Physics 162; Spring 2021
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Project 3: Solar Potential

Goals: We've learned how electricity generation from solar power works. We've also made some simple estimates of potential solar power – in other words, how much we could possibly tap, in principle. Let's build on all these things and compare some regions of the country and the world.

Groups: You are encouraged (but not required) to work in groups of up to three students. Feel free to use the Discussion board to find classmates, and feel free to work in the same group as Project 1.

Due date: Wednesday June 2, by 5:00 pm, **via Canvas**. No late assignments will be accepted. Submit your assignment as one PDF. Clearly indicate all group members' names.

Solar Power Potential Assessment

For various states, as detailed below, you'll calculate a very rough estimate of the possible power we could get from solar power.

- Data on solar insolation is at the Global Solar Atlas (https://globalsolaratlas.info/). This lets you draw a polygon in which to evaluate regions, or to select particular regions such as U.S. States. (The Wind Atlas also allowed choosing states, but I didn't realize this when I assigned Project 2.) To select a state, click the "Region" icon, then select the Country, and you should see a "select region" box that lets you choose a state.
- For whatever region you're considering, note the "direct normal irradiation," for which the minimum and maximum energy per square meter are shown. Click "Details" and find the "Statistics" box. Note the average for the region you're considering; you can select MJ/m^2 or kWh/m^2. This is the average energy per square meter over a time period of one day. For Oregon, you should find 4.97 kWh/m^2, or 17.89 MJ/m^2. Be sure you can find these numbers. Note that this corresponds to an average **power** of 207 W/m^2. (Why? Be sure to think and understand how to get from 17.89 MJ/m^2 to this number!)
- Be sure to consistently **use SI units.** Also note that M = Mega = 10^6, and G = Giga = 10^9.

Actual solar power:

- To find the *actual* solar electricity generation output of a state, use the same U.S. Energy Information Administration site and 2019 data we used in Projects 1 and 2, but of course for the "Solar Thermal and Photovoltaic" part of "Total Electric Power Industry" For Oregon in 2019, for example, it is about 676,000 **MWh**, in other words about 676,000 MWh/year:

2019	**OR**	Total Electric Power Industry	Solar Thermal and Photovoltaic	676,337

Sources: If you use sources other than those I list here, cite them in your writeup.

Part 1: States

Group A: WA, ID, MT
Group B: CA, AZ, NM
Group C: PA, NY, NC, AL

Pick one state each from groups A, B, and C, and pick **two** other states. Pick states that don't border each other.

1.1 Calculate (15 pts.)

For each state, calculate the following and **write your results in a clear table.**

a) The total power hitting the entire state in the form of sunlight, in GW. (You'll need the average power per square meter and the total area of the state.)
b) The power, in GW, that the state could get from solar photovoltaics with 20% efficiency, if 1% of the state's area is covered.
c) Express the answer to (b) as power per person for that state, in kW.
d) From the EIA table, note the 2019 solar power generation of that state, in GW...
e) ... and the 2019 solar power generation per capita, in kW
f) Suppose each person in the state uses 10 kW of power, and all of this can be supplied by electricity. Figure out the area the state would need to cover in 20% efficient solar panels to supply this electricity. Write how many miles on a side a square of this area would be.

1.2 Comment (6 pts.)

In a few sentences, comment on your results. Are the states similar, or different? Which of them currently uses the greatest fraction of its potentially available solar power?

Part 2: Other Parts of the World

(12 pts.) Explore the world using the Global Solar Atlas. Choose two regions, in two different continents, and estimate the available solar power as above. Also estimate the population in each region and the per capita power available. Finally, calculate the "square length" as in (f) above – you can either use 10 kW as the per capita power consumption, or the actual value of that region, but clearly indicate what you've chosen. Explain your findings with both a table and text.

Part 3: Illustrations

(10 pts.) For two of your regions (either U.S. States or other parts of the world) indicate the "square" needed to supply 10 kW per person by drawing a box on a map of that region. You can do this by hand or on a computer. It doesn't have to be very exact. This sort of illustration is very good for convincing people of the scale of solar power!

Other scoring

General clarity: 10 pts.