Biomass Energy

Cord Wood: Stack of wood comprising 128 cubic feet (3.62 m³)
Standard dimensions are 4 x 4 x 8 feet
includes air space and bark
One cord contains approx. 1.2 U.S. tons (oven-dry)
= 2400 pounds
= 1089 kg

1.0 metric tonne wood = 1.4 cubic meters (solid wood, not stacked)

Energy content of wood fuel (HHV, bone dry)
= 18-22 GJ/t (7,600-9,600 Btu/lb)

Energy content of wood fuel (air dry, 20% moisture)
≈ 15 GJ/t (6,400 Btu/lb)

Energy content of agricultural residues (varying moisture content)
= 10-17 GJ/t (4,300-7,300 Btu/lb)

Metric tonne charcoal = 30 GJ
= 12,800 Btu/lb
Ethanol – Biodiesel Energy

Metric tonne ethanol = 7.94 petroleum barrels
= 1262 liters

LHV Ethanol energy content = 11,500 Btu/lb
= 75,700 Btu/gallon

HHV for ethanol = 84,000 Btu/gallon
= 89 MJ/gallon
= 23.4 MJ/liter

Average ethanol density (average) = 0.79 g/ml

Average metric tonne biodiesel = 37.8 GJ
typically 33.3 - 35.7 MJ/liter

Average biodiesel density = 0.88 g/ml
Areas and Crop Yields

1.0 hectare = 10,000 m$^2$  
= 328 x 328 ft  
= 2.47 acres

1.0 km$^2$ = 100 hectares  
= 247 acres

1.0 acre = 0.405 hectares

1.0 US ton/acre = 2.24 t/ha

1 metric tonne/hectare = 0.446 ton/acre

100 g/m$^2$ = 1.0 tonne/hectare = 892 lb/acre

Target bioenergy crop yield might be:

5.0 US tons/acre (10,000 lb/acre)  
= 11.2 tonnes/hectare (1120 g/m$^2$)

1.0 US Bushel corn/sorgum = 56 lb, 25 kg

1.0 US Bushel wheat/soybeans= 60 lb, 27 kg (wheat or soybeans)

1.0 US Bushel barley = 40 lb, 18 kg (barley)
Fossil Fuel Energy

Barrel of oil equivalent (boe) $\cong 6.1$ GJ ($5.8$ million Btu), equivalent to $1,700$ kWh. 
Petroleum barrel = $42$ U.S. gallons = $35$ Imperial gallons = $159$ liters 
$7.2$ barrels oil $\cong$ equivalent to one tonne of oil (metric) = $42-45$ GJ.

  $HHV = 125,000$ Btu/gallon $= 132$ MJ/gallon $= 35$ MJ/liter 
  Metric tonne gasoline $= 8.53$ barrels $= 1356$ liter $= 43.5$ GJ/t (LHV) 
  $= 47.3$ GJ/t (HHV)

Average gasoline density $= 0.73$ g/ml

Petro-diesel $= 130,500$ Btu/gallon $= 36.4$ MJ/liter $= 42.8$ GJ/t  
Average petro-diesel density $= 0.84$ g/ml

Metric tonne coal $= 27-30$ GJ (bituminous/anthracite) 
  $= 15-19$ GJ (lignite/sub-bituminous)

Typical coal usually means bituminous coal, the most common fuel for power plants 
$\cong 27$ GJ/t

Natural gas: $HHV = 1027$ Btu/ft$^3 = 38.3$ MJ/m$^3$ 
  $LHV = 930$ Btu/ft$^3 = 34.6$ MJ/m$^3$

Therm natural gas/methane $= 100,000$ Btu $= 105.5$ MJ
Energy units

1.0 joule = 0.239 calories (cal)
1.0 calorie = 4.187 J
1.0 gigajoule (GJ) = \(10^9\) joules
   = 0.948 million Btu
   = 239 million calories
   = 278 kWh
1.0 British thermal unit (Btu) = 1055 joules

1.0 Quad = One quadrillion Btu (1015 Btu)
   = 1.055 exajoules (EJ)
   ≈ approximately 172 million barrels of oil equivalent (boe)
1000 Btu/lb = 2.33 gigajoules per tonne (GJ/t)
Power Units

1.0 watt = 1.0 joule/second
   = 3.413 Btu/hr
1.0 kilowatt (kW) = 3413 Btu/hr
   = 1.341 horsepower
1.0 kilowatt-hour (kWh) = 3.6 MJ
   = 3413 Btu
1.0 horsepower (hp) = 550 foot-pounds per second
   = 2545 Btu per hour
   = 745.7 watts = 0.746 kW
1.0 U.S. ton (short ton) = 2000 pounds
1.0 imperial ton (long ton or shipping ton) = 2240 pounds
1.0 metric tonne (tonne) = 1000 kilograms
   = 2205 pounds
1.0 US gallon = 3.79 liter
   = 0.833 Imperial gallon
1.0 imperial gallon = 4.55 liter
   = 1.20 US gallon
1.0 liter = 0.264 US gallon
   = 0.220 Imperial gallon
1.0 US bushel = 0.0352 m³
   = 0.97 UK bushel