Renewable Energy ME460 **Exercise Wind 1**

Wind power potential in Switzerland

The idea is to make an educated guess of the wind power potential in Switzerland. A site like https://www.uvek-gis.admin.ch/BFE/storymaps/EE_Windatlas/?lang=en, but also others, give relevant data. What is needed to make such an estimate: (a) the known average wind-speeds per location and at certain heights, and (b) the restrictions per location to put up wind turbines (urban, protected areas,…). For the sake of the estimate, a number of assumptions have to be made, which in principle you should find out by yourself... (In an engineering consulting office, your client will not give you the data to answer the question that he asks you ; you need to go and find the relevant data yourself….). For now let's assume :

Data :

- Annual electricity production in Switzerland: $E_{el,an}$ = 65 TWh_{el}
- Average wind velocity on exploited sites : v = 5 [m/s] (see e.g. the wind map link)
- Approximately 5% of the territory can be exploited with wind turbines : => 2'000 km^2
- Rated wind (m/s) speed on exploited sites : = twice the average wind speed
- Size of a typical turbine : 80 m diameter
- Spacing between any neighbouring turbines = 10 times the diameter
- Mechanical efficiency of wind turbines ε_{wt} = 70 % (=> the power coefficient Cp = 0.59 * 0.7 = 0.4)
- Equivalent operating time at rated wind speed (=load factor): 1800 h / year
- Air density: ρ_{air} = 1.1 [kg/m^3] (density at 1000 m altitude)

Question :

How much wind power from how many turbines could theoretically contribute to the total annual electricity needs, using the above assumptions?