

***Climate Change: What to Do? How to Fix It?***  
**Energy Units**  
**Jonathan F. Ormes**  
**Academy for Lifelong Learning, Fall, 2016**

**Units of energy**

One **joule** of energy is common in everyday life:

- the energy required to lift a small apple vertically through one meter of air.
- the heat required to raise the temperature of a cup of water by 50°F.
- the kinetic energy of a 50 kg human moving very slowly (0.2 m/s).
- the kinetic energy of a tennis ball moving at 90 m/h or me moving about 3 ft/s is about 6 joules.

Since the joule is also a watt-second and the common unit for electricity sales to homes is the kWh (kilowatt-hour), a kWh is thus 1000 (kilo) x 3600 seconds = 3.6 MJ (megajoules).

A human being emits about the same energy as a 120 watt lightbulb. (Gives new meaning to the phrase “He’s not the brightest bulb in the room.”)

So how much energy does it take just to keep us all alive for a year?  
 $7.3 \times 10^9$  humans \* 100 watts \* 3600 s/hr \* 24 hr/day \* 365 days/yr \*  
1 yr =  $2 \times 10^{19}$  Joules = 3 quintillion joules  
(a 2000 Cal/day diet is about 10 times this energy; this allows us to move around, play tennis, or get fat).

The total annual energy consumption on Earth is  $0.5 \times 10^{21}$  joules = 500 quintillion joules.

So on average, each person is consuming 250 times the energy to stay alive and 25 times the energy we need to be active.

The change in the heat content of the Earth since 1975:  $2 \times 10^{23}$  joules = 0.2 YJ = 200 sextillion Joules.

## **Mega (million)**

The **megajoule (MJ)** is equal to one *million* ( $10^6$ ) joules. The smallest nuclear power plant produces about 500 MW of power. A kWhr is 3.6 MJ.

## **Giga (billion)**

The **gigajoule (GJ)** is equal to one *billion* ( $10^9$ ) joules. Six gigajoules is about the amount of potential chemical energy in a barrel of oil, when combusted. A barrel is about 42 gallons.

## **Tera (trillion)**

The **terajoule (TJ)** is equal to one *trillion* ( $10^{12}$ ) joules. About 63 terajoules were released by the atomic bomb that exploded over Hiroshima.

## **Peta (quadrillion)**

The **petajoule (PJ)** is equal to one *quadrillion* ( $10^{15}$ ) joules. 210 PJ is equivalent to about 50 megatons of TNT. This is the amount of energy released by Khrushchev's so-called Tsar Bomba, the largest man-made nuclear explosion ever (1961).

## **Exa (quintillion)**

The **exajoule (EJ)** is equal to one *quintillion* ( $10^{18}$ ) joules. The [2011 Tōhoku earthquake and tsunami](#) in Japan had 1.41 EJ of energy. Energy usage per year in the United States is roughly 94 EJ.

## **Zetta (sextillion)**

The zettajoule (ZJ) is equal to one *sextillion* ( $10^{21}$ ) joules. Annual global energy consumption is approximately 0.5 ZJ.

## **Yotta (septillion)**

The yottajoule (YJ) is equal to one *septillion* ( $10^{24}$ ) joules. This is approximately the amount of energy required to heat the entire volume of [water on Earth](#) by 1 °Celsius.

## **Gazillion is undefined.**

A gazillion is an extremely large, indeterminate number.