SECTION 5
Calculation tools

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Comparing greenhouse gases—the concept of 'CO_2 equivalent'

Some gases are more powerful than others in contributing to global warming. Methane, for example, is 21 times more powerful than carbon dioxide and some chlorofluorocarbons are many thousand times more powerful than carbon dioxide.

To make it easier to talk about the effects of greenhouse gas emissions as a whole, the greenhouse-enhancing effect or 'global warming potential' of each gas is expressed relative to that of carbon dioxide. Thus methane is said to have a **global warming potential** (GWP) of 21, and 1 kilogram of methane can be described as 21 kilograms of **carbon dioxide equivalent** (CO_2 equivalent, or CO_2 equiv).

Use of the terms 'CO_2 equivalent' or 'global warming potential' allows aggregate estimates of emissions to be developed, covering all gases. Comparisons can then be made between total emissions at different times, and between the emissions of different sectors and nations.

Calculating energy-related greenhouse gas emissions

The CCP™ software package provides all the tools necessary to calculate greenhouse gas emissions from buildings, facilities and vehicle fleets.

You simply enter the energy consumption and other relevant data (such as floor area) for the facility, and the software automatically calculates emissions.

If you want to **manually calculate greenhouse gas emissions** associated with energy used for particular activity—for example, after you have collected metering results for a refrigerator—the following procedure can be used.

Multiply energy consumption by greenhouse coefficient (for relevant fuel and location—see below).

To find the relevant greenhouse coefficient:

- open the CCP™ software
- open the ‘Settings’ pulldown menu
- select ‘Geographical Information’ and select your state; this selects the appropriate greenhouse coefficients for your location
- **for fuels other than electricity**, select ‘emissions coefficients’, to see a table of CO_2 coefficients for all fuels likely to be used. Copy out the required coefficient and use it as explained above
- **for electricity**, select ‘electricity coefficients’, to see a table of CO_2 coefficients for electricity in your state for several years. Select the year nearest the year to which your energy data apply. Copy out the required coefficient and use it as explained above. Alternatively, your electricity supplier may be able to provide you with the greenhouse coefficient most applicable for your circumstances.

  The greenhouse coefficient for Green Power is zero.

Some examples are provided on the following pages, drawn from the Energy sheets in section 4 of the workbook.

Lighting

For each group of lights:

1. Calculate the annual electricity use for one light in kilowatt hours (kWh) by multiplying the power of the lamp by the number of hours of operation; the table below gives sample values for a range of different lamp types and applications.
2. Multiply by the number of lights to give the total energy use of the group of lights,
3. Use the greenhouse coefficients in your CCP™ software to convert the annual electricity use (kWh) to greenhouse gas emissions (tonnes of CO_2 equivalent)

Lighting application	Operating hrs/year	Annual energy use (kWh/year) by lamp type				
		Fluorescent		Incandescent		
		Single 1200 mm (45 W[1])	Twin 1200mm (90 W[1])	Low-voltage 50 watt (65 W[2])	Standard 'bulb' (75 W)	Tungsten (example) (250 W)
Office, individual	1,250	56	113	81	94	313
Office, open plan	2,000	90	180	130	150	500
Library	3,000	135	270	195	225	750
Depot office, two shifts	4,000	180	360	260	300	1,000
Gymnasium	5,000	225	450	325	375	1,250
Continuous running	8,760	394	788	569	657	2,190

[1] Including ballast

[2] Including transformer

Example

A Perth library has 150 fluorescent fittings, each with two 1200 mm lamps. These operate for 3,000 hours per year. The electricity supply contract includes 25 per cent Green Power. What is the amount of CO_2 emitted as a result of supplying lights with electricity?

1. Annual electricity use for one light	From table above	= 270 kWh/yr
2. Annual electricity use for all lights	270 kWh/yr x 150 lights	= 40,500 kWh/yr
3. Deduct proportion of Green Power	40,500 – (0.25 x 40,500)	= 30,375 kWh/yr
4. Greenhouse emissions from lighting	From CCP™ software[1]	= 33.4 tonnes CO_2/yr

[1] Factor for WA electricity is 1.10, so emissions are 30,375 kWh x 1.10 = 33,4125 kg CO_2 = 33.4 tonnes CO_2 per year

Motors

For each motor:

1. Calculate the annual electricity use in kilowatt hours (kWh) by multiplying the average power of the motor by the number of hours of operation; the table below gives sample values for a range of different motors and applications.
2. Use the greenhouse coefficients in your CCP™ software to convert the annual electricity use (kWh) to greenhouse gas emissions (tonnes of CO_2 equivalent)

Application	Operating hrs/year	Annual energy use (MWh/year[1]) by average power of motor					
		1 kW	2 kW	5 kW	7.5 kW	15 kW	25 kW
Office cooling	1,000	1.0	2.0	5.0	7.5	15	25
Office heating pump	1,500	1.5	3.0	7.5	11.3	23	38
Office airconditioning fan	2,500	2.5	5.0	12.5	18.8	38	63
Depot (2 shifts)	4,000	4	8	20	30	60	100
Gymnasium fan	5,000	5	10	25	38	75	125
Continuous running	8,760	9	18	44	66	131	219

[1] 1 MWh (megawatt hour) = 1000 kWh (kilowatt hours)

Example

For example, a 20 kW airconditioning fan in the municipal offices operates for 2500 hours per year. The electricity supply contract includes a 25 per cent Green Power component, with the remainder of the electricity generated in Queensland. What is the amount of CO_2 emitted as a result of supplying the motor with electricity?

In this case, the table doesn't give values for a 20 kW motor, so you could use the figure for a 1 kW motor operating for 2500 hours and multiply it by 20.

1. Annual electricity use for a 1 kW motor	From table above	= 2.5 MWh/yr
2. Annual electricity use for 20 kW motor	2.5 MWh/yr x 20	= 50 MWh/yr
3. Deduct proportion of Green Power	50 – (0.25 x 50)	= 37.5 MWh/yr
4. Greenhouse emissions from lighting	From CCP™ software[1]	= 38.3 tonnes CO_2/yr

[1] Factor for Qld electricity is 1.02, so emissions are 37.5 MWh x 1.02 = 38.25 tonnes CO_2 per year

Heating and cooling buildings

Ideally, energy use for HVAC should be separately metered. If this is the case, this data can be easily converted to greenhouse gas emissions.

If separate metered data is not available, ‘house power’ may be separately metered. This includes HVAC, lighting of common areas, lifts, and so on. It may be possible to estimate electricity use for activities other than HVAC, and subtract this from the ‘house power’ to give an estimate of HVAC consumption.

If only the whole building’s energy use is metered, this at least gives some indication of HVAC energy consumption.

Once you have some information on energy use, use the greenhouse coefficients from the CCP™ software to convert energy consumption into greenhouse gas emissions.

Hot water

To calculate the energy required to heat water, multiply the number of litres by the temperature rise by 0.00116 to calculate energy in kilowatt hours. For gas heating, multiply by 0.0053 for energy in megajoules (assuming 80 per cent efficient combustion).

For example, heating 100 litres of water from 15°C to 65°C (a rise of 50 degrees) consumes:

- for electricity: 100 x 50 x 0.00116 = 5.8 kWh
- for gas: 100 x 50 x 0.0053 = 26.5 MJ

Once you have some information on energy use, use the greenhouse coefficients from the CCP™ software to convert energy consumption into greenhouse gas emissions.

The **efficiency** of a hot water system can be calculated by comparing the energy content of the water (calculated as above) with the total energy consumption of the HWS.

For example, if an electric HWS consumes 10 kWh per day to supply the 100 litres of hot water as above (energy content 5.8 kWh), the efficiency would be:

$$\frac{5.8\text{ kWh}}{10.0\text{ kWh}} \times 100 = 58\%$$

Office equipment, refrigeration, cooking and catering

For these activities, it is unlikely that centrally metered data will provide accurate information on energy consumption.

You may be able to collect metered data yourself (see Energy sheet E4 *Using an electricity meter*). Alternatively, you should seek information from relevant equipment suppliers: remember to ask for information on standby losses as well as consumption while operating.

You should note that the information printed on the appliance approval label is unlikely to accurately reflect actual consumption: this usually indicates the maximum possible consumption.

Once you have some information on energy use, use the greenhouse coefficients from the CCP™ software to convert energy consumption into greenhouse gas emissions.