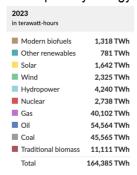
Renewable Energy Biomass Exercise 1

## World fossil energy consumption entirely replaced by biomass resource?

## Data

https://ourworldindata.org/grapher/global-primary-energy

World primary energy consumption in 2023:



- 33.2% = 54'564 TWh oil (=196,4 EJ = 4688 Mton oil, using 41,9 PJ per Mtoe)
- 24.4% = 40'102 TWh gas (=144,4 EJ = 4010 Gm<sup>3</sup> natural gas, using 10 kWh per m<sup>3</sup> NG)
- 27.7% = 45'565 TWh coal (= 164 EJ = 8.42 Gton coal, using 19.5 MJ per kg coal)

At the same time we see that traditional biomass (essentially wood) accounts for 11'111 TWh (=40 EJ) or 6.8% of the total, and modern biofuels for 1'318 TWh (4.7 EJ) or 0.8% of the total.

## Replacement by biomass

We want to replace, in energy-equivalent terms, all fossil resources by renewable biomasses:

- coal by wood (for electricity generation)
  with coal plant electrical efficiency = 40%, but wood plant electrical efficiency = 25%
- oil by biodiesel (for mobility fuels)
- gas by biogas (for heating in buildings and industry)

Use the following simplified conversions

(we justify these conversion factors in the 'Biomass' chapters of the course):

- we can grow 2 kg wood per year per m<sup>2</sup> of forest, with lower heating value = 17 MJ/kg
- we can obtain 1000 L biodiesel (heating value = 33 MJ/L,  $\rho$  = 0.88 kg/L) per year per hectare (=10'000 m<sup>2</sup>) of appropriate plantations such as sunflowers/rapeseed
- we can digest agrowastes from 1 hectare of land to 2000 m<sup>3</sup> of methane per year contained in biogas (lower heating value of methane  $CH_4 = 10 \text{ kWh/m}^3$ )

## **Questions:**

- 1. What would be the land-use for all this biomass to replace all fossil fuel?
- 2. Compare the obtained result with the available forest and agricultural area (11% and 3% of the Earth surface, respectively) cf. course slides
- 3. Compare it also with the yearly biomass production of 32 Gtoe in forests and 3.6 Gtoe in agriculture.