CO_2 Emission Factor of a Fuel

CO_2 per kg of fuel and per GJ on gross and net calorific value from the carbon content, with hourly and annual CO_2 for a firing rate.

Method: IPCC 2006 Guidelines Vol. 2 Ch. 1–2 (carbon-content method); IUPAC atomic weights; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Carbon, as fired, by mass	45.000	%
Hydrogen, as fired, by mass	3.5000	%
Moisture, as fired, by mass	10.000	%
Gross calorific value, as fired	18,600	kJ/kg
Fraction of carbon oxidised IPCC 2006 default is 100 %. Lower it only for measured unburned carbon in ash.	100.00	%
Fuel firing rate (0 = skip)	50,000	kg/h
Operating hours per year	8,000.0	h

Calculated results

Parameter	Value	Unit
CO_2 per kg of fuel	1.6488	kg/kg
CO_2 per unit of heat, on NCV (IPCC basis)	93.725	kg/GJ
CO_2 per unit of heat, on GCV	88.647	kg/GJ
Net calorific value	17,592	kJ/kg
CO_2 emitted	82.441	t/h
CO_2 per year	659,530	t

Formula and method

$$e_m = C \cdot \frac{M_{CO_2}}{M_C} \cdot f_{ox} = 3.664\, C\, f_{ox}$$

$$NCV = GCV - h_{fg,25}\left(\frac{M_{H_2O}}{M_{H_2}} H + M\right) \qquad e_{NCV} = \frac{e_m}{NCV} \qquad e_{GCV} = \frac{e_m}{GCV}$$

$$\dot{m}_{CO_2} = \dot{m}_f e_m \qquad m_{CO_2} = \dot{m}_{CO_2} t_{op}$$

Variables

C	carbon in the fuel as fired, by mass	–
H	hydrogen in the fuel as fired	–
M	moisture in the fuel as fired	–
GCV	gross calorific value as fired	J/kg
f_{ox}	fraction of carbon oxidised	–
$\dot{m}_f$	fuel firing rate	kg/s
t_{op}	operating hours per year	s
e_m	CO_2 per kg of fuel	kg/kg
e_{NCV}	CO_2 per unit of heat on NCV	kg/J

e_{GCV}	CO_2 per unit of heat on GCV	kg/J
NCV	net calorific value	J/kg
$\dot{m}_{CO_2}$	CO_2 emitted	kg/s
m_{CO_2}	CO_2 per year	kg
$M_{CO_2}, M_C, M_{H_2O}, M_{H_2}$	molar masses (44.009, 12.011, 18.015, 2.016)	kg/kmol
$h_{fg,25}$	latent heat of water at 25 °C (2 441.7 kJ/kg, IF97)	J/kg

Method and standards

The carbon-content method of the IPCC 2006 Guidelines (Vol. 2, Energy): CO_2 = carbon × 44/12 × fraction oxidised, here with exact IUPAC molar masses (44.009/12.011). The IPCC default fraction oxidised is 1. The net calorific value is the gross value less the latent heat at 25 °C of the water formed from hydrogen and the fuel moisture, the ASME PTC 4 convention; the latent heat comes from FireCAD's IAPWS-IF97.

Assumptions and limits

- Carbon content as fired, on the same moisture basis as the calorific value and the firing rate.
- All carbon that is oxidised ends as CO_2; carbonates in the ash and limestone used for desulphurisation add CO_2 not counted here.
- The net value is the PTC 4 style deduction (latent heat at 25 °C, no constant-volume oxygen and nitrogen correction). Net values measured to ISO 1928 or used in IPCC tables may differ slightly, so e_{NCV} depends on this convention.
- For natural gas enter the analysis by mass (methane: 74.9 % carbon, 25.1 % hydrogen).

References

• IPCC 2006 Guidelines Vol. 2 Ch. 1–2 (carbon-content method)
• IUPAC atomic weights
• IAPWS R7-97(2012) IF97 (latent heat)

Report details

Report reference	FCC-H064-N5X4 (the same inputs always give the same reference)
Generated	17 November 2026, 19:35 UTC
Calculator	CO_2 Emission Factor of a Fuel
Method last reviewed	10 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/emissions-stacks/co2-emission-factor

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.