Hydrological Cycle:

\[ \text{potential energy: } m \times g \times h \]

- \(2 \times 10^4 \text{ J/kg energy in evaporated water} \)
- \(2 \times 10^4 \text{ J/kg energy in water evaporation} \)
- \(1 \text{ m}^3 \text{ water per } 1 \text{ m}^3 \text{ land} \)

*Assume we catch every drop of rain (over-estimate)*

\[ E = m \cdot g \cdot h \]

\[ \frac{E}{m} = \text{energy density} = gh \]

\[ \left[ \frac{\text{J/kg}}{} \right] \]

\[ p_e \approx (10 \text{ m/s}) \cdot (100 \text{ m}) \]

\[ p_e \approx 1000 \text{ J/kg water in dam} \]

Efficiency:

\[ \epsilon = \frac{\text{energy out}}{\text{energy in}} = \frac{1 \times 10^3}{2 \times 10^4} = 0.057 \]

\[ \ln \text{ evaporation} \]

Hydro cannot fulfill energy needs:

\[ \left[ \text{efficiency relative to sun: } \epsilon = \frac{1 \times 10^2}{2 \times 10^4} \times rac{28}{200} \approx 0.027 \right] \]

Max efficiency dams:

Avg. land elevation \( H \) is too high:

\( H = 1000 \text{ m} \)

10 m too low:

\( H = 10 \text{ m} \)

\[ \frac{H}{h} = \frac{E_{\text{max}}}{\epsilon} = 10 \Rightarrow E_{\text{max}} \approx 0.57 \]

\( \text{terraens} \)

\( 44 \)

Hydro definitely can't fulfill energy needs.
Biofuels:

How efficient is photosynthesis?

Corn: enough corn to feed me = 100 W

land required to grow corn = \[ \frac{6 \text{ acres} = 30,000 \text{ m}^2}{2000 \text{ m}^2 = \frac{1}{2} \text{ acre}} \approx \frac{0.05}{200} = 0.00025 \text{ W/m}^2 \]

It's the sun

about 5 times more non-edible part than edible, so:

\[ E_{\text{food}} = 5 \times E_{\text{food}} = 0.157 \text{ W/m}^2 \text{ (our estimate)} \]

\[ E_{\text{food}} \text{ (promoted):} \approx 0.15 \text{ W/m}^2 \]

\[ E_{\text{food}} \text{ (fertilized):} \approx 0.25 \text{ W/m}^2 \]

\[ E_{\text{food}} \text{ (fertilized corn):} 0.5 \text{ W/m}^2 \rightarrow \text{ corn is the super food!} \]

land area for agriculture: 300,000

Biofuels cannot fuel the world.

avg. land per person = 6 acres \approx \text{area of main quad}

\[ \text{acre} \quad \text{forest} \quad \text{rainforest} \quad \text{beach} \quad \text{ice} \]

about half the Harper quad

avg. 2500 m\(^2\) per person