World fossil energy consumption entirely replaced by biomass resource ?

Data

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

World primary energy consumption in 2023:

2023 in terawatt-hours	
Modern biofuels	1,318 TWh
Other renewables	781 TWh
Solar	1,642 TWh
Wind	2,325 TWh
Hydropower	4,240 TWh
Nuclear	2,738 TWh
Gas	40,102 TWh
Oil	54,564 TWh
Coal	45,565 TWh
Traditional biomass	11,111 TWh
Total	164,385 TWh

- 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^3 natural gas, using 10 kWh per m^3 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^2 of forest, with lower heating value = 17 MJ/kg
- we can obtain 1000 L biodiesel (heating value = 33 MJ/L, ρ = 0.88 kg/L) per year per hectare (=10'000 m^2) of appropriate plantations such as sunflowers/rapeseed
- we can digest agrowastes from 1 hectare of land to 2000 m^3 of methane per year contained in biogas (lower heating value of methane CH_4 = 10 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.