**Energy and Power**

**Energy** is the capacity to do work. Energy is power integrated over time.

Energy = U = W = joules = watt-second

Work = Force x Distance

**Power** is the rate at which work is done, or energy is transmitted

Power = Work / time = W / t

P = watt = joules/second

https://en.wikipedia.org/wiki/Power_(physics)

**Types of Energy**

Mechanical  
Electrical  
Thermal  
Chemical  
Electromagnetic fields  
Mass  
Nuclear

<table>
<thead>
<tr>
<th>Kinetic Energy</th>
<th>Potential Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>The energy of a body or a system with respect to the motion of the body or of the particles in the system.</td>
</tr>
<tr>
<td><strong>Relation to environment</strong></td>
<td>Kinetic energy of an object is relative to other moving and stationary objects in its immediate environment.</td>
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<tr>
<td></td>
<td>Potential Energy is the stored energy in an object or system because of its position or configuration.</td>
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<tr>
<td><strong>Transferability</strong></td>
<td>Kinetic energy can be transferred from one moving object to another, say, in collisions.</td>
</tr>
<tr>
<td></td>
<td>Potential energy cannot be transferred.</td>
</tr>
<tr>
<td><strong>Examples</strong></td>
<td>Flowing water, such as when falling from a waterfall.</td>
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<tr>
<td></td>
<td>Water at the top of a waterfall, before the precipice.</td>
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<tr>
<td><strong>SI Unit</strong></td>
<td>Joule (J)</td>
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<tr>
<td></td>
<td>Joule (J)</td>
</tr>
<tr>
<td><strong>Determining factors</strong></td>
<td>Speed/velocity and mass</td>
</tr>
<tr>
<td></td>
<td>Height or distance and mass</td>
</tr>
</tbody>
</table>
Common Units of Energy and Power

1. Barrel of oil
2. Calorie
3. Horsepower
4. Joule (J)
5. Kilowatt-hour (kWh)
6. Kilowatt (kW)
7. Megajoule (MJ)
8. Megawatt (MW)
9. Unit of electricity
10. Volt (V)
11. Watt (Electric)
12. Watt (Thermal)
13. Watt-hour (Wh)
14. Related Resources

More Units of Energy

1 calIT = 4.1868 J, International Table calorie
1 calth = 4.184 J, thermochemical calorie
1 cal15 ≈ 4.1855 J, calories to heat from 14.5 °C to 15.5 °C
1 erg = 10⁻⁷ J, cgs [centimeter-gram-second] unit
1 eV ≈ 1.60218 × 10⁻¹⁹ J, electron volt
1 Eh ≈ 4.35975 × 10⁻¹⁸ J, Hartree, atomic energy unit
1 Btu = 1055.06 J, British thermal unit according to ISO, to heat 1 pound water from 63 °F to 64 °F
1 tce = 29.3076 × 10⁹ J, ton of coal equivalent, 7000 kcalIT
1 toe = 41.868 × 10⁹ J, ton of oil equivalent, 10000 kcalIT

Basic & Derived SI Units
Energy Units and Conversions

1 Joule (J) is the MKS unit of energy, equal to the force of one Newton acting through one meter.  
1 Watt is the power of a Joule of energy per second

Power = Current x Voltage (P = I V)  
1 Watt is the power from a current of 1 Ampere flowing through 1 Volt.  
1 kilowatt is a thousand Watts.  
1 kilowatt-hour is the energy of one kilowatt power flowing for one hour. (E = P t).  
1 kilowatt-hour (kWh) = 3.6 x 10^6 J = 3.6 million Joules

1 calorie of heat is the amount needed to raise 1 gram of water 1 degree Centigrade.  
1 calorie (cal) = 4.184 J  
(The Calories in food ratings are actually kilocalories.)

A BTU (British Thermal Unit) is the amount of heat necessary to raise one pound of water by 1 degree Fahrenheit (F).

1 British Thermal Unit (BTU) = 1055 J (The Mechanical Equivalent of Heat Relation)  
1 BTU = 252 cal = 1.055 kJ  
1 Quad = 10^{15} BTU (World energy usage is about 300 Quads/year, US is about 100 Quads/year in 1996.)  
1 therm = 100,000 BTU  
1,000 kWh = 3.41 million BTU

Power Conversion

1 horsepower (hp) = 745.7 watts

Gas Volume to Energy Conversion

One thousand cubic feet of gas (Mcf) -> 1.027 million BTU = 1.083 billion J = 301 kWh  
One therm = 100,000 BTU = 105.5 MJ = 29.3 kWh  
1 Mcf -> 10.27 therms

Energy Content of Fuels

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Energy Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>25 million BTU/ton</td>
</tr>
<tr>
<td>Crude Oil</td>
<td>5.6 million BTU/barrel</td>
</tr>
<tr>
<td>Oil</td>
<td>5.78 million BTU/barrel = 1700 kWh / barrel</td>
</tr>
<tr>
<td>Gasoline</td>
<td>5.6 million BTU/barrel (a barrel is 42 gallons) = 1.33 therms / gallon</td>
</tr>
<tr>
<td>Natural gas liquids</td>
<td>4.2 million BTU/barrel</td>
</tr>
</tbody>
</table>
Natural gas 1030 BTU/cubic foot
Wood 20 million BTU/cord

CO2 Pollution of Fossil Fuels

Pounds of CO2 per billion BTU of energy:
Coal 208,000 pounds
Oil 164,000 pounds
Natural Gas 117,000 pounds

Ratios of CO2 pollution:
Oil / Natural Gas = 1.40
Coal / Natural Gas = 1.78

Pounds of CO2 per 1,000 kWh, at 100% efficiency:
Coal 709 pounds
Oil 559 pounds
Natural Gas 399 pounds