Problem 22, Ch. 14, Modern 2.

Note Title 3/28/2008

Grams of ^{235}U to make 1 GW·day?

$E_p = 1\ \text{GW}\cdot\text{day} = (10^9\ \text{J/s})(8.64\times10^4\ \text{s})$
$= 8.64\times10^{13}\ \text{J}$

1 fission = 200 MeV of energy

$E/\text{fission} = (2\times10^8\ \text{eV})(1.6\times10^{-19}\ \text{J/eV})$
$= 3.2\times10^{-11}\ \text{J}$

$\#\ \text{fissions} = \frac{E_p}{E/\text{fission}} = \frac{8.64\times10^{13}\ \text{J}}{3.2\times10^{-11}\ \text{J}}$
$= 2.7\times10^{24}$

This is number of atoms used.

$\text{Mass used} = (235\ \text{g/mol})\left(\frac{2.7\times10^{24}}{6.02\times10^{23}}\right)$
$= 1053\ \text{g} \approx 1\ \text{kg}$

By contrast, Coal has a chemical energy density of about 25 MJ/kg

So this would take $\frac{8.64\times10^{13}\ \text{J}}{2.5\times10^7\ \text{J/kg}}$

$= 3.5\times10^6\ \text{kg} = 3500\ \text{tonne}$ of coal.