

## OIL INDUSTRY CONVERSIONS

Crude petroleum, and the refined products made from crude oil, are normally measured either by volume in gallons and US barrels, or by weight in tons or tonnes. The relationship between volume and weight is usually measured by density in the United Kingdom (the alternative measure is relative density or specific gravity). American oilmen usually reckon quantities of oil produced, moved or processed in barrels per day (bpd or b/d). The loose but simple rule of thumb for conversion is that a barrel a day is roughly 50 tonnes a year, but the relationship varies according to density and so according to product.

### CONVERSION FACTORS FOR OIL

Product	At 86°F (30°C)			
	----- Approximation -----			
	Liters per E.Ton	Liters per M.Ton	A.Gallons per M.Ton	A.Barrels per M.Ton
L.P.G	1,864	1,835	484.6	11.54
JP.4	1,355	1,333	352.4	8.39
Jet A-1	1,274	1,254	331.2	7.89
Premium	1,375	1,353	357.5	8.51
Regular	1,440	1,418	374.5	8.92
Kerosene	1,293	1,273	336.2	8.00
Gas Oil	1,197	1,177	311.2	7.41
Diesel Fuel	1,177	1,159	306.1	7.29
Fuel oil 80 CST	1,082	1,065	281.2	6.70
Fuel oil 180 CST	1,067	1,050	277.4	6.60
Fuel oil 230 CST	1,064	1,047	276.6	6.59
Fuel oil 280 CST	1,061	1,044	275.9	6.57
Bitumen	994	979	258.5	6.15

1 MMSCF of natural gas	= 172.3 barrels of crude oil equivalent
	= 365 x 1,000,000 scf
1 million cu.ft. of natural gas	= 18.91 tons liquid
	= 1598.69 cu.ft.liquid
1 std.cu.feet of natural gas	= 1000 BTU = 252 kilocalories
1 m.ton of coal	= 4.879 barrels of crude oil equivalent
1 m.ton of lignite	= 2.053 barrels of crude oil equivalent
1 ltr of fuel oil 1500 sec	= 38.9 cubic feet of natural gas
1 kg of LPG	= 47.0 cubic feet of natural gas
1 normal cu.m. per day (Nm <sup>3</sup> /d)	= 37.33 standard cu.ft. per day (SCFD)
[flow rate of gas]	
1 ton of LNG	= 1.14 1.4 x 10 <sup>3</sup> normal cu.m.natural
(LNG conversions)	gas (Nm <sup>3</sup> )
	= 52.3 x 10 <sup>3</sup> standard cubic feet natural
	gas (SCF)
	= 55.0 x 10 <sup>9</sup> joules (HHV)
1 ton of LNG	= 1.22 tonne crude oil
(energy equivalents)	= 0.80 tonne heavy fuel oil
	= 0.91 tonne LPG (commercial composition)
	= 1.91 tonne coal
1 barrel per day (b/d)	= 50 tonnes per year (approx.)
1 barrel of oil equivalent	= 1 barrel of crude oil
	= 5,487 cubic feet of gas *

\* Natural gas is converted to barrels of oil equivalent using a ratio of 5,487 cubic feet of natural gas per one barrel of crude oil. This ratio is based on the actual average equivalent energy content of TOTAL's natural gas reserves.

1 barrel of crude oil per day	= appr. 50 tons of crude oil per year
1 ton of crude oil	= 1 metric ton of crude oil

= apprx. 7.3 barrels of crude oil (assuming  
 a specific gravity of 33 API)  
 = 6.6-8.0 bbl. of crude oil with 7.333 bbl.  
 taken as average  
 = 1.16 kl. of crude oil (average)  
 1 ton of oil equivalent = apprx. 1,125 cubic meters of natural gas

MMSCF Million standard cubic feet  
 CST Centi-Stroke  
 A. American  
 E. English

**VOLUME** 1 American barrel = 158.984 liters  
 = 42 American (US) gallons  
 = 34.9726 Imperial (UK) gallons  
 = 5.6146 cubic feet  
 = 0.15899 cubic metre  
 = 3.78541 cubic decimeters (dm<sup>3</sup>)  
 = 0.136 tonne (approx)  
 1 American gallon = 231 cubic inches  
 = 0.133681 cubic foot  
 = 3.7854 liters  
 = 0.0238095 American barrel  
 = 0.83268 Imperial gallon  
 = 0.0037854 cubic meter  
 1 Imperial gallon = 277.42 cubic inches  
 = 1.20094 American gallons  
 = 4.54609 liters  
 = 0.028594 American barrel  
 = 0.160544 cubic foot  
 = 0.004561 cubic meter  
 1 liter = 1,000 cubic centimeters  
 = 1 cubic decimeter (dm<sup>3</sup>)  
 = 0.035314 cubic foot  
 = 61.024 cubic inches  
 = 1.7597 pints  
 = 0.219969 Imperial gallon  
 = 0.26417 American gallon  
 1 kiloliter = 1,000 cubic decimeters (dm<sup>3</sup>)  
 = 6.28981 American barrels  
 1 gross ton (shipping) = 100 cubic feet or 2.83 cubic metres of permanently enclosed space  
 1 cubic meter = 35.315 cubic feet  
 = 219.97 Imperial gallons  
 = 1,000 liters  
 = 6.2898 American barrels  
 = 264.17 American gallons

**WEIGHT** 1 oz. = 28.35 grams  
 1 lb. = 0.453592 kilograms  
 = 0.009 cwt.  
 1 kg. = 2.20462 lb.  
 = 0.01 quintal  
 1 cwt = 112 lb.  
 = 50.802 kg.  
 1 metric ton = 0.98421 long ton or English ton  
 = 1.10231 short ton  
 = 2,204.6 lb  
 1 English ton or long ton = 1.01605 metric tons  
 = 1.12 short tons  
 1 short ton = 0.907186 metric ton  
 = 0.892857 long ton  
 = 2,000 lb.

\* These conversions are based on the assumption that all weights are weights in air, which is the correct basis for computing bulk commercial quantities of petroleum.

**PRICE** 1 US cent/AG = 0.42 US\$/BBL  
 1 US\$/BBL = 0.163 Baht/Liters

(Based on exchange rate of 25.9 Baht/US\$)

**PETROLEUM SPECIFIC GRAVITY VOLUME PER TON**

Degree API	Specific gravity	Barrels * per metric tonne	Long tonne
25	0.904	6.98	7.09
26	0.898	7.02	7.13
27	0.893	7.06	7.18
28	0.887	7.10	7.22
29	0.882	7.15	7.27
30	0.876	7.19	7.31
31	0.871	7.24	7.36
32	0.865	7.28	7.40
33	0.860	7.33	7.45
34	0.855	7.37	7.49
35	0.850	7.42	7.54
36	0.845	7.46	7.58
37	0.840	7.51	7.63
38	0.835	7.55	7.67
39	0.830	7.60	7.72
40	0.825	7.64	7.76
41	0.820	7.69	7.81
42	0.816	7.73	7.85

\* Approx. figures 60°F  
141.5

Specific gravity = -----  
131.5 + °API

**POWER AND HEAT UNITS**

1 HP (UK Horsepower)	= 550 foot pounds per second
	= 0.7457 kilowatt
	= 1.014 PS (or Cheval Vapeur)
1 PS (Pferdestaerke)	= 542 foot pounds per second
or CV (Cheval Vapeur)	= 0.986 hp
	= 0.736 kW
1 kW (Kilowatt)	= 1,000 watts
	= 1,340 hp
	= 1.359 PS or CV
	= 737 foot pounds per second
1 foot pound per second	= 0.00136 kilowatt
	= 0.00182 hp
	= 0.00184 PS or CV
1000 Btu	= 0.293 kWh
100,000 Btu	= 1 therm
1 calorie (dieticians')	= 4.1855 kilojoules
1 Therm	= 100,000 Btu (British Thermal Units)
	= 25,200 kilocalories
	= 25.2 thermies
	= 29.3 kilowatt hours
1000 kilocalories	= 3,968 Btu
(Large Calories)	= 1.163 kilowatt hours
	= 1 thermie
1 kilowatt hour	= 3,411 Btu
	= 1.340 hp hours
	= 859.6 kilocalories

**LIQUEFIED METHANE**

1 Ton of Liquefied Methane	= approximately 16 barrels
	= approximately 50,000 cubic feet
	(1400 cubic meters) of natural gas,
	depending on methane content

**PRODUCT SPECIFIC GRAVITY RANGES**

	Spec. Gravity	Barrels per metric ton
Crude oils	0.80-0.97	8.0-6.6
Aviation gasolines	0.70-0.78	9.1-8.2
Motor gasolines	0.71-0.79	9.0-8.1
Kerosines	0.78-0.84	8.2-7.6
Gas oils	0.82-0.90	7.8-7.1
Diesel oils	0.82-0.92	7.8-6.9
Lubricating oils	0.85-0.95	7.5-6.7
Fuel oils	0.92-0.99	6.9-6.5
Asphaltic bitumens	1.00-1.10	6.4-5.8

### CALORIFIC VALUE OF FULES

Rough gross values in Btu per lb

Crude oils	18,300-19,500
Gasolines	20,500
Kerosines	19,800
Benzole	18,100
Ethyl alcohol	11,600
Gas oils	19,200
Fuel oils (bunker)	18,300
Coal (bituminous)	10,200-14,600
LNG	22,300
LPG (butane)	21,300

### TYPICAL PROPERTIES OF EXPORT STREAMS

	MIRI	Bintulu	Labuan
API Gravity	33°	35°	32°
Pour Point	45°F	15°F	45°F
Wt. % Sulphur	0.07	0.1	0.07

### PRESSURE

1 Bar	= 0.987 atmospheres
	= 750.1 mm Hg
	= 14.50 pound/sq inch
	= 1.020 kg force/sq cm
1 kg force/sq cm	= 14.22 pounds/sq inch
1 pound/sq inch	= 0.070 kg force/sq inch

### HEAT AND ENERGY

1 megajoule	= 238.8 kilocalories
	= 947.8 British Thermal Units
	= 0.278 kilowatt hours
1 terajoule	= 0.00002388 Mtoe
1 kilocalorie	= 3.968 Btu
	= 4186 joules
	= 1.163 x 10 <sup>-3</sup> kWh
1 kilowatt hour	= 859.8 kilocalories
	= 3412 Btu
1 million Btu	= 1055 megajoule
	= 2520 megacalories
	= 293.1 kilowatt hours
1 ton of oil equivalent (toe)	= 10000000 kilocalories
	= 41.868 gigajoules
	= 40.047 x 10 <sup>6</sup> BTU
	= 42.244 GJ

### INTERFUEL CONVERSION FACTOR

Whilst individual crudes, coals and gases vary widely in quality, certain standard qualities are often assumed for statistical

purposes:

Reference Fuel	Barrel Oil Equivalent	Ton Oil Equivalent	Ton Coal Equivalent	1,000 Cubic Feet Natural Gas
Calorific Value	5.8x10 <sup>6</sup> Btu gross	43x10 <sup>6</sup> Btu gross	7x10 <sup>6</sup> Kcal net	1x10 <sup>6</sup> Btu gross
Conversion Factors	1 7.41 4.71 0.17	0.14 1 0.64 0.02	0.21 1.57 1 0.04	5.8 43.0 27.3 1

Based on these qualities, the following equivalent rates of consumption can be used with reasonable accuracy:

LNG t/y	NG 10 <sup>6</sup> mmcF/d 10 <sup>9</sup> Nm <sup>3</sup> /y	OIL toe/y	OIL boe/y	COAL tce/y
1	1.41	1.22	25	1.9
0.71	1	0.87	18	39
0.82	1.15	1	20	1.55
0.04	0.056	0.049	1	0.076
0.53	0.74	0.64	13	1

#### CALORIFIC VALUE

1 megajoule/cu m	= 25.84 Btu/cu ft
1 megajoule per normal cubic meter	= 25.368 BTU per standard cubic feet (BTU/SCF)
	= 2.388 x 10 <sup>2</sup> kilocalorie per normal cubic meter (kcal/Nm <sup>3</sup> )
1 kilocalorie/cu m	= 0.016 Btu/cu ft
1 megajoule/kg	= 429.9 Btu/pound
1 kilocalorie	= 1.8 Btu/pound (exact)
1 Btu/cu ft	= 37.38 kilojoules/cu m
	= 9.410 kilocalories/cu m
1 Btu/pound	= 2.326 kilojoules/kg
	= 0.556 kilocalories/kg

#### ENERGY VALUES

Btu per lb:	
wood: green	4,400
dry	7,310
peat, sod	6,200
lignite	9,000
coke	12,100
coal: bituminous	13,000
anthracite	14,500
oil: fuel	18,500
gas	19,500

#### NATURAL GAS AND OTHER ENERGY EQUIVALENTS

The following are quick-reference equivalents. All figures are APPROXIMATE VALUES only for use where precision is not required. They are based on:

- (i) for natural gas:  
1,000 Btu/ft<sup>3</sup> = 9,500 kcal/m<sup>3</sup> (Groningen gas 8,400 kcal/m<sup>3</sup>)
- (ii) for LPG:  
an assumed 50/50 propane/butane mixture with (r) or (p) indicating that the LPG is either refrigerated or pressurised.
- (iii) calorific values, MMBtu (gross):  
per tonne - LNG 51.8; LPG 47.3; oil 42.3; coal 27.3  
per barrel - LNG 3.8; LPG (r) 4.45; LPG (p) 4.1; oil 5.8

per cubic metre - LNG 23.8; LPG (r) 28; LPG (p) 25.8

### Natural Gas: Cubic Metre Equivalentents

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1 mrd m<sup>3</sup> Natural Gas per Year  
per year = 0.04 Tcf gas (38 trillion Btu)  
= 890 000 tonnes oil  
= 800 000 tonnes LPG  
= 725 000 tonnes LNG  
= 1.4 million tonnes coal  
per day = 100 million ft<sup>3</sup> gas  
= 17 800 barrels oil  
= 23 200 barrels LPG (r)  
= 25 200 barrels LPG (p)  
= 27 200 barrels LNG

1 million m<sup>3</sup> Natural Gas per Day  
per year = 0.014 Tcf gas (14 trillion Btu)  
= 325 000 tonnes oil  
= 290 000 tonnes LPG  
= 265 000 tonnes LNG  
= 500 000 tonnes coal  
per day = 37 million ft<sup>3</sup> gas  
= 6 500 barrels oil  
= 8 500 barrels LPG (r)  
= 9 200 barrels LPG (p)  
= 9 900 barrels LNG

1 m<sup>3</sup> Groningen gas = 0.88 m<sup>3</sup> (9 500 kcal)  
1 m<sup>3</sup> (9 500 kcal) = 1.13 m<sup>3</sup> Groningen gas

### Natural Gas: Cubic Foot Equivalentents

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1 Tcf Natural Gas per Year  
per year = 27 mrd m<sup>3</sup> gas (30 mrd Groningen)  
= 24 million tonnes oil  
= 37 million tonnes coal  
per day = 2 700 million ft<sup>3</sup> gas  
= 470 000 barrels oil

100 MMcf Natural Gas per Day  
per year = 0.04 Tcf (37 trillion Btu)  
= 1 mrd m<sup>3</sup> gas (1.1 mrd Groningen)  
= 860 000 tonnes oil  
= 770 000 tonnes LPG  
= 700 000 tonnes LNG  
= 1.35 million tonnes coal  
per day = 2.7 million m<sup>3</sup> gas (3 million Groningen)  
= 17 250 barrels oil  
= 22 500 barrels LPG (r)  
= 24 400 barrels LPG (p)  
= 26 300 barrels LNG

### LNG: Volumetric Equivalentents

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1 million tonnes LNG per Year  
per year = 77 million ft<sup>3</sup> (liquid)  
= 2.2 million m<sup>3</sup> (liquid)  
= 14 million barrels (liquid)  
= 0.05 Tcf (gas)  
= 1.4 mrd m<sup>3</sup> (gas)  
= 1.1 million tonnes LPG  
= 1.2 million tonnes oil  
= 52 trillion Btu  
= 1.9 million tonnes coal  
per day = 140 million ft<sup>3</sup> (gas)  
= 4 million m<sup>3</sup> (gas)  
= 37 500 barrels LNG  
= 31 900 barrels LPG (r)  
= 34 600 barrels LPG (p)

= 24 500 barrels oil  
 1 million m<sup>3</sup> LNG per Year  
   per year = 460 000 tonnes LNG  
           = 6.3 million barrels LNG  
           = 0.2 Tcf (gas)  
           = 0.6 mrd m<sup>3</sup> (gas)  
           = 500 000 tonnes oil  
           = 560 000 tonnes oil  
           = 24 trillion Btu  
           = 870 000 tonnes coal  
   per day = 65 million ft<sup>3</sup> gas  
           = 14 700 barrels LPG (r)  
           = 15 900 barrels LPG (p)  
           = 17 200 barrels LNG  
           = 11 200 barrels oil  
 m<sup>3</sup> = kilolitre

**LPG & Ethane: Weight, Volume, Heat Conversions**

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 Barrels Per Tonne

	Ethane	Propane	n-Butane	C3/C4 mix
Pressured	17.6	12.4	10.8	11.6
Refrigerated	11.5	10.8	10.4	10.6

Cubic Metres Per Tonne

	Ethane	Propane	n-Butane	C3/C4 mix
Pressured	2.80	1.97	1.71	1.84
Refrigerated	1.83	1.72	1.66	1.69

10<sup>6</sup> Btu Per Barrel

	Ethane	Propane	n-Butane	C3/C4 mix
Pressured	2.79	3.85	4.35	4.10
Refrigerated	4.27	4.41	4.49	4.45

10<sup>6</sup> Btu Per Cubic Metre

	Ethane	Propane	n-Butane	C3/C4 mix
Pressured	17.6	24.2	27.4	25.8
Refrigerated	26.9	27.7	28.3	28.0

10<sup>6</sup> Btu Per Tonne

	Ethane	Propane	n-Butane	C3/C4 mix
Pressured        }	49.2	47.7	46.9	47.3
Refrigerated    }				

1 Barrel/Day = Tonnes Per Annum

	Ethane	Propane	n-Butane	C3/C4 mix
Pressured	20.7	29.4	33.8	31.6
Refrigerated	31.7	33.8	35.0	34.4

**Natural Gas: Inter-Fuel Price Equivalentents (US Currency)**

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 ONE CENT per MMBtu

= 5.8 Cents per Barrel crude oil  
 = 6.4 Cents per Barrel fuel oil  
 = 5.2 Cents per Barrel naphtha  
 = 4.5 Cents per Barrel LPG (r)  
 = 4.1 Cents per Barrel LPG (P)  
 = 3.8 Cents per Barrel LNG

ONE CENT per MMBtu

= 0.42 Dollars per Tonne crude oil  
 = 0.40 Dollars per Tonne fuel oil  
 = 0.45 Dollars per Tonne naphtha  
 = 0.47 Dollars per Tonne LPG  
 = 0.52 Dollars per Tonne LNG

ONE DOLLAR per BARREL

= 17 Cents per MMBtu crude oil  
 = 16 Cents per MMBtu fuel oil  
 = 19 Cents per MMBtu naphtha

= 22 Cents per MMBtu LPG (r)  
 = 24 Cents per MMBtu LPG (p)  
 = 26 Cents per MMBtu LNG  
 ONE DOLLAR per TONNE  
 = 2.4 Cents per MMBtu crude oil  
 = 2.5 Cents per MMBtu fuel oil  
 = 2.2 Cents per MMBtu naphtha  
 = 2.1 Cents per MMBtu LPG  
 = 1.9 Cents per MMBtu LNG  
 ONE CENT per US gallon LPG = 10 CENTS per MMBtu

**Oil and Coal Equivalent**

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1 million tonnes Oil per Year

per year = 1.1 mrd m<sup>3</sup> gas (1.3 mrd Groningen)  
 = 1.5 million tonnes coal  
 = 815 000 tonnes LNG  
 = 890 000 tonnes LPG  
 = 0.04 Tcf gas (42 trillion Btu)  
 per day = 115 million ft<sup>3</sup> gas  
 = 3 million m<sup>3</sup> gas  
 = 30 500 barrels LNG  
 = 26 000 barrels LPG (r)  
 = 28 300 barrels LPG (p)  
 = 20 000 barrels oil

1 million tonnes Coal per Year

per year = 0.7 mrd m<sup>3</sup> gas (0.8 mrd Groningen)  
 = 640 000 tonnes oil  
 = 525 000 tonnes LNG  
 = 580 000 tonnes LPG  
 = 0.03 Tcf gas (27 trillion Btu)  
 per day = 75 million ft<sup>3</sup> gas  
 = 2 million m<sup>3</sup> gas  
 = 19 700 barrels LNG  
 = 16 800 barrels LPG (r)  
 = 18 200 barrels LPG (p)  
 = 12 900 barrels oil

10 000 barrels Oil per Day

per year = 0.6 mrd m<sup>3</sup> gas  
 = 500 000 tonnes oil  
 = 780 000 tonnes coal  
 = 0.02 Tcf gas (21 trillion Btu)  
 per day = 58 million ft<sup>3</sup> gas  
 = 1.5 million m<sup>3</sup> gas

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Rich Gas = natural gas having a gross calorific value of 41,868 kJ/m<sup>3</sup>. This term is used particularly for the natural gas from the North Sea and from Algeria.

Degree-days = the number of degree-days of a day is calculated on the basis of a reference temperature set by experience at 16.5 C; it gives the difference between that reference temperature and the daily mean temperature if the latter is the lower. The number of degree-days of a year is the sum of the degree-days registered for each day of that year.

G-factor = invoicing factor representing the average monthly cost of natural gas at the Belgian border in francs per gigajoule.

	1GJ	1Gcal	10 <sup>-6</sup> Btu	1toe	1kWh	1m <sup>3</sup>
1GJ	1	0.239	0.948	0.024	277.778	23.884
1Gcal	4.186	1	3.967	0.1	1,163	100
10 <sup>-6</sup> Btu	1.055	0.252	1	0.025	293.1	25.2
1toe	41.855	10	39.671	1	11,626	1,000
1kWh	3.600 10 <sup>-3</sup>	0.860 10 <sup>-3</sup>	3.421 10 <sup>-3</sup>	0.083 10 <sup>-3</sup>	1	86.011 10 <sup>-3</sup>

