), solar power, and biomass power generation. These projects ultimately reduce fossil fuel reliance, lowering 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 capital generated from selling carbon credits also contribute to renewable energy projects being more commercially viable.

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

Greenhouse gas capture is the capture of greenhouses gases to prevent them from entering the atmosphere. These consist of methane (CH_4), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), methane nitrous oxide (N_2O) and perfluorocarbons (PFCs) from agriculture and industrial processes. The captured gases are then used for other purposes.

For the NZSSES conference, preference for offsetting projects other than tree planting has been specified[7] due to the unreliability of the credits and their associated controversy. Therefore offset companies that provide only forestation projects were not covered.

Offset Standards

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. International accreditation standards are the Gold Standard and the Kyoto Protocol flexibility mechanisms: Clean Development Mechanism, Joint Implication and Emissions Trading. The two major standards Clean Development Mechanism and Gold Standard are outlined.

Clean Development Mechanism (CDM) projects are part of the United Nations Framework Convention on Climate Change (UNFCCC). They are designed for developed countries to offset their carbon emissions, via projects in developing countries. CDM credits are Certified Emission Reduction (CERs) which 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 that issue of double counting is avoided which occurs from projects hosted 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. This can be easily solved but so far no mechanisms have been implemented to do so[44]. CDM projects require additionality assessment to confirm that the project would not have occurred without the financial assistance of carbon credits, and hence is an additional means of reducing carbon emissions.

The Gold standard (GS) managed by the Basal-based Gold Standard Foundation, was founded in 2003 by a number of prominent non-governmental organizations to allow for a wider range of smaller offset projects. Based on CDM rules and still requiring a UNFCCC accredited organisation for validation, the purpose of the GS is to encourage sustainable development at a local level with smaller scale projects. An easier and more affordable accreditation process, the GS allows small micro-finance projects to band together to gain joint accreditation, with a requirement of community involvement. The GS only covers energy efficiency and renewable energy projects but they can be hosted anywhere unlike CDM projects. The Gold Standard can also be used within the voluntary market with Verified Emission Reduction (VERs). Both CDM and GC credits are recorded within a registry to ensure they are not sold more than once.

CDM Certified Emission Reductions (CERs) are for trade within the mandatory market and can be purchased before the actual reduction. They are developed to help countries meet their Kyoto targets which result in high accreditation costs, and are therefore generally used for large industrial scale projects. GS Verified Emission Reduction (VERs) is a standard lower than the CERs which can only be used within the voluntary market. They are cheaper and easier to gain accreditation for and are generally used for smaller community projects with more social and environmental benefits. VER credits require no additionality compliance and provide the flexibility to utilise methodology and innovative technologies that have not been yet approved for the CDM. Both one CER and one VER are equal to one tonne of CO_2.

Other standards present are the Joint Implication, another Kyoto Protocol mechanism which provides Emission Reduction Units (ERU), Voluntary Carbon Standard (VCS) which provide Voluntary Carbon Units (VCU) specifically for the voluntary market, and proprietary standards from individual offsetting providers (for example, Greenhouse friendly). The International Organisation for Standardisation (ISO) and the Greenhouse Gas Initiative have also produced an auditing framework for validation and verification for emission removing projects[45].

Offset Providers

Most carbon offsetting providers supply offset credits but require use of their specific calculator to determine total emissions. Some offer event packages of a set CO_2 tonnage predetermined from a general number of attendees, transportation, flights and heating, cooking, waste etc[46,47]. Table 12 presents a comparison of major offset providers that provide carbon credit purchase with their current offset projects, accreditation and certification standards and price to offset one tonne of carbon ($NZ).

Table 12: Comparison of Offset Providers

Offset provider	Country	Projects	Standards	One tonne CO_2 (NZ$)
Offset the Rest[47]	NZ	Renewable energy: NZ -Te Apiti wind farm and India- Biomass power plant	GS, CDM	$39.28
Climate Friendly[48]	Australia	Renewable Energy NZ - Te Apiti wind farm India- Jaisalmer wind farm	GS, VERs	$31.70
Carbon Reduction Institute[37]	Australia	Landfill gas capture	Greenhouse Friendly	$20.70
Go Zero Footprint[49]	Canadian	Biosequestration for micro-finance projects	CDM, ISO 14064-2	$20.65
The Carbonneutral Company[50]	UK	Renewable energy, energy efficiency, landfill gas capture, forestry	CDM, GS, VCS	$19.50
Climate Care[51]	UK	Renewable energy, energy efficiency	CDM (CERs), GS. VCS	$23.00
Terrapass[46]	USA	Renewable Eenergy, landfill gas capture, biodigester	VCS, GS, ISO 14064-2	$14.50

For a NZ based offset company, 'Offset the Rest' is the primary choice as it provides GS carbon credits for a NZ based project and a CDM project. The disadvantage is that these are the highest priced credits 'per tonne of carbon' observed, though purchase of these will be supporting a NZ company. For international offset companies considered, UK Terrapass and The Carbonnuetral Company provide credits for CDM and GS projects for a price considerably lower than Offset the Rest. There is no preference for NZ or international offset projects as greenhouse gas emissions are a global issue irrespective of where the emissions are produced.

Conclusion

This paper and the CCEM developed provide a simple tool for conference organisers to quantify conference carbon emissions produced and implement carbon offsetting, resulting in a more sustainable means of holding a conference. With inputs of specified conference usage quantities, the CCEM calculates the total carbon emissions produced by the conference, and individual emissions produced from delegate travel and accommodation. The CCEM allows easy adaption for other conference use and updates of future emission factors. This paper specifies the technical background for the emission factors and methodology used for each CCEM input parameter.

The CCEM input parameters required to calculate the total emissions for the conference consist of conference venue information, conference consumables and delegate travel and accommodation information. The conference venue inputs are area used and hours of usage, to output a total emission related to the energy used. Conference consumables consist of food, beverage, materials and waste quantities used. Delegate travel is provided for air travel and overland travel with inputs of travel distances and transportation mode required. Travel distances are provided for a selection of origins with the option of manually inputting a distance. The list of different transportation modes consists of bus, car (small, large and hybrid), taxi, train and walking/cycling. Accommodation inputs are for the selection of accommodation type from hotel, motel or backpackers with the corresponding number of nights and rooms. Initiatives recommended to reduce emissions are to use locally produced food and beverages, recycle waste, transport via train and bus, and use Green Globe accommodation close to venue.

Carbon offset projects consist of four different types of emission offsetting projects, biosequestration, renewable energy, energy efficiency and greenhouse gas capture projects. The projects are accredited by Clean Development mechanism, Gold Standards, Voluntary Carbon Standards and ISO 14064 producing certified and verified reduction units and voluntary carbon units respectively. From numerous offset programs available a recommended NZ company 'Offset the Rest' is proposed to support a NZ company. They provide Gold standard carbon credits at $39.28 (as at June 2008) for renewable energy projects within New Zealand and India (Clean Development Mechanism project). A range of International offset providers offer similar accredited projects for a price considerably less from $15.00 -$30.00 NZ.

References

[1] NZ Landcare Research Carbonzero. [cited 2008 Jun 5]. Available from: www.carbonzero.co.nz

[2] SoFi EM [homepage on the internet]. PE International “Experts in Sustainability”. [cited 2008 Jun 5]. Available from: www.sofi-software.com/fileadmin/SoFi/SoFi_EM_demo-final.pdf

[3] Sima Pro [homepage on the internet]. [Cited 2008 Jun 3]. Available from: www.simapro.com/simapro

[4] SETAC carbon neutral conference [homepage on the internet]. [Cited 2008 Jun 4]. Available from: www.pe-international.com/consulting/carbon-footprint/co2-concept/project-carbon-offset-setac-conference/

[5] Climate change: carbon offsetting [homepage on the internet]. Department for Environmental Food and Rural Affairs (DEFRA) [cited 2008 Jun 21]. Available from: www.defra.gov.uk/environment/climatechange/uk/carbonoffset

[6] NZ Society for Sustainability Engineering and Science (NZSSES). [homepage on the internet]. http://www.nzsses.auckland.ac.nz/

[7] Vicky Adin, NZSSES Conference Manager [2008 May 15]

[8] Saunders, C. Barber, A. & Taylor, G. *Food Miles – Comparative Energy/Emissions Performance of New Zealand’s Agriculture Industry*. Research Report 285. AERU, Lincoln University, New Zealand. 2006.

[9] Barber, A. Seven Case Study Farms: Total Energy & Carbon Indicators for New Zealand Arable & Outdoor Vegetable Production, AgriLINK New Zealand Ltd. 2005.

[10] LCA Food Database [homepage on the internet]. LCA Food Database, Denmark [Cited 2008 Jun 4]. Available from: http://www.lcafood.dk/.

[11] Rose, BJ “*How to reduce greenhouse gas emissions, save money and maintain quality of life*”. 2006. http://www.tweed.nsw.gov.au/Agenda21/pdfs/Household%20GHG%20reduction%20guide.pdf

[12] IPCC EFDB, NMVOC Emission Factor for Food and Drink Production. [Cited 2008 Jun 4]. Available from: http://www.ipcc-nggip.iges.or.jp/EFDB/find_ef_ft.php

[13] Garnett, T. *The Alcohol we drink and its contribution to the UK's Greenhouse Gas Emissions*. 2007. http://www.fcrn.org.uk/frcnResearch/publications/PDFs/ALCOHOL%20final%20version%20TG%20feb%202007.pdf

[14] New Zealand Wine Company [homepage on the internet]. [Cited 2008 Jun 4]. Available from: www.nzwineco.co.nz

[15] The International Wine Industry Greenhouse Gas Accounting Calculator [homepage on the internet].Winemakers’ Federation of Australia. 2008. [Cited 2008 May 17]. Available from: http://www.wfa.org.au/PDF/GHG_Calculator_Version_1.1.xls

[16] Colman, T. Pastor, P. "*Red, White, and “Green”: the Cost of Carbon in the Global Wine Trade",* American Association of Wine Economists Working paper No.9. 2007

[17]SMP Solutions [homepage on the internet]. [Cited 2008 Jun 2]. Available from: www.smpsolutions.co.nz

[18]Soar print [homepage on the internet]. [Cited 2008 Jun 2]. Available from: www.soarprint.co.nz

[19]Forest Stewardship Council (FSC) [homepage on the internet]. [Cited 2008 Jun 4]. Available from: www.fsc.org.

[20] World Resource Institute – CO_2 Inventory Report for calendar years 2004 & 2005, [homepage on the internet]. [Cited 2008 May 19]. Available from: http://pdf.wri.org/wri_co2_inventory_0405.pdf

[21] EPA Ecological Footprint Calculator Technical Background Paper. [homepage on the internet]. [Cited 2008 May 24]. Available from: http://epanote2.epa.vic.gov.au/EPA/Publications.nsf/2f1c2625731746aa4a256ce90001cbb5/f4750e35750290ecca256fbd000b030c/$FILE/972.pdf

[22] The Green Initiative. *Carbon Free CD Project.* 2005 [homepage on the internet]. [Cited 2008 May 24]. Available from: www.thegreeninitiative.com/files/pdf/cd_carbon_free.pdf

[23] Guidance for Voluntary, Corporate Greenhouse Gas Reporting.April 2008. NZ Ministry for the Environment (MFE)

[24] Waste Management. [homepage on the internet]. [Cited 2008 May 24]. Available from: www.transpacific.com.au

[25] The Development of Acceptable Solutions for Office Building Energy Efficiency. Paul Bannister BSc(Hons) PhD. Lisa Guan BE MBldgSc

[26] Correspondence from David L. Cunningham, Teaching Environments Lead , Lecture Theatre Management Unit, University of Auckland. [2008 21 May]

[27] Correspondence from Denis Agate , Energy Manager, Property Services, University of Auckland

[28] Time of use (TOU) metering service from 'STREAM' using the University of Auckland online account [cited 2008 22 May] Available from: www.streaminfo.co.nz

[29] University of Auckland Property Services InSite floor plan database

[30]Travel Happy Flight Calculator [homepage on the internet]. Travel Happy [Cited 2008 Jun 4]. Available from www.travelhappy.co.uk/mytrip/

[31] Aviation and the Global Atmosphere, section 8.2.2.323. Intergovernmental Panel on Climate Change. 1999

[32] Quantas Points Calculator [homepage on the internet]. Quantas Airlines [Cited 2008 Jun 4]. Available from: https://www.qantas.com.au/fflyer/do/dyns/InitialPointsRedeemed

[33] 'Passenger transport emission factors' methodology paper (2007) British Department for Environment, Food and Rural Affairs (DEFRA)

[34] Toyota Hybrid Prius 2007 [homepage on the internet].Toyota New Zealand [Cited 2008 Jun 4]. Available from: www.toyota.co.nz

[35]Holden Commodore Executive 2004 Emission factor [homepage on the internet]. The Right Car , Land Transport New Zealand [Cited 2008 Jun 4]. Available from: /www.rightcar.govt.nz

[36]BECKEN, S. *Energy Use in the New Zealand Accommodation Sector- Report of a survey*. 2009. Landcare Research and Tourism Research and Educaiton Centre, Lincoln University. http://www.lincoln.ac.nz/story_images/909_sbaccom_s3364.pdf

[37]The Carbon Reduction Institute [homepage on the internet]. [Cited 2008 Jun 4]. Available from: www.noco2.com.au

[38] Easy Being Green calculator [homepage on the internet] Last Minute[Cited 2008 Jun 4]. Available from http://lastminute.easybeinggreen.com.au

[39] The Langham Auckland: Corporate Social and Environmental Responsibility

[40] Thesen, S. Pacific Gas & Electric Co. *Greenhouse Gas Emissions Associated with Attending the "3rd International Conference on* SF_6 *and the Environment".* http://www.epa.gov/electricpower-sf6/documents/conf04_thesen_addinfo.pdf

[41] Becken, S. Measuring National Carbon Dioxide Emissions from Tourism as a Key Step Towards Achieving Sustainable Tourism. *Journal of Sustainable Tourism.* 2006. Vol 14. No. 4

[42]Green Globe Standards [homepage on the internet]. Green Globe New Zealand [Cited 2008 Jun 4]. Available from: http://www.greenglobenz.com/

[43]Green Globe [homepage on the internet]. Heritage hotels New Zealand [Cited 2008 Jun 4]. Available from: http://www.heritagehotels.co.nz/Green-Globe/

[44]Kollmuss, A. Carbon Offsets 101. *World Watch.* 2007. Vol. 20 Issue 4, p9-14, 6p, 6c

[45]Zerofootprint: Everything you wanted to know about offsetting but were afraid to ask. Available from: http://calc.zerofootprint.net/pdf/Everything_Zero_web.pdf

[46]Terrapass Carbon Offsets [homepage on the internet]. Terrapass, USA. [Cited 2008 Jun 4]. Available from: www.terrapass.com

[47]Offset the Rest Carbon Offsets [homepage on the internet]. Offset the Rest, New Zealand [Cited 2008 Jun 4]. Available from: www.offsettherest.co.nz

[48]Climate Friendly Carbon Offsets [homepage on the internet]. Climate Friendly, Australia [Cited 2008 Jun 4]. Available from: www.climatefriendly.com

[49] Zerofootprint Offsets [homepage on the internet]. Zerofootprint, Canada [Cited 2008 Jun 4]. Available from: http://www.zerofootprint.net/offsets

[50] The Carbonneutral Company Carbon Offsets [homepage on the internet]. The Carbonneutral Company, UK [Cited 2008 Jun 4]. Available from: www.carbonneutral.com

[51]ClimateCare Carbon Offsets [homepage on the internet]. ClimateCare, UK [Cited 2008 Jun 4]. Available from: www.climatecare.org