

More Windpower and Areas

Physics and Mathematics of Sustainable Energy

College of the Atlantic. January 25, 2021

1. A 2MW wind turbine has a capacity factor of 0.38.
 - (a) How much energy does this turbine generate in a year?
 - (b) How much many Maine homes could this turbine power? (One Maine home uses 531 kWh per month on average.)
 - (c) If the wind turbine were relocated somewhere where the average windspeed was 15% higher, how much energy would it produce in a year? How many more homes could the turbine supply with electricity?
2. In 2018 the Scherer coal plant in Georgia, USA, generated 15,420,000 MWh of electricity.
 - (a) What is the power of the plant expressed in Watts?
 - (b) If we wanted to shut down this coal plant and replace it with electricity generated by wind, how large would such a wind farm need to be.
 - (c) Express the above area in a meaningful way. What size square has this area?
3. Residential electricity use in Maine is 21 billion kWh/year. What area of land would be needed to generate this electricity from terrestrial windpower?
 - (a) Answer in square meters, square kilometers, square miles, and acres.
 - (b) A square of what side (in km or miles) has this same area?
 - (c) If this amount of electricity was generated using existing methods, how much CO₂ would be released into the atmosphere? Express your answer in tonnes per person.
4. COA uses around 800,000 kWh of electricity in one year.
 - (a) Express this power in Watts.
 - (b) What size terrestrial wind installation would we need shore to generate this much power? Express this area in a meaningful way.
 - (c) What size offshore wind installation would we need shore to generate this much power? Express this area in a meaningful way.
5. The transportation sector in Maine in 2014 used 38×10^9 kWh.
 - (a) Convert this to kWh per person per day.
 - (b) Convert this to W.
 - (c) Suppose we wanted to replace half of this 38×10^9 with electricity from wind? (This would roughly result in a complete electrification of the transport sector, since electric vehicles are much more efficient than gas vehicles.) How much land mass would we need to devote to wind turbines in order to do so? Express your answer in a meaningful way.