F (33%) If we switch from a 20 mpg car to one whose efficiency is 30 mpg, and the car is driven 15,000 miles per year, the annual CO₂ savings exceed $10^3$ kg of carbon per car.

\[
\text{gas足迹} = \frac{8 \times 12 \text{ kg C}}{(8 \times 12 + 18) \text{ kg gas/L}} \times \frac{0.8 \text{ kg gas}}{1 \text{ L}} \times \frac{3.86 \text{ L/gal}}{1 \text{ gal}} = 2.56 \frac{\text{kg C}}{\text{gal}}
\]

\[
\frac{\text{gal/yr}}{1 = 750} \Rightarrow \text{Savings} = (750 \frac{\text{gal}}{\text{yr}}) (2.56 \frac{\text{kg C}}{\text{gal}}) = 1.4 \times 10^3 \frac{\text{kg C}}{\text{yr}} < 10^3
\]

F (33%) If the efficiency of a 1000-MW power plant (10,000 BTU/lb coal at 85% CUF) increases from 33 to 35%, the annual CO₂ savings exceed $10^3$ g of carbon.

Coal input \#1 = $7.7 \times 10^9 \frac{\text{lb}}{\text{yr}} \Rightarrow \text{Coal emissions} \#1 = 2.62 \times 10^9 \frac{\text{kg C}}{\text{yr}}$

\[
\Rightarrow \text{Coal inputs} = 1.5 \times 10^8 \frac{\text{kg C}}{\text{yr}} < 10^9
\]

F (34%) If natural-gas-based electricity requires an investment of 500 million dollars for a 500 MW plant, and if the cost of gas is $5/10^6$ BTU and the other annual operating costs add up to 10% of the investment, a crudely estimated payback period (without taking into account the time value of money) exceeds 10 years if the price of electricity is 10 cents/kWh.

\[
\frac{\text{Wh/kWh}}{1} = 3.72 \times 10^9 \Rightarrow \frac{\$}{\text{yr}} = 3.72 \times 10^8 \frac{\$}{\text{yr}} \quad \left(\text{revenues}\right)
\]

\[
\text{Expenses} = 1.59 \times 10^8 + 5.0 \times 10^7 \frac{\$}{\text{yr}}
\]

\[
\text{Payback} = \frac{5 \times 10^8 \frac{\$}{\text{yr}}}{1.64 \times 10^8 \frac{\$}{\text{yr}} \frac{\text{yr}}{\text{yr}} < 10
\]

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