3/28 Orientation Estimation

What is the total mass of CO_2 put into the atmosphere by a 1-GW coal power plant per year?

1-GW $= 10^9 \frac{\text{J}}{\text{s}}$

$10^9 \frac{\text{J}}{\text{s}} \times 365 \frac{\text{days}}{\text{yr}} \times 24 \frac{\text{hr}}{\text{day}} \times 3600 \frac{\text{s}}{\text{hr}} =$

$10^9 \times \pi \times 10^2 \times \pi \times 10 \times \pi \times \pi \times 10^3 \frac{\text{J}}{\text{yr}} = \pi \times 10^{16} \frac{\text{J}}{\text{yr}}$

The plant has an efficiency of $\frac{1}{3}$ and that burning coal releases 10^7 J kg^{-1}.

$\text{M}_{\text{carbon}} = \text{efficiency} \times \pi \times 10^{16} \frac{\text{J}}{\text{yr}} \times \frac{\text{kg}}{10^7 \text{J}}$

$\text{M}_{\text{carbon}} = \pi \times \pi \times 10^9 \frac{\text{kg}}{\text{yr}} = 10^{10} \frac{\text{kg}}{\text{yr}}$

1 mol C is 12 g, 1 mol CO_2 is 44 g. Thus:

$\text{M}_{\text{CO}_2} = \text{M}_{\text{carbon}} \cdot \frac{44\text{g}}{12\text{g}}$

$\text{M}_{\text{CO}_2} = \pi \times 10^{10} \frac{\text{kg}}{\text{yr}}$

Total world power consumption is 10^5 TW-h per year. How many 1-GW power stations would be needed to supply this power?

$10^5 \text{TW-h} \times 10^3 \frac{\text{GW}}{\text{TW}}$