

Region	Population	Area (km ²)	Density (per km ²)	Area each (m ²)
World	6 440 000 000	148 000 000	43	23 100
Afghanistan	29 900 000	647 000	46	21 600
Mexico	106 000 000	1 970 000	54	18 500
Ireland	4 010 000	70 200	57	17 500
Kenya	33 800 000	582 000	58	17 200
Myanmar	42 900 000	678 000	63	15 800
Scotland	5 050 000	78 700	64	15 500
Ethiopia	73 000 000	1 120 000	65	15 400
Egypt	77 500 000	1 000 000	77	12 900
Ukraine	47 400 000	603 000	78	12 700
Spain	40 300 000	504 000	80	12 500
Turkey	69 600 000	780 000	89	11 200
France	60 600 000	547 000	110	9 010
European Union	456 000 000	3 970 000	114	8 710
Indonesia	241 000 000	1 910 000	126	7 930
Thailand	65 400 000	514 000	127	7 850
China	1 300 000 000	9 590 000	136	7 340
Nigeria	128 000 000	923 000	139	7 170
Wales	2 910 000	20 700	140	7 110
Pakistan	162 000 000	803 000	202	4 940
Germany	82 400 000	357 000	230	4 330
<i>United Kingdom</i>	59 500 000	244 000	<i>243</i>	<i>4 110</i>
Vietnam	83 500 000	329 000	253	3 940
Philippines	87 800 000	300 000	292	3 410
India	1 080 000 000	3 280 000	328	3 040
Japan	127 000 000	377 000	337	2 960
<i>England</i>	<i>49 561 800</i>	<i>130 423</i>	<i>380</i>	<i>2 630</i>
South Korea	48 400 000	98 400	491	2 030
Mauritius	1 230 000	2 040	603	1 650
Taiwan	22 800 000	35 900	636	1 570
Bangladesh	144 000 000	144 000	1 000	997
Gaza Strip	1 370 000	360	3 820	261
Hong Kong	6 890 000	1 092	6 310	158
Singapore	4 420 000	692.7	6 380	156

Table 5. Some regions with population density greater than or equal to the world average. Populations above 50 million and areas greater than 5 million km² are highlighted.

Region	Population	Area	Density (per km ²)	Area each (m ²)
World	6 440 000 000	148 000 000	43	23 100
Asia	3 670 000 000	44 500 000	82	12 100
Africa	778 000 000	30 000 000	26	38 600
Europe	732 000 000	9 930 000	74	13 500
North America	483 000 000	24 200 000	20	50 200
Latin America	342 000 000	17 800 000	19	52 100
Oceania	31 000 000	7 680 000	4	247 000
Antarctica	4 000	13 200 000		

Table 6. Population densities of the continents

Power, Carbon, and Area Cheat-sheet

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	CO ₂ per kWh	Carbon per GWh
Coal	1000 g CO ₂ /kWh	250 tC/GWh
Gas	400 g CO ₂ /kWh	100 tC/GWh
Nuclear	16 g CO ₂ /kWh	4.4 tC/GWh

Table 1. Exchange rate between Carbon emissions and Electrical energy

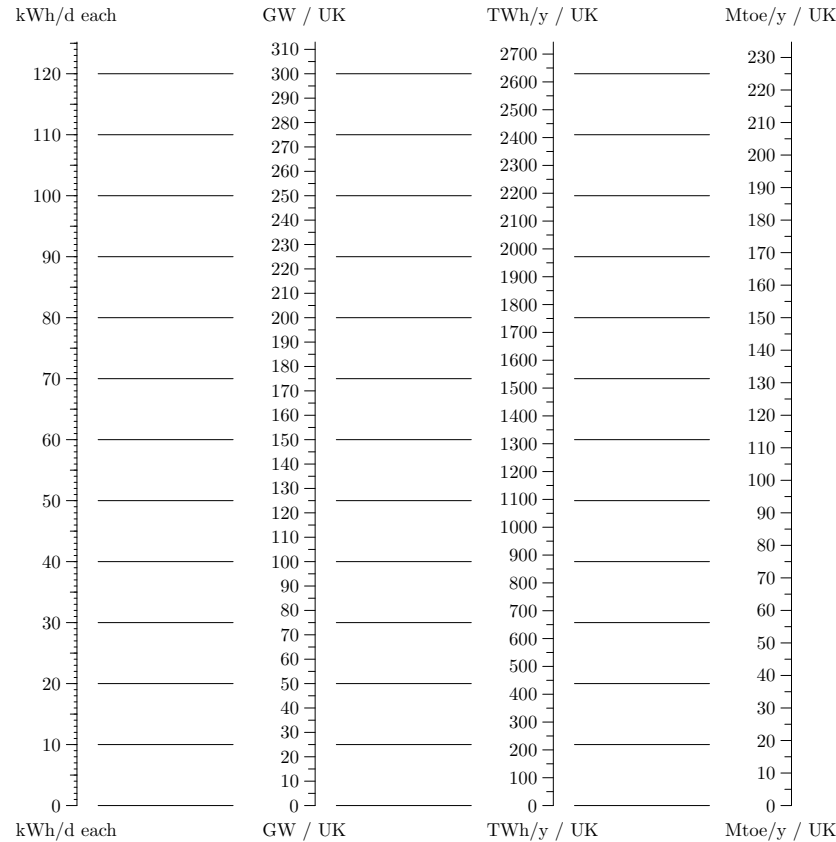
POWER TYPE	POWER PER UNIT AREA OF FLAT GROUND
WIND FARM: $v = 6$ m/s (force 4)	2 W/m ²
SOLAR efficiency	
Photovoltaic	20% 16 W/m ² South-facing roof 20% 10 W/m ² flat ground
Biomass	1% 0.5 W/m ² flat ground
Ocean thermal	5 W/m ² (upper bound)
Tide pool	4 W/m ²
Tide-farm (using currents) (spring 1.5 m/s : neap 0.9 m/s)	6 W/m ²
Geothermal	17 mW/m ²

Table 2. Power densities of renewable sources (per unit land- or sea-area)

hectare	= 10 ⁴ m ²	= 10 ⁻² km ²
acre	= 4050 m ²	= 0.0040 km ²
square mile	= 2.6 × 10 ⁶ m ²	= 2.6 km ²

Table 3. Areas.
 The population density of England is 380 people per km², or 2630 m² per person.

Power



1 kWh/d the same as 1/24kW
 GW often used for 'capacity' (peak output)
 TWh/y often used for average output
 1 Mtoe 'one million tonnes of oil equivalent'

'UK' = 60 million people
 USA: 300 kWh/d each
 Europe: 120 kWh/d each

Region	Population	Area (km ²)	Density (per km ²)	Area each (m ²)
Antarctica	4 000	13 200 000		
Greenland	56 300	2 160 000	0.026	38 400 000
Alaska	655 000	1 480 000	0.44	2 260 000
Western Sahara	273 000	266 000	1	974 000
Mongolia	2 790 000	1 560 000	1.8	560 000
Namibia	2 030 000	825 000	2.5	406 000
Australia	20 000 000	7 680 000	2.6	382 000
Suriname	438 000	163 000	2.7	372 000
Botswana	1 640 000	600 000	2.7	366 000
Mauritania	3 080 000	1 030 000	3	333 000
Libya	5 760 000	1 750 000	3.3	305 000
Canada	32 800 000	9 980 000	3.3	304 000
Kazakhstan	15 100 000	2 710 000	6	178 000
CAR	3 790 000	622 000	6	163 000
Chad	9 820 000	1 280 000	8	130 000
Bolivia	8 850 000	1 090 000	8	124 000
Russia	143 000 000	17 000 000	8	119 000
Angola	11 100 000	1 240 000	9	111 000
Niger	11 600 000	1 260 000	9	108 000
Mali	12 200 000	1 240 000	10	100 000
Somalia	8 590 000	637 000	13	74 200
Saudi Arabia	26 400 000	1 960 000	13	74 200
Algeria	32 500 000	2 380 000	14	73 200
Argentina	39 500 000	2 760 000	14	69 900
Zambia	11 200 000	752 000	15	66 800
New Zealand	4 030 000	268 000	15	66 500
Sudan	40 100 000	2 500 000	16	62 300
Chile	16 100 000	756 000	21	46 900
Peru	27 900 000	1 280 000	22	46 000
Brazil	186 000 000	8 510 000	22	45 700
Mozambique	19 400 000	801 000	24	41 300
DRC	60 000 000	2 340 000	26	39 000
Venezuela	25 300 000	912 000	28	35 900
Madagascar	18 000 000	587 000	31	32 500
America (ex. Alaska)	295 000 000	8 150 000	36	27 600
South Africa	44 300 000	1 210 000	36	27 500
Colombia	42 900 000	1 130 000	38	26 500
Tanzania	36 700 000	945 000	39	25 700
Yemen	20 700 000	527 000	39	25 400
Iran	68 000 000	1 640 000	41	24 200
World	6 440 000 000	148 000 000	43	23 100

Table 4. Some regions with population density less than or equal to the world average. Populations above 50 million and areas greater than 5 million km² are highlighted.

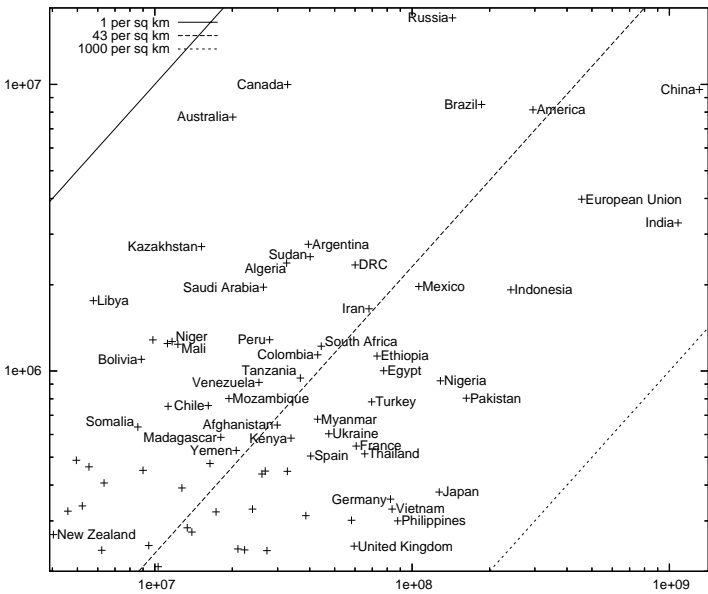
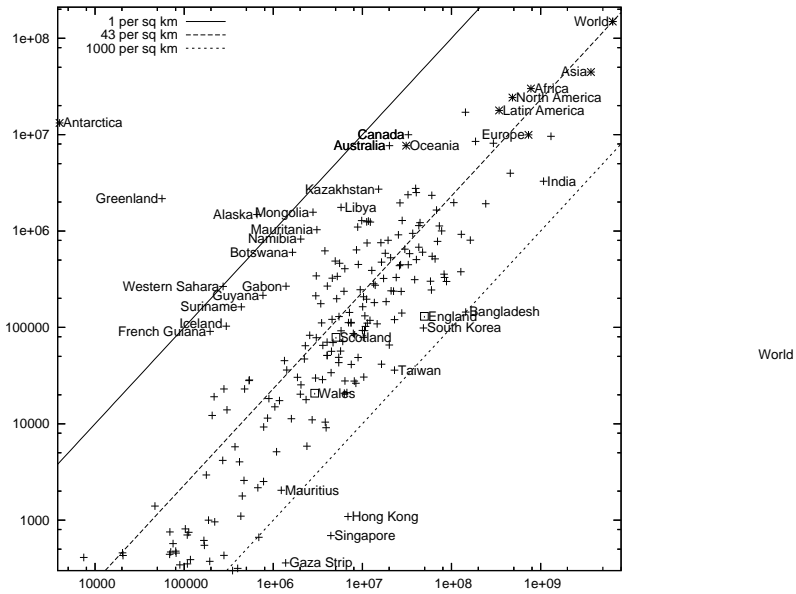
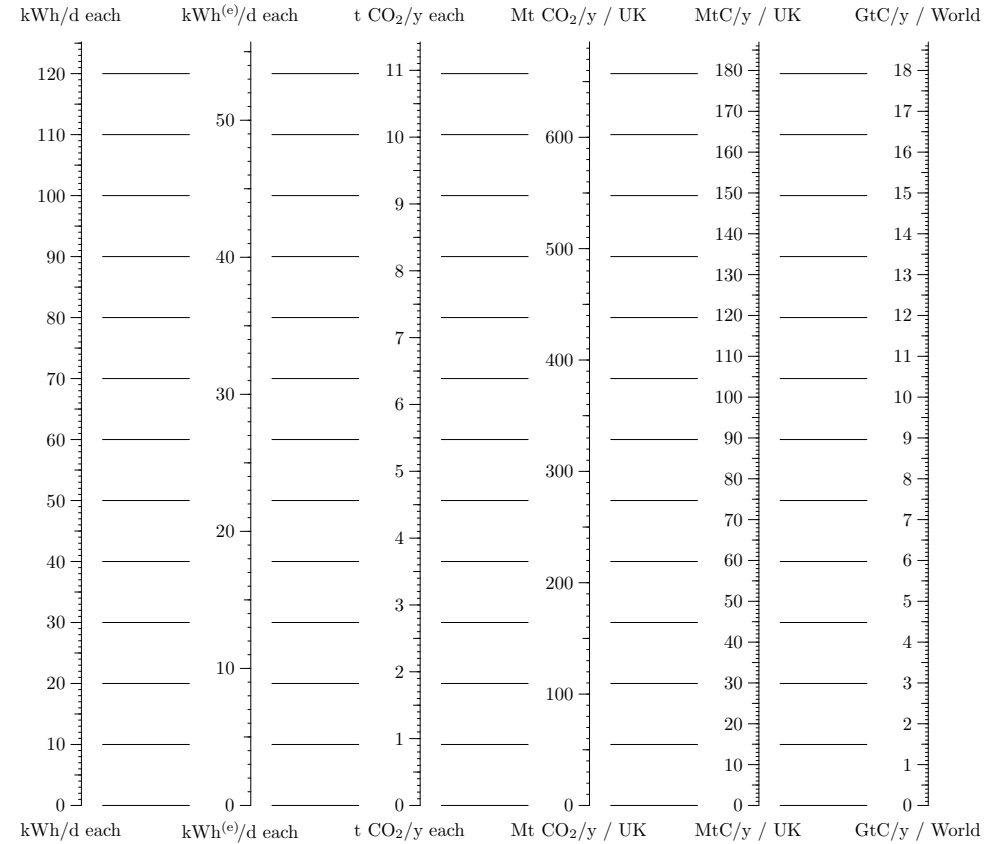


Figure 1. Populations (horizontal axis) and areas (vertical axis, in km²) of countries and regions of the world.

Carbon

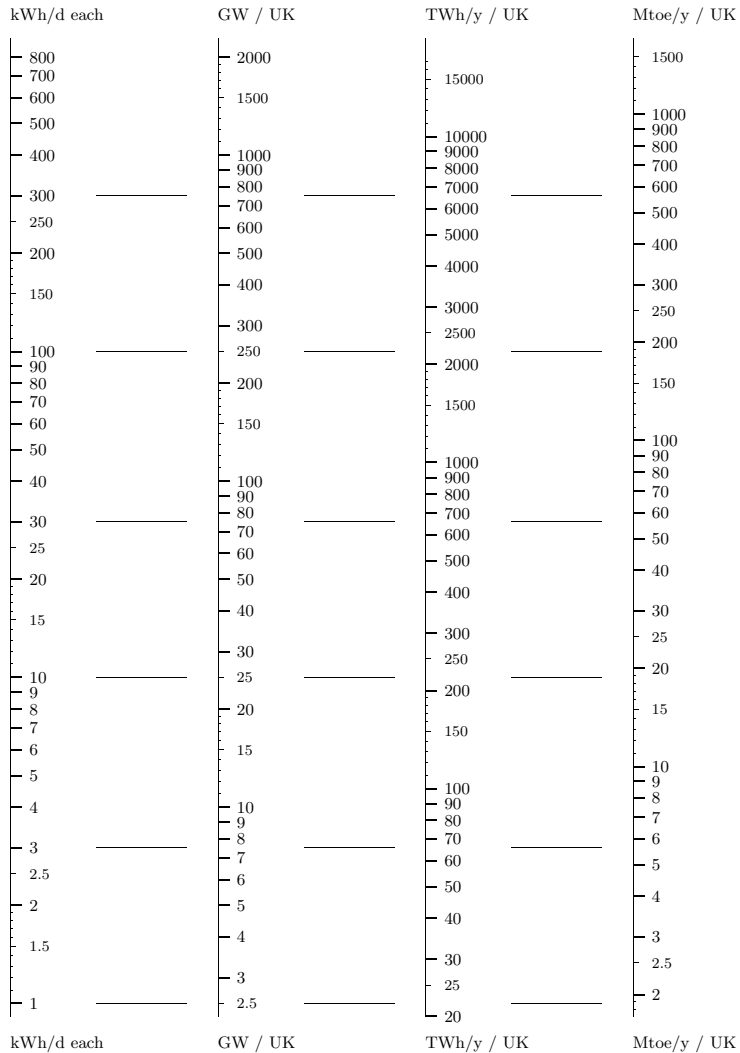


1 kWh/d thermal energy exchange rate:
 1 kWh ↔ 250 g of CO₂ (oil, petrol)
 1 kWh(e)/d electrical energy is more costly:
 1 kWh(e) ↔ 445 g of CO₂ (gas)
 (Coal costs twice as much CO₂)

tCO₂ tonne of CO₂
 MtC million tonnes of Carbon
 GtCO₂ billion tonnes of CO₂

‘UK’ = 60 million people
 ‘World’ = 6 billion people
 UK: 150 MtC per year (2000)
 USA: 20 tCO₂/y each (1.5 GtC/y total)
 World: 7 GtC per year (2005)
 To avoid 2C global warming, need < 2–3 GtC/y

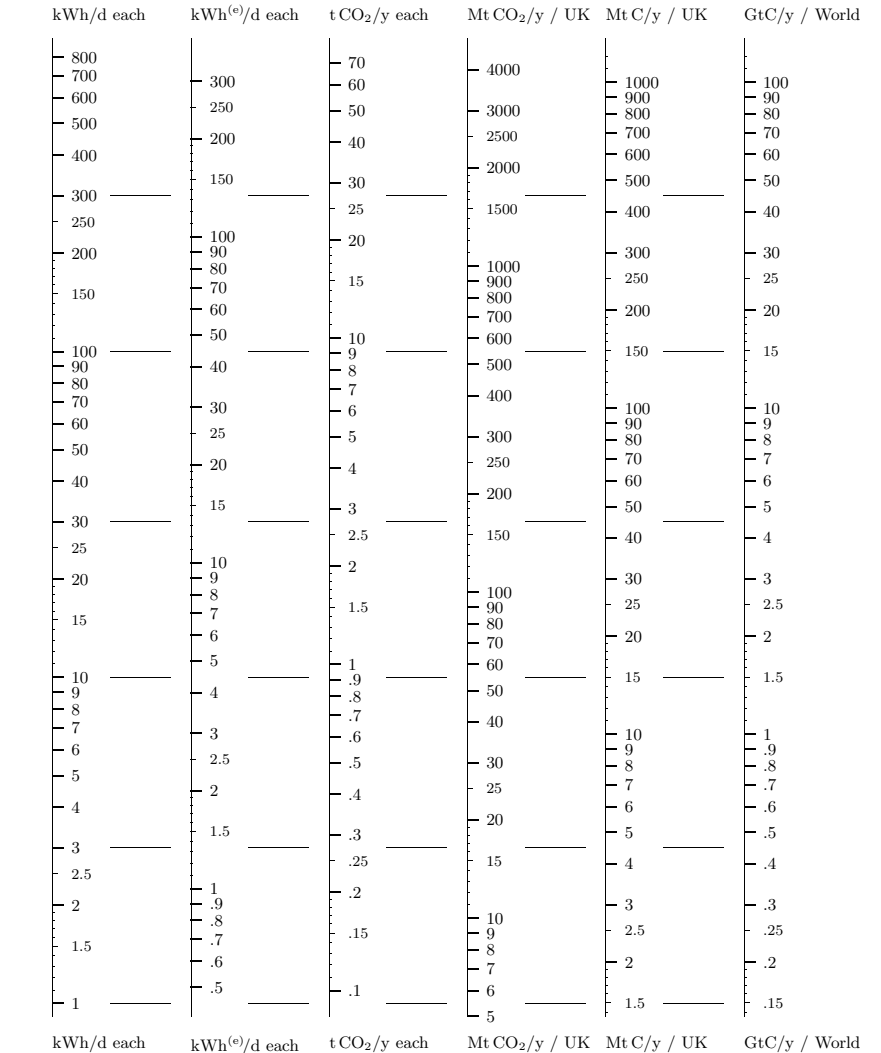
Power (log scale)



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Carbon (log scale)



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