Total Solar Power Striking the Earth

The radius of the earth is $r_e = 6400$ km, so the cross-sectional area of the earth that can absorb solar radiation is

$$A = \pi r_e^2 = 120\times10^6 \text{ km}^2 = 1.2\times10^8 \text{ km}^2 = 1.2\times10^{14} \text{ m}^2 \ .$$

At the top of Earth's atmosphere, the *solar insolation* $I_\circ$ is defined as the total solar power per square meter striking a surface oriented exactly perpendicular to the sun's rays. The value of $I_\circ$ is 1360 W/m^2.

The total solar power that can be absorbed by the earth is then

$$P = AI_\circ = 1.2\times10^{14} \text{ m}^2 \times 1360 \text{ W/m}^2 = 1.6\times10^{17} \text{ W} \ .$$

The solar energy (in Joules) striking the earth each year is simply $P\times$ the number of seconds in one year.

$$U = P\times3.2\times10^7 \text{ s} \ = 1.6\times10^{17} \text{ W} \times3.2\times10^7 \text{ s} \ = 5.1\times10^{24} \text{ J} \ .$$

Using the definition of the *quad* as

$$Q = 10^{15} \text{ BTU} \ = 10^{15} \times 1055\text{J} \ = 1.055\times10^{18} \text{ J} \ ,$$

the total annual solar energy is

$$U = \frac{5.1\times10^{24} \text{ J}}{1.055\times10^{18} \text{ J/Q}} = 4.8\times10^6 \text{ Q} \ .$$

This is many times the average annual U.S. energy consumption of 100 Q and the total world energy consumption of about 400 Q.