Wood fuel in New Zealand is produced from carbon neutral biomass from plantation forests

According to the IPCC Guidelines[1] $C0_2$ emissions from the combustion of biomass are reported as zero in the energy sector.

[Extracted from Intergovernmental Panel on Climate Change (IPCC) www.ipcc-nggip.iges.or.jp/faq/faq.htm]

IPCC Guidelines consider biomass used for energy to be carbon neutral if from organic waste and plantation forests[2]

Biomass used for energy can arise from liquid or solid organic waste streams; forest residues after extraction of logs; crop residues after harvest; or purpose-grown energy crops.

A natural forest remains carbon neutral over millennium with trees dying and new ones growing to replace them as well as the soil carbon recycling and remaining at constant levels. The exception is loss of biomass (and hence reduction in carbon stock) from degradation by external influences such as deer or possum browsing. While the use of biomass sourced from organic waste and plantation forestry are considered to be carbon neutral the Intergovernmental Panel on Climate Change (IPCC) Guidelines do not automatically consider biomass used for energy as "carbon neutral," even if the biomass is thought to be produced sustainably, because:

1. in any time period there may be CO_2 emissions and removals from the atmosphere due to the harvesting and regrowth of bioenergy crops;
2. land use changes (including soil carbon content fluctuations) caused by biomass production can also result in significant GHG fluxes; and
3. there may also be significant additional emissions which are estimated and reported in the sectors where they occur e.g.:
   a) from the processing and transportation etc. of the biomass when fossil fuels are consumed;
   b) direct methane and nitrous oxide emissions from the biomass combustion;
   c) from the production and use of fertilisers and lime if either is used in cultivation of the biomass.

For example, direct methane and nitrous oxide emissions from biomass combustion for energy use are reported in the energy sector section in the IPCC Guidelines. Although direct CO2 emissions from biomass combustion used for energy are recorded as a memo item in the Energy sector section of the IPCC Guidelines, these emissions are not included in the Energy sector total. This is to avoid double counting, because under IPCC guidelines carbon dioxide emissions and removals as a result of

[1] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf

[2] The carbon neutrality only occurs at the source of the raw biomass. Once collected, moved or treated then carbon emissions are produced and the biomass fuel is not carbon neutral.

the use of biomass for energy are included in the Agriculture, Forestry and Other Land-Use (AFOLU) sector (previously the LULUCF sector) as one of the factors that influence the losses (due to harvest) and any regrowth. Emission and removals in the AFOLU sector include:

- CO_2 emissions or removals due to changes in soil carbon and dead organic matter, and
- for perennial crops, CO_2 emissions or removals resulting from changes in biomass stocks due to harvest and regrowth.

For annual crops, the IPCC Guidelines assume that biomass carbon stock lost through harvest and plant/tree mortality equal biomass carbon stock gained through regrowth in that same year and so there are no net CO_2 emissions or removals from biomass carbon stock changes.

What is carbon neutral in biomass energy?

Carbon neutrality is a property of wood or other biomass harvested from forests (or crops) where new growth completely offsets losses of carbon caused by harvesting. Under these conditions, as carbon is released from harvested wood back into the atmosphere over time[3], usually as biogenic CO_2, growing trees are removing CO_2 from the atmosphere at a rate that completely offsets these emissions of biogenic CO_2, resulting in net biogenic CO_2 emissions of zero or less[4].

A forest producing carbon neutral wood will have stable or increasing stocks of forest carbon[5].

Growing crops for energy can result in land-use changes, both directly through the conversion of land to bioenergy production, and indirectly by driving land use changes elsewhere. GHG emissions and removals due to all the land-use changes in a country are reported in the AFOLU sector and can occur for many years after the land-use change. These will include emissions from indirect land use change within a country, although it is difficult to separate out only those fluxes due to indirect land use change driven by bioenergy production.

Indirect changes in terrestrial carbon stocks have considerable uncertainties, are not directly observable, are complex to model and are difficult to attribute to a single cause, as in this case, bioenergy production.

Why is carbon neutrality important?

Woody biomass and logs produced from forests with stable reoccurring carbon stocks (i.e. carbon neutral wood) can be used without causing long term accumulation of carbon in the atmosphere. This is because the carbon in the logs and woody biomass removed from the forest, which will eventually return to the atmosphere, is offset by carbon in CO2 removed from the atmosphere by growing trees. The use of carbon neutral wood in applications where it displaces fossil fuels, either directly or indirectly, contributes to efforts to reduce the accumulation of CO2 in the atmosphere.

If wood-producing forests have stable or increasing carbon stocks, they are producing carbon neutral wood.

[3] It is assumed in IPCC inventory that all the carbon is released at time of harvest whereas in reality of course some is locked in paper for weeks, and in building materials for years - but eventually it is released sooner or later.

[4] http://newgenerationplantations.org/multimedia/file/3229dff2-a606-11e4-9137-005056986313

[5] https://worldbioenergy.org/uploads/Factsheet%20-%20Carbon%20neutrality.pdf

Do products made from carbon neutral wood cause zero greenhouse gases?

No. Fossil fuels are used to transport wood logs and by-product residues and to produce forest products such as paper, sawn timber and pellets. In addition, small amounts of minor greenhouse gases (i.e. methane and nitrous oxide) are produced when biomass is burned and methane can be released from landfills receiving biomass products at end of life.

While biomass from plantation forests is carbon neutral, once it is collected, processed into being a fuel, and transported it is no longer carbon neutral (unless 100% renewable electricity and carbon neutral transport biofuels are used which is not yet feasible).

Voluntary reporting of greenhouse gas emissions in NZ

The Ministry for the Environment has published the report "*Measuring Emissions: A Guide for Organisations, 2022 Detailed Guide*[6]" in 16 August 2022. It sets out the methods for common emission sources for commercial, industry and residential organisations including the combustion of liquid, solid and gaseous fuels. Wood is included for industry and residential heat. The Detailed Guide sets out the methodology and provides examples.

Methodologies to determine emissions from wastewater treatment, combustion, transport and landfills are covered by a suit of eight documents as listed in Annex C.

Fuel emission factors

The emission factors for estimating emissions from combustion of biomass, transport and from waste disposed at a landfill are set out in the document "*Measuring emissions: A guide for organisations: 2022 summary of emission factors*" .

Data used in the calculations are shown in Annex B. For full details see the full guide.

The emission factor for wood is taken as 1 for CO_2 which reflects its carbon neutrality. However, the emission factors for CH_4 and N_2O emissions arising from the combustion of wood, plus fossil fuel use for the treatment of wood into a wood fuel and delivery to heat plant, means that the CO_2-e overall emission factor for wood fuel is 0.015 kg CO_2-e/ kg of wood fuel.

[6] https://environment.govt.nz/publications/measuring-emissions-a-guide-for-organisations-2022-detailed-guide/ This is the twelth version of the publication previously titled Guidance for Voluntary Greenhouse Gas Reporting. This Quick Guide is part of a suite of eight documents that comprise Measuring Emissions: A Guide for Organisations. It is for New Zealand-based organisations wishing to self-report their greenhouse gas emissions. It encourages best practice in greenhouse gas monitoring and reporting.

It explains how to produce an inventory, provides the latest emissions factors for common sources of emissions in New Zealand (based on the latest national inventory), enables organisations to easily calculate their emissions through an interactive spreadsheet, and provides examples to show what a GHG inventory and GHG report look like.

The Quick Guide is the go-to document explaining what has changed since the last update, how to produce an inventory, and what data you need to collect to work out emissions from your activities.

From a CO_2 perspective the wood resource is carbon neutral but when you consider it as a fuel delivered to a user it can't be considered to be carbon neutral if fossil fuels have been consumed during the processing and transport activities.

Bioenergy Association is currently not aware of the similar methodologies in Australia and would appreciate being advised on what applies in Australia.

Applying the IPCC Guidelines to New Zealand, Australia and the Pacific

Bioenergy produced in New Zealand and Australia where plantation forests are used as the source of biofuel is considered carbon neutral because there are no net CO_2 emissions.

Solid biomass arising from forest harvest or wood processing residues, if not used for energy are likely to be left to decompose on the forest floor or put into landfills. Both carbon dioxide and some methane will be ultimately produced. In New Zealand there is no cutting of forests for energy. Any woody biomass used to make solid fuels would otherwise have been a waste product from logging and processing the wood into timber or pulp. About 15-20% of a tree is wasted in the wood processing industry. It is going to turn into CO_2 whether it is burned or allowed to rot.

Most harvested New Zealand forests, and certainly those being logged for industrial purposes, are not native. They are fast growing exotics, grown as a crop and the waste is part of a cycle of harvest and replanting.

In Australia and elsewhere the biomass used as a fuel for heat and power production often comes from agricultural crop residues such as cereal straw, sugar cane bagasse, maize stover etc.

Annex A: Other sources of information on biomass carbon neutrality.

Dispelling misconceptions on climate effects of bioenergy from managed forests. IEA Bioenergy
https://www.usewoodfuel.org.nz/resource/iea-bioenergy-dispelling-misconceptions-on-climate-effects-of-bioenergy-from-managed

Recommendations on biomass carbon neutrality. Forest Solutions Group
https://www.usewoodfuel.org.nz/resource/report-recommendations-on-biomass-carbon-neutrality

The carbon neutrality of biomass from forests, World Bioenergy Association.
https://www.usewoodfuel.org.nz/resource/wba-factsheet-carbon-neutrality

Is energy from woody biomass positive for the climate? IEA Bioenergy
https://www.ieabioenergy.com/iea-publications/faq/woodybiomass

Campaigns questioning the use of woody biomass for energy are missing key facts, IEA Bioenergy
https://www.ieabioenergy.com/blog/publications/campaigns-questioning-the-use-of-woody-biomass-for-energy-are-missing-key-facts

The use of woody biomass for energy production in the EU, European Commission
https://www.usewoodfuel.org.nz/resource/wba-factsheet-carbon-neutrality

Annex B: Emission Factors

The emission factors for estimating emissions from combustion of biomass, transport and from waste disposed at a landfill are set out in the document "Measuring emissions: A guide for organisations: 2022 summary of emission factors"

Table 1: Stationary combustion of fuels: Residential use

Residential fuel emission Source	Unit	kg CO_2-e/unit
Coal – default	kg	2.10
Coal – bituminous	kg	2.86
Coal – sub-bituminous	kg	2.15
Coal – lignite	kg	1.54

Table 2: Stationary combustion of fuels: Commercial use

Commercial fuel emission source	Unit	kg CO_2-e/unit
Coal – default	kg	2.01
Coal – bituminous	kg	2.66
Coal – sub-bituminous	kg	2.01
Coal – lignite	kg	1.43
Diesel	litre	2.67
LPG	kg	3.03
Heavy fuel oil	litre	3.02
Light fuel oil	litre	2.96
Natural gas	kWh	0.195
	GJ	54.1

Table 3: Stationary combustion of fuels: Industrial use

Industrial fuel emission source	Unit	kg CO_2-e/unit
Coal – default	kg	1.93
Coal – bituminous	kg	2.66
Coal – sub-bituminous	kg	2.01
Coal – lignite	kg	1.43
Diesel	litre	2.66
LPG	kg	3.02
Heavy fuel oil	litre	3.02
Light fuel oil	litre	2.92
Natural gas	kWh	0.194
	GJ	54.0

Table 4: Emission factors for the stationary combustion of fuels

Emission source	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit	Uncertainties kg CO_2-e/unit
Residential use						
Coal – default	kg	1.88	1.74	0.134	0.00800	4.9%
Coal – bituminous	kg	2.86	2.64	0.211	0.0126	4.8%
Coal – sub-bituminous	kg	2.15	1.99	0.154	0.00919	4.8%
Coal – lignite	kg	1.54	1.42	0.109	0.00648	4.8%
Commercial use						
Coal – default	kg	1.77	1.76	0.00452	0.00808	3.5%
Coal – bituminous	kg	2.66	2.64	0.00703	0.0126	3.5%
Coal – sub-bituminous	kg	2.01	1.99	0.00514	0.0092	3.5%
Coal – lignite	kg	1.43	1.42	0.00362	0.0065	3.5%
Diesel	litre	2.66	2.65	0.00907	0.0065	0.5%
LPG	kg	3.03	3.02	0.00594	0.0014	0.5%
Heavy fuel oil	litre	3.03	3.01	0.00971	0.0069	0.5%
Light fuel oil	litre	2.93	2.92	0.00958	0.00685	0.5%
Natural gas	kWh	0.195	0.194	0.000405	0.0000966	2.4%
	GJ	54.1	54.0	0.113	0.0268	2.4%
Industrial use						
Coal – default	kg	2.05	2.03	0.00529	0.00946	3.5%
Coal – bituminous	kg	2.66	2.64	0.00703	0.0126	3.5%
Coal – sub-bituminous	kg	2.01	1.99	0.00514	0.00919	3.5%
Coal – lignite	kg	1.43	1.42	0.00362	0.00648	3.5%
Diesel	litre	2.66	2.65	0.00272	0.00649	0.5%
LPG	kg	3.02	3.02	0.00119	0.00142	0.5%
Heavy fuel oil	litre	3.02	3.01	0.00291	0.00695	0.5%
Light fuel oil	litre	2.92	2.92	0.00287	0.00685	0.5%
Natural gas	kWh	0.194	0.194	0.0000810	0.0000966	2.4%
	GJ	54.0	54.0	0.0225	0.0268	2.4%

Notes

- These numbers are rounded to three significant figures.
- The kg CH_4 and kg N_2O figures are expressed in kg CO_2-e.
- Commercial and industrial classifications are based on standard classification.[16]
- Use the default coal emission factor if it is not possible to identify the type of coal.
- Convert LPG-use data in litres to kilograms by multiplying by the specific gravity of 0.536 kg/litre.

Table 6: Biofuels and biomass emission factors

Biofuel type	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit	kg N_2O/unit	Uncertainties kg CO_2-e/unit
Bioethanol	GJ	3.42	64.2	2.85	0.570	0.1%
	litre	0.0000807	1.52	0.0000673	0.0000135	0.1%
Biodiesel	GJ	3.42	67.3	2.85	0.570	0.1%
	litre	0.000125	2.45	0.000104	0.0000208	0.1%
Wood – fireplaces	kg	0.0670	0.862	0.0578	0.00918	36.3%
Wood – industrial	kg	0.0150	0.862	0.00578	0.00918	43.7%

Notes

- These numbers are rounded to three significant figures.
- The kg CH_4 and kg N_2O figures are expressed in kg CO_2-e.
- The guide does not expect many commercial or industrial users will burn wood in fireplaces, but this emission factor has been provided for completeness. It is the default residential emission factor.
- The total CO_2-e emission factor for biofuels and biomass only includes methane and nitrous oxide emissions. This is based on *ISO 14064-1:2018* and the *GHG Protocol* reporting requirements for combustion of biomass as direct (Scope 1) emissions. Carbon dioxide emissions from the combustion of biologically sequestered carbon are reported separately.

Table 26: Road freight: Heavy goods vehicles

Emission source		Unit	Pre-2010 fleet kg CO_2-e	2010–2015 fleet kg CO_2-e	Post-2015 fleet kg CO_2-e
HGV diesel	<5,000 kg	km	0.446	0.423	0.421
	5,000– <7,500 kg	km	0.510	0.484	0.477
	7,500– <10,000 kg	km	0.624	0.592	0.583
	10,000– <12,000 kg	km	0.740	0.702	0.692
	12,000– <15,000 kg	km	0.841	0.798	0.786
	15,000– <20,000 kg	km	0.982	0.957	0.955
	20,000– <25,000 kg	km	1.308	1.274	1.271
	25,000– <30,000 kg	km	1.460	1.423	1.420
	≥30,000 kg	km	1.538	1.499	1.496

Table 33: Wastewater treatment

Emission source		Unit	kg CO_2-e/unit
Domestic wastewater	Average for wastewater treatment plants	m_3 water supplied	0.48
		Per capita	48.36
	Septic tanks	Per capita	175.2
Industrial wastewater	Meat (excluding poultry)	tonne of kills	47.528
	Poultry	tonne of kills	47.025
	Pulp and paper	tonne of product	10.530
	Wine	tonne of crushed grapes	5.173
	Dairy processing	m_3 of milk	0.115

Table 34: Waste disposal with and without landfill gas recovery (LFGR)

Emission source		Unit	With LFGR kg CO_2-e/unit	Without LFGR kg CO_2-e/unit
Waste (known composition)	Food	kg	0.602	1.881
	Garden	kg	0.492	1.539
	Paper	kg	0.876	2.736
	Wood	kg	0.339	1.060
	Textile	kg	0.438	1.368
	Nappies	kg	0.219	0.684
	Sludge	kg	0.137	0.428
	Other (Inert)	kg	n/a	n/a
Waste (unknown composition)	General waste	kg	0.207	0.647
	Office waste	kg	0.594	1.858

Table 35: Composting

Emission source	Unit	kg CO_2-e/unit
Composting	kg	0.172
Anaerobic digestion	kg	0.020

Table 36: Forest growth removal source

Emission source	Unit	kg CO_2-e/unit
Planted forests: Approach one – Stock change accounting		
All planted forests	ha	-35,561
Pinus radiata	ha	-36,689
Other softwoods	ha	-29,453
All hardwoods	ha	-15,957
Planted forests: Approach two – Averaging accounting		
All planted forests – first rotation (age 23 years and under)	ha	-35,561
Pinus radiata – First rotation (age 22 years and under)	ha	-36,689
Other softwoods – First rotation (age 28 years and under)	ha	-29,453
All hardwoods – First rotation (age 13 years and under)	ha	-15,957
All planted forest above the long-term average age	ha	0
Natural forests		
Post-1989 Regenerating natural forest	ha	-7,973
Pre-1990 Regenerating natural forest	ha	-1,567
Pre-1990 Tall natural forest	ha	0

Table 37: Land-use change

Emission source		Unit	kg CO_2-e/unit
Planted forests: Approach one – Stock change accounting			
All planted forests	Harvest or deforestation	ha	995,700
Pinus radiata	Harvest or deforestation	ha	1,027,286
Other softwoods	Harvest or deforestation	ha	1,178,113
All hardwoods	Harvest or deforestation	ha	239,354
Planted forests: Approach two – Averaging accounting			
All planted forests	Harvest	ha	n/a
All planted forests	Deforestation	ha	995,700
Pinus radiata	Harvest	ha	n/a
Pinus radiata	Deforestation	ha	1,027,286
Other softwoods	Harvest	ha	n/a
Other softwoods	Deforestation	ha	1,178,113
All hardwoods	Harvest	ha	n/a
All hardwoods	Deforestation	ha	239,354
Natural forests			
Post-1989 Regenerating natural forest	Deforestation	ha	141,350
Pre-1990 Regenerating natural forest	Deforestation	ha	898,704
Pre1990 Tall natural forest	Deforestation	ha	275,595

Table 38: Agriculture

Emission source		Unit	kg CO_2-e/unit
Enteric fermentation	Dairy cattle	per head	2,264
	Non-dairy cattle	per head	1,540
	Sheep	per head	318
	Deer	per head	597
	Swine	per head	27
	Goats	per head	224
	Horses	per head	450
	Alpaca	per head	200
	Mules & asses	per head	250
	Poultry	per head	0
Manure management	Dairy cattle	per head	238
	Non-dairy cattle	per head	21.4
	Sheep	per head	3.53
	Deer	per head	7.57
	Swine	per head	206
	Goats	per head	5.0
	Horses	per head	58.5
	Alpaca	per head	2.57
	Mules & asses	per head	27.5
	Poultry	per head	1.44
Fertiliser use	Nitrogen content of non-urea nitrogen fertiliser	kg	5.40
	Nitrogen content of urea nitrogen fertiliser not coated with urease inhibitor	kg	5.07
	Nitrogen content of urea nitrogen fertiliser coated with urease inhibitor	kg	4.86
	Limestone	kg	0.440
	Dolomite	kg	0.477
Agricultural soils	Dairy cattle	per head	468
	Non-dairy cattle	per head	267
	Sheep	per head	36.3
	Deer	per head	83.8
	Swine	per head	5.4
	Goats	per head	68.7
	Horses	per head	325
	Alpaca	per head	75.9
	Mules & asses	per head	145
	Poultry	per head	0.11

Annex C: The Full suite of documents setting out the methodologies used to work out the emission factors for each emission source.

This emission factors summary is part of a suite of documents that comprise Measuring emissions: A guide for organisations. https://environment.govt.nz/publications/measuring-emissions-a-guide-for-organisations-2022-summary-of-emission-factors/

Measuring emissions: a guide for organisations		
Quick guide	The go-to document explaining changes since the last update, how to produce an inventory, and what data you need to work out emissions from your activities	
Detailed guide	For users who need to know the data sources, methodologies, uncertainties and assumptions behind the emission factors for each emission source	
Emission factors summary	Quick look up tables providing the main emission factors for each emission source	THIS DOCUMENT
Emission factors workbook	As above but in Excel format across multiple tabs	
Emission factors flat file	Simple format for integration with software	
Interactive workbook	Use this spreadsheet to input your activity data, in order to work out your organisation's emissions and produce an inventory	
Example GHG inventory	Shows what a finished inventory might look like	
Example GHG report	Shows what a finished report might look like	

For guidance on how to measure and report your organisation's GHG emissions see the Quick Guide. For understanding how these emission factors were derived, see the Detailed Guide.

Annex C: Data used in the calculation of emission factors.

From 2019 Detailed Guide

Table 67: Composition of waste sent to NZ municipal landfills in 2016

Waste category	Description	Estimated composition of waste to municipal landfills 2016
Food	Food waste	16.8%
Garden	Organic material	8.3%
Paper	Paper and cardboard waste	10.7%
Wood	Wood waste	11.9%
Textile	Fabrics and other textiles	5.6%
Nappies	Nappies and similar sanitary waste	3.0%
Inert	Waste that does not produce greenhouse gas emissions	43.8%

Table 57: Industrial wastewater treatment methane emissions calculation information

Factor	Industry				Source
	Pulp and paper	Meat (excluding poultry)	Poultry	Wine	
Biodegradable chemical oxygen demand load (kg CODb/tonne)	36	50	50	12.42	Cardno (2015)
CH_4 emission factor (kg CH_4/kg CODb)	0.0117	0.03575	0.034375	0.016661	Cardno (2015)
GWP	25	25	25	25	IPCC default AR4

It is assumed that the methods used to treat wastewater from dairy processing do not result in methane emissions.

Table 58: Industrial wastewater treatment nitrous oxide emissions calculation information

Factor	Industry			Source
	Dairy product processing	Meat (excluding poultry)	Poultry	
Biodegradable chemical oxygen demand load (kg CODb/tonne)	2	50	50	Cardno (2015)
Total N:biodegradable COD ratio	0.044	0.09	0.09	Cardno (2015)
Nitrous oxide emission factor (kg N_2O/kg CODb)	0.00279	0.001348	0.001925	Cardno (2015)
GWP	298	298	298	IPCC default AR4

Based on the Cardno 2015 report we assume that there are no nitrous oxide emissions from the methods used to process wastewater from the wine and pulp and paper industries.

A.4 Reference data

Table A1: Underlying data used to calculate fuel emission factors

Emission source	User	Unit	Calorific value (MJ/unit)	t CO_2 / TJ	t CH_4 / TJ	t N_2O / TJ
Stationary combustion						
Coal – bituminous	Residential	kg	29.59	89.13	0.285	0.001425
Coal – sub-bituminous	Residential	kg	21.64	91.99	0.285	0.001425
Coal – lignite	Residential	kg	15.26	93.11	0.285	0.001425
Distributed natural gas	Commercial	kWh	n/a	0.19	0.00002	0.00000
		GJ	n/a	53.96	0.005	0.000
Coal – bituminous	Commercial	kg	29.59	89.13	0.0095	0.0014
Coal – sub-bituminous	Commercial	kg	21.64	91.99	0.0095	0.0014
Coal – lignite	Commercial	kg	15.26	93.11	0.0095	0.0014
Diesel	Commercial	litre	38.21	69.31	0.0095	0.0006
LPG	Commercial	g	50.00	60.43	0.005	0.0001
Heavy fuel oil	Commercial	litre	40.90	73.59	0.010	0.0006
Light fuel oil	Commercial	litre	40.32	72.30	0.010	0.0006
Distributed natural gas	Industry	kWh	n/a	0.19	0.000003	0.0000003
		GJ	n/a	53.96	0.001	0.00009
Coal – bituminous	Industry	kg	29.59	89.13	0.0095	0.001
Coal – sub-bituminous	Industry	g	21.64	91.99	0.0095	0.001
Coal – lignite	Industry	kg	15.26	93.11	0.0095	0.001
Diesel	Industry	litre	38.21	69.31	0.0029	0.0006
LPG	Industry	kg	50.00	60.43	0.001	0.0001
Heavy fuel oil	Industry	litre	40.90	73.59	0.003	0.0006
Light fuel oil	Industry	litre	40.32	72.30	0.003	0.0006
Transport fuels						
Regular petrol	Mobile use	litre	35.17	66.70	0.03	0.008
Premium petrol	Mobile use	litre	35.38	66.12	0.03	0.008
Diesel	Mobile use	litre	38.21	69.31	0.004	0.004
LPG	Mobile use	litre	26.54	60.43	0.06	0.0002
Heavy fuel oil	Mobile use	litre	40.90	73.59	0.007	0.002
Light fuel oil	Mobile use	litre	40.32	72.30	0.007	0.002
Jet kerosene	Mobile use	litre	46.29	68.22	0.48	1.9
Jet aviation gas	Mobile use	litre	47.3	65.89	0.48	1.9
Biofuels and biomass						
Biodiesel	All uses	litre	23.6	64.2	0.00285	0.00057
Bioethanol	All uses	litre	36.42	67.26	0.00285	0.00057

Emission source	User	Unit	Calorific value (MJ/unit)	t CO_2 / TJ	t CH_4 / TJ	t N_2O / TJ
Wood	Industry	kg	9.63	89.47	0.02	0.003
Wood	Fireplaces*	kg	9.63	89.47	0.2	0.003

Note: It is not expected that many commercial or industrial users will burn wood in fireplaces, but this emission factor is included for completeness. It is the default residential emission factor. Source: MBIE.