How to calculate your business's carbon footprint

What is a carbon footprint?

A carbon footprint is the total greenhouse gas emissions emitted by a business for a financial year or over the entire lifetime of a product or service. For national reporting purposes emission estimates are calculated over a 12 month period. It is essential that estimates are transparent, consistent, comparable, complete and accurate.

Which greenhouse gases should be included in my carbon footprint?

Greenhouse gases that are required to be included in a carbon footprint for National Greenhouse and Energy Reporting (NGERS) purposes include:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Sulphur hexafluoride (SF_6)
- Hydrofluorocarbons
- Perfluorocarbons

If your business combusts any fossil fuel such as petrol, diesel or LPG it will be emitting CO_2, CH_4 and N_2O.

If you are from the magnesium production industry, an electrical utility or an electronics manufacturer then your may be emitting sulphur hexafluoride. This gas is called a fugitive gas as it is emitted as a result of leaks or from some other unintended or irregular release.

Hydrofluorocarbons (HFC) are a replacement for chlorofluorocarbons (CFC) which were banned in Australia because they release chlorine atoms in the stratosphere that then deplete the ozone layer. HFCs typically leak from commercial air conditioning systems and industrial refrigeration units. Similarly perfluorocarbons (PFTs) are being used in large refrigeration units to replace CFCs.

CONTACT

UniQuest Pty Limited

T: 3365 4037
E: enquiries@uniquest.com.au
www.uniquest.com.au

What are the units for carbon footprint?

A carbon footprint is expressed as kilograms or tonnes of CO_2 equivalents or CO_2-e. Converting all greenhouse gases to CO_2-e allows the impacts of different greenhouse gases to be added together.

Carbon dioxide equivalents are computed by multiplying the weight of the gas being emitted (for example, methane) by its estimated global warming potential (e.g. 21 for methane). See the table below for typical GWP values.

Global Warming Potential (GWP)

Gas	Chemical formula	GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbons HFCs		
HFC-23	CHF_3	11,700
HFC-32	CH_2F_2	650
HFC-41	CH_3F	150
HFC-43-10mee	$C_5H_2F_{10}$	1,300
HFC-125	C_2HF_5	2,800
HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1,000
HFC-134a	C2H2F4 (CH2FCF3)	1,300
HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	300
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3,800
HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	140
HFC-227ea	C_3HF_7	2,900
HFC-236fa	$C_3H_2F_6$	6,300
HFC-245ca	$C_3H_3F_5$	560
Perfluorocarbons PFCs		
Perfluoromethane (tetrafluoromethane)	CF_4	6,500
Perfluoroethane (hexafluoroethane)	C_2F_6	9,200
Perfluoropropane	C_3F_8	7,000
Perfluorobutane	C_4F_{10}	7,000
Perfluorocyclobutane	c-C_4F_8	8,700
Perfluoropentane	C_5F_{12}	7,500
Perfluorohexane	C^6F^{14}	7,400
Sulphur hexafluoride	SF_6	23,900

Example

In a 12 month reporting period a wastewater treatment system emitted 107 tonnes of methane gas. Convert the methane gas into CO_2-e tonnes.

Tonnes of CO_2-e = amount of gas x GWP
= 107 tCH_4 x 21
= 2 247 tCO_2-e

This means 107 tonnes of methane has the equivalent impact on global warming as 2, 247 tonnes of CO_2.

How are the boundaries of a carbon footprint set?

For national reporting purposes a carbon footprint has two types of boundaries.

1. The carbon footprint's organisational boundary

A business's carbon footprint should include all fully owned and partially owned entities over which it has operational control i.e. the business has the authority to introduce and implement operating, health, safety and environmental policies.

2. The carbon footprint's operational boundary

Emissions from within the business's organisational boundary can be broken down into three scopes that separate and define emissions produced by their operation.

For reporting purposes only scopes 1 and 2 emissions are included.

Carbon pricing (e.g. carbon tax or an emissions trading scheme) generally only targets scope 1 emissions.

Scope 1 emissions[1]

Direct greenhouse gas emissions that arise from sources or activities owned or controlled by the business.

Sources or activities that generate direct scope 1 emissions can include:

- generation of energy, heat, steam and electricity onsite from machinery that combusts carbon fuels or waste e.g. boilers, burners, turbines, heaters, furnaces, ovens, dryers or open burning.
- transport by vehicles owned and operated by the business
- onsite wastewater treatment plants
- unintentional or fugitive emissions from refrigeration and air conditioning systems

Scope 2 emissions [2]

Indirect greenhouse gas emissions from electricity, heat, or steam purchased by the business.

Activities that generate indirect scope 2 emissions include:

- operation of electrical equipment, appliances, tools and fixtures
- electric vehicles
- equipment using purchased heat or steam

Scope 3 emissions

Indirect greenhouse gas emissions from sources not owned or controlled by the business.

Activities that generate indirect scope 3 emissions include:

- employee travel to and from work
- freight transport to the site
- solid waste disposal at centralised landfill sites
- extraction and production of purchased materials
- treatment of wastewater off site

[1] NGERS (Measurement) Technical Guidelines 2010 Page 22

[2] NGERS (Measurement) Technical Guidelines 2010 Page 27

- contractor owned vehicles and outsourced activities.

'Biogenic' carbon emissions
For reporting purposes carbon dioxide emissions that result from the movement of carbon through the biogenic (short term) carbon cycle are not included in a typical carbon footprint.

'Biogenic' carbon dioxide emissions that do not need to be included in a typical carbon footprint includes those that arise from the:

- combustion of wood or other biomass
- combustion of bio-gasoline and bio-diesel
- decomposition of waste at landfill sites
- decomposition of wastewater

Note: that CH_4 and N_2O emissions from these sources are included in emissions calculations.

Scope 1: Emissions from the combustion of fuels

How are emissions from the combustion of fuels estimated?
Fuel combustion activities include stationary fuel combustion (e.g. for boilers and generators) and mobile fuel combustion (e.g. on and off road vehicles, rail, air and waterborne craft). Combustion creates water vapour, CO_2 plus very small quantities of CH_4 and N_2O.

Method [3]

$$E = Q \times EC \times EF$$

Where

E = Quantity of CO_2, CH_4 or N_2O emissions from the combustion of the specific fuel in kg CO_2-e.

Q = Quantity of the specific fuel combusted in kL, t, m^3 (must be same unit as EC).

EC = Energy content for the specific fuel in GJ/kL, GJ/t, GJ/ m^3.

EF = Emission factor for the specific fuel in kg CO_2-e /GJ.

Example
A business's car fleet consumed 300kL of diesel in the last financial year. Calculate the emissions.

[3] NGERS (Measurement) Technical Guidelines 2010 Page 57 (solid fuels), Page 83 (Gaseous fuels) and Page 105 (Liquid fuels)

CO_2 = 300kL x 38.6 GJ/kL x 69.2 kg CO_2-e/GJ
= 801 336 kgCO_2 or 801.3 tCO_2

CH_4 = 300kL x 38.6 GJ/kL x 0.2 kg CO_2-e/GJ
= 2 316 kgCO_2-e or 2.3 tCO_2-e

N_2O = 300kL x 38.6 GJ/kL x 0.5 kg CO_2-e/GJ
= 5790 kgCO_2-e or 5.8 tCO_2-e

Total CO_2-e = CO_2 + CH_4 + N_2O
= 801 tCO_2+ 2.3 tCO_2-e + 6 tCO_2-e
= 809.4

Typical energy content (EC) and emission factors (EF)
Stationary combustion

Fuel combusted	**Energy content factor (EC)**	**Emission factors (EF) kg CO_2-e/GJ**		
		CO_2	**CH_4**	**N_2O**
Black coal	27.0 GJ/t	88.2	0.03	0.2
Dry wood	16.2 GJ/t	0	0.08	1.2
CNG	0.0393 GJ/m3	51.2	0.1	0.03
Town gas	0.0390 GJ/m3	59.9	0.03	0.03
LNG	25.3 GJ/kL	51.2	0.1	0.03
Petroleum based oils (not used for fuels)	38.8 GJ/kL	27.9	0	0
Petroleum based greases	38.8 GJ/kL	27.9	0	0
Gasoline (other than for use as fuel in an aircraft)	34.2 GJ/kL	66.7	0.2	0.2
Diesel oil	38.6 GJ/kL	69.2	0.1	0.2
Fuel oil	39.7 GJ/kL	72.9	0.03	0.2
Liquefied petroleum gas	25.7 GJ/kL	59.6	0.1	0.2

Mobile combustion

Fuel combusted	**Energy content factor (EC)**	**Emission factors (EF) kg CO_2-e/GJ**		
		CO_2	**CH_4**	**N_2O**
Gasoline (other than for use as fuel in an aircraft)	34.2 GJ/kL	66.7	0.6	2.3
Diesel oil	38.6 GJ/kL	69.2	0.2	0.5
Gasoline for use as fuel in an aircraft	33.1 GJ/kL	66.3	0.04	0.7
Fuel oil	39.7 GJ/kL	72.9	0.06	0.6
Liquefied petroleum gas	26.2 GJ/kL	59.6	0.6	0.6
Biodiesel	34.6 GJ/kL	0.0	1.2	2.2
Ethanol for use as fuel in an internal combustion engine	23.4 GJ/kL	0.0	1.2	2.2
Natural gas (light duty vehicles)	0.0393 GJ/m3	51.2	5.5	0.3
Natural gas (heavy duty vehicles)	0.0393 GJ/m3	51.2	2.1	0.3

Scope 1: Emissions from industrial refrigeration units or commercial air-conditioning

How are emissions from industrial refrigeration units or commercial air-conditioning calculated?

These emissions are reported under the national reporting system if the equipment is charged with more than 100kg of refrigerant and/or uses a refrigerant with a GWP more than 1 000 and/or is a particular type of business e.g. food processor, retailer, warehouse/ wholesaler or rental, hiring or real services.

Method [4]

$$E = SR \times GWP \times L$$

Where:

E = Hydrocarbon emissions kg CO_2-e.
SR = Stock rate of gas type (kg)
GWP = Global Warming Potential of the gas type kg CO_2-e/kg gas type
EF = Rate of annual leakage (defaults in table below)

Default annual leakage rates of gas (%)

Equipment type	Default annual leakage rate of gas	
	Hydrofluorocarbons	Sulphur hexafluoride
Commercial air conditioning	0.09	
Commercial refrigeration	0.23	
Industrial refrigeration	0.16	
Gas insulated switchgear and circuit breaker applications		0.005

Example

A business's industrial refrigeration system has a stocking rate of 100kg HFC-32. The annual leakage rate is unknown. Calculate the fugitive emissions.

E = SR x GWP x L
E = 100 kg HFC-32 x 650 kg CO_2-e/kg HFC-32 x 0.16
E = 10, 400kg CO_2-e

Scope 1: Emissions from on-site sewage treatment systems

How are methane emissions from onsite sewage treatment systems calculated?

Generally sewage is either treated onsite (considered scope 1 emissions) or at a centralised treatment plant (e.g. municipal treatment plant) (considered scope 3 emissions).

[4] NGERS (Measurement) Technical Guidelines, 2010 Page 265 - 266

CO_2 emissions are not considered part of the total carbon footprint as they are part of the biogenic carbon cycle.

However, methane emissions from some types of sewage treatment plants can be significant. There are basically two types of sewage treatment systems.

1. Aerobic treatment systems that breakdown organic matter or carbon in the presence of oxygen
2. Anaerobic treatment plants that breakdown organic matter or carbon in the absence of oxygen.

Well managed aerobic systems do not generate methane and therefore no calculations are required.

Anaerobic systems and aerobic systems that are not well managed (i.e. the oxygen is not thoroughly mixed with the wastewater) do create methane emissions.

Companies that generate tradewaste refer to the next section.

Method [5]

Step 1. Find out how much BOD (Biochemical Oxygen Demand) there is in the wastewater. The breakdown of BOD in wastewater treatment systems in the absence of oxygen will create methane gas.

$$BOD_{(ww)} = Pop_{(site)} \times BOD_{(per\ person)}$$

Where:

$BOD_{(ww)}$ = Biochemical Oxygen Demand (BOD) of the wastewater in kg per year
$Pop_{(site)}$ = Population of the site measured in persons
$BOD_{(per\ person)}$ = BOD per capita per year. Default is 22.5kg per person per year.

Step 2. Determine how much CO_2-e is generated from the treatment of BOD in the wastewater and sludge

$$E = [CH_{4(ww)} + CH_{4(sludge)}]$$

Where
E = methane emissions from treatment of the site's wastewater in kg CO_2-e
$CH_{4\ (ww)}$ = methane emissions from the treatment of the wastewater in kg
$CH_{4\ (sludge)}$ = methane emissions from the treatment of the sludge in kg

To find kg CO_2-e emitted from treatment of sewage:

$$CH_{4(ww)} = BOD_{(ww)} \times (1-F_{sl}) \times F_{an} \times EF \times 21$$

Where
$CH_{4\ (ww)}$ = Methane emissions in kg CO_2-e

BOD = Biochemical Oxygen Demand of the wastewater in kg
F_{sl} = Fraction of BOD in the sludge that is removed. Default is 0.54 or 54%.
F_{an} = Fraction of the BOD that is treated anaerobically (that is in the absence of oxygen) - See table for defaults
EF = Default methane emission factor for wastewater is 0.65 $kgCH_4$/kg of BOD
21 = Global Warming Potential to convert kg CH_4 to kg CO_2-e

To find kg CO_2-e emitted from treatment of sludge:

$$CH_{4(sl)} = BOD_{(ww)} \times F_{sl} \times F_{an\ sl} \times EF \times 21$$

[5] National Greenhouse Accounts (NGA) Factors, 2010 Page 70

Where

$CH_{4\,(sl)}$ = Methane emissions in kg CO_2-e

BOD = Biochemical Oxygen Demand of the wastewater in kg

F_{sl} = Fraction of BOD in the sludge. Default is 0.54 or 54%.

$F_{an\,sl}$ = Fraction of BOD that is treated anaerobically. Default is 0.29 or 29%.

EF = Default methane emission factor for sludge is 0.65kg CH_4/kg of BOD

21 = Global Warming Potential to convert kg CH_4 to kg CO_2-e

Defaults for F_{an} [6]

Type of system	Fraction of BOD in the wastewater that will be treated anaerobically
Aerobic system (oxygen is pumped in)	0 - no methane emissions
Poorly managed aerobic system (oxygen is not being pumped to all parts of the wastewater treatment system)	0.3 or 30% of the system's BOD will be treated anaerobically which will generate some methane emissions
Anaerobic wastewater system or deep anaerobic lagoon where only a small amount of oxygen gets into the wastewater	0.8 or 80% of the wastewater is treated anaerobically which will generate a significant amount of methane emissions
Shallow anaerobic lagoon more oxygen gets into the wastewater than deeper lagoons	0.2 or 20%

Example

An onsite anaerobic wastewater treatment plant services a population of 1,000 people. Calculate the methane emissions in kg CO_2-e.

BOD = Population x BOD
BOD = 1,000 $_{person}$ x 22.5$_{kg/person/yr}$
BOD = 22,500 kg/yr

$CH_{4\ (ww)}$ = BOD x (1-F_{sl}) x F_{an} x EF x 21
(use defaults for F_{sl} = 0.54, F_{an}=0.8 and EF=0.65)
= 22,500 $_{(kg/yr)}$ x (1-0.54) x 0.8 x 0.65 x 21
= 5,382 kg x 21
= 113,022 kg CO_2-e or 113 tonnes CO_2-e

$CH_{4\ (sl)}$ = BOD x F_{sl} x $F_{an\ sl}$ x EF x 21
(use defaults for F_{sl} = 0.54, $F_{an\ sl}$=0.29 and EF=0.65)
= 22,500 (kg/yr) x 0.54 x 0.29 x 0.65 x 21
= 2,290 kg x 21
= 48,090 kg CO_2-e or 48 tonnes CO_2-e
Total Emissions = $CH_{4(ww)}$ + $CH_{4(Sl)}$ = 161 t CO_2-e

Scope 1: Emissions from off-site wastewater treatment systems

How are methane emissions from offsite wastewater (tradewaste) treatment systems calculated?

Generally wastewater is either treated onsite (considered scope 1 emissions) or at a centralised treatment plant (considered scope 3 emissions).

CO_2 emissions are not considered part of the total carbon footprint as they are part of the biogenic carbon cycle

Methane emissions from some types of wastewater treatment plants however can be significant. There are basically two types of wastewater treatment systems.

[6] National Greenhouse Accounts (NGA) Factors, 2010 Page 70

1. Aerobic treatment systems that breakdown organic matter or carbon in the presence of oxygen
2. Anaerobic treatment plants that breakdown organic matter or carbon in the absence of oxygen.

Well managed aerobic systems do not generate methane and therefore no calculations are required.

Anaerobic systems and aerobic systems that are not well managed (i.e. the oxygen is not thoroughly mixed with the wastewater) do create methane emissions.

Method [7]

Find out how much COD (Chemical Oxygen Demand) there is in the wastewater being sent off-site. The breakdown of COD in wastewater treatment systems in the absence of oxygen will create methane gas.

$$CH_{4\,(ww)} = Prod \times W_{gen} \times COD_{con} \times (1-F_{sl}) \times F_{wan} \times EF \times 21$$

$$CH_{4(sl)} = Prod \times W_{gen} \times COD_{con} \times F_{sl} \times EF \times 21$$

Where:

$CH_{4(ww)}$: Methane emissions from wastewater in kg CO_2-e
$CH_{4\,(sl)}$: Methane emissions from sludge in kg CO_2-e
COD: COD for wastewater or sludge in kg
Prod: Annual production of the business in tonnes
W_{gen}: Amount of wastewater generated by the business in kL/t (see default table below)
COD_{con}: Concentration of COD entering the wastewater treatment plant in kg/kL (see defaults table below)
F_{sl}: Fraction of COD removed from wastewater as sludge during the year (default value is 0.15 if unknown).
F_{wan}: Fraction of COD anaerobically treated by the plant during the year (see defaults table below)
EF = Default methane emission factor for wastewater and sludge is 0.25kg CH_4/kg of BOD
21 = Global Warming Potential to convert kg CH_4 to kg CO_2-e

Defaults for W_{gen}, COD_{con}, F_{wan}

Commodity	W_{gen}	COD_{con}	F_{wan}
Dairy	5.7	0.9	0.4
Pulp and paper	26.7	0.4	0.0
Meat and poultry	13.7	6.1	0.4
Organic chemicals	67.0	3.0	0.1
Sugar	0.4	3.8	0.3
Beer	5.3	6.0	0.5
Wine	23.0	1.5	0.0
Fruit	20.0	0.2	1.0
Vegetables	20.0	0.2	1.0

National Greenhouse Accounts (NGA) Factors, 2010 Page 48

[7] National Greenhouse Accounts (NGA) Factors, 2010 Page 28

More defaults for F_{an}

Type of system	Fraction of BOD in the wastewater that will be treated anaerobically
Aerobic system (oxygen is pumped in)	0 - no methane emissions
Poorly managed aerobic system (oxygen is not being pumped to all parts of the wastewater treatment system)	0.3 or 30% of the system's BOD will be treated anaerobically which will generate some methane emissions
Anaerobic wastewater system or deep anaerobic lagoon where only a small amount of oxygen gets into the wastewater	0.8 or 80% of the wastewater is treated anaerobically which will generate a significant amount of methane emissions
Shallow anaerobic lagoon more oxygen gets into the wastewater than deeper lagoons	0.2 or 20%

National Greenhouse Accounts (NGA) Factors, 2010 Page 70

Example

Calculate the emissions for a poultry producer's wastewater. The business provided the following table:

Information required for calculation	Information provided by the business
Production	150t
Wastewater generated	12kL/t
COD concentration of wastewater	5kg/kL
% sludge	10
Type of treatment	Anaerobic lagoon therefore fraction of wastewater treated anaerobically (F_{wan}) is 80% or 0.80.

$CH_{4(ww)}$

$= Prod \times W_{gen} \times COD_{con} \times (1-F_{sl}) \times F_{wan} \times EF \times 21$

= 150t x 12kL/t x 5 kg/kL x (1-0.1) x 0.8 x 0.25 x 21

= 34,020kg or 34 t CO_2-e

$CH_{4\ (sl)}$

$= Prod \times W_{gen} \times COD_{con} \times (F_{sl}) \times EF \times 21$

= 150 t x 12kL/t x 5kg/kL x 0.1 x 0.25 x 21

= 4,725 kg or 5 t CO_2-e

Example

Calculate the methane emissions from an onsite organic chemicals wastewater plant. The business produces 10,000 tonnes of organic chemical each year.

(Use defaults from table and F_{sl} default of 15%)

$CH_{4\ (ww)} = Prod \times W_{gen} \times COD_{con} \times (1-F_{sl}) \times F_{wan} \times EF \times 21$

= 10,000t x 67kL/t x 3 kg/kL x (1-0.15) x 0.1 x 0.25 x 21

= 896,962 kg or 897 t CO_2-e

$CH_{4\ (sl)}$
= Prodx W_{gen} x COD_{con} x (F_{sl}) x EF x 21

= 10,000 t x 67kL/t x 3kg/kL x 0.15 x 0.25 x 21

= 1 582 875 kg or 1 583 t CO_2-e

Scope 2: Emissions from purchase electricity

How are indirect emissions from purchased electricity calculated?
Electricity is used by small businesses for activities include lighting, space and water heating, ventilation and cooling, appliances and white goods, electronics, wastewater treatment systems and even cars.

Electricity can be generated onsite through fuel combustion or renewable energy sources. The emissions from onsite electricity generation are considered scope 1 direct emissions.

Emissions from electricity purchased from an external electricity supplier are considered a scope 2 emissions, although emissions are not directly generated onsite they are generated during production of electricity and the consumer has control over how much electricity is used.

Method [8]

E = Q x EF

Where:

E = Emissions from the consumption of purchased electricity measured in kg CO_2-e

Q = Quantity of electricity purchased in kWh (kilowatt hours)

EF = Scope 2 emission factor for the State or Territory (see table)

Note: If the electricity is purchased in gigajoules (GJ) the quantity of kilowatt hours can be calculated by dividing the amount of gigajoules by 0.0036.

Indirect emission factors for consumption of purchased electricity from a grid [9]

State, Territory or grid description	Emission factor kg CO_2-e/kWh
NSW and ACT	0.90
VIC	1.23
QLD	0.89
SA	0.72
South West interconnected system for WA	0.82
NT	0.68
TAS	0.32

8 NGERS (Measurement) Technical Guidelines, 2010 Page 340
9 NGERS (Measurement) Technical Guidelines, 2010 Page 341

Example
A Queensland company consumes 300 000kWh of electricity annually. Calculate the company's scope 2 emissions.

E = Q x EF
= 300,000 kWh x 0.89 kg CO_2-e/kWh
= 267,000 kg CO_2-e

Example
A Queensland company consumes 415 GJ of electricity annually. Calculate the company's scope 2 emissions.

Note: In this example the quantity of electricity is in GJ and needs to be converted to kWh.

E = Q x EF
= 415 GJ x 1kWh/0.0036GJ x 0.89 kg CO_2-e/kWh
= 102,597 kg CO_2-e = 103 t CO_2-e

Uncertainty of emissions estimates

How certain are we the carbon footprint we have calculated is accurate?
To ensure emissions estimates are comparable and accurate it is important to analyse how certain we are the footprint is accurate.

With the emergence of carbon pricing (e.g. carbon tax or emissions trading schemes) and new reporting schemes, there is an increased focus on data robustness as a prerequisite for accurate determinations of greenhouse gas emissions and emission reductions.

For Australia's NGERS it is a requirement to report the uncertainty of all scope 1 emissions.

1. There are many types of uncertainties in calculating greenhouse gas emissions however the only uncertainty we have to worry about for reporting purposes is statistical uncertainty. That is the error in the parameters of the equations we have used, and in particular. The uncertainty of the activity data, for example, how fuel consumption was quantified.

2. Uncertainty of the energy content factor. The energy content of some fuels varies. For example, coal varies with water content type.

3. The uncertainty of the emission factor. The conditions during combustion can impact efficiency and vary emissions produced. Examples include temperature, humidity, management practices or technology, sampling errors such as incorrectly calibrated equipment.

Below is a table of assessment of uncertainty for estimates of carbon dioxide emissions from combustion of fuels that assumes the activity data was collected using invoices

Uncertainty assessments (aggregate of uncertainty associated with activity data, energy content and emission factor) for estimates of carbon dioxide emissions from combustion of fuels. [10]

Fuel combusted	Aggregated uncertainty (%)	Fuel combusted	Aggregated uncertainty (%)
Black coal	± 29	Landfill biogas captured for combustion *	± 50
Brown coal	± 51	Sludge biogas captured for combustion *	± 50
Industrial material and tyres	± 56	Petroleum based oils (other than those used for fuels)	± 11
Non-biomass municipal materials if recycled and combusted to produce electricity	± 56	Petroleum based greases	± 11
Dry wood	± 50	Gasoline (other than for use in an aircraft)	± 5
Green or air dried wood	± 50	Gasoline used in an aircraft	± 5
Bagasse	± 50	Heating oil	± 6
Biomass municipal materials if recycled and combusted to produce electricity	± 50	Diesel oil	± 3
Unprocessed natural gas *	± 6	Fuel oil	± 3
Coal seam methane captured for combustion *	± 6	Liquefied Petroleum Gas (LPG)	± 9
Coal mine waste gas captured for combustion *	± 6	Biodiesel	± 50
Compressed Natural Gas reverted to standard conditions (CNG)	± 6	Ethanol for use as a fuel in an internal combustion engine	± 50
Town gas	± 6	Biofuels (other)	± 50
Liquefied Natural Gas (LNG)	± 8		

* Assumed quantity was measured using calibrated measuring equipment traceable to the appropriate National Standard of measurement rather than quantity obtained from invoices

[10] NGERS (Measurement) Determination, 2008 Page 230-232

Uncertainty assessments for estimates of fugitive emissions from underground and open cut mines [11]

Sources	Aggregated uncertainty (%)
Underground mines	± 50
Open cut mines	± 50
Decommissioned underground mines	± 50

Uncertainty assessment for estimates of emissions from waste [12]

Activities	Aggregated uncertainty (%)
Solid waste disposal on land	± 35
Wastewater handling (industrial)	± 65
Wastewater handling (domestic or commercial)	± 40

Uncertainty assessment for estimates of emissions from industrial refrigeration units and commercial air-conditioning systems [13]

Industrial process source	Aggregated uncertainty(%
Emissions from hydrofluorocarbons	± 30

[11] NGERS (Measurement) Determination, 2008 Page 233
[12] NGERS (Measurement) Determination, 2008 Page 233
[13] NGERS (Measurement) Determination, 2008 Page 234

(a) No liability of any nature which would otherwise exist or arise in any circumstances by reference to any part of this Fact Sheet is accepted by UniQuest;
(b) No person should rely upon all or any part of this Fact Sheet; and
(c) These provisions apply in favour of UniQuest and its directors, employees, servants, agents and consultants.