Solar Suitability Model

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Solar Energy Output Submodel

We downloaded raster data from Cal-Adapt using the the CCSM3 climate model under an A2 emissions scenario. To create the solar energy output submodel we used projected monthly minimumum, maximum, and average temperatures as well as net solar insolation data in California for 2020 and 2050. Running this submodel for two different years allows us to conduct analyses on projected change in solar energy output across California. For example, from 2020 to 2050 we can see that generally solar energy output is projected to increase in Northern California and decrease in southeastern California (Figure 1).

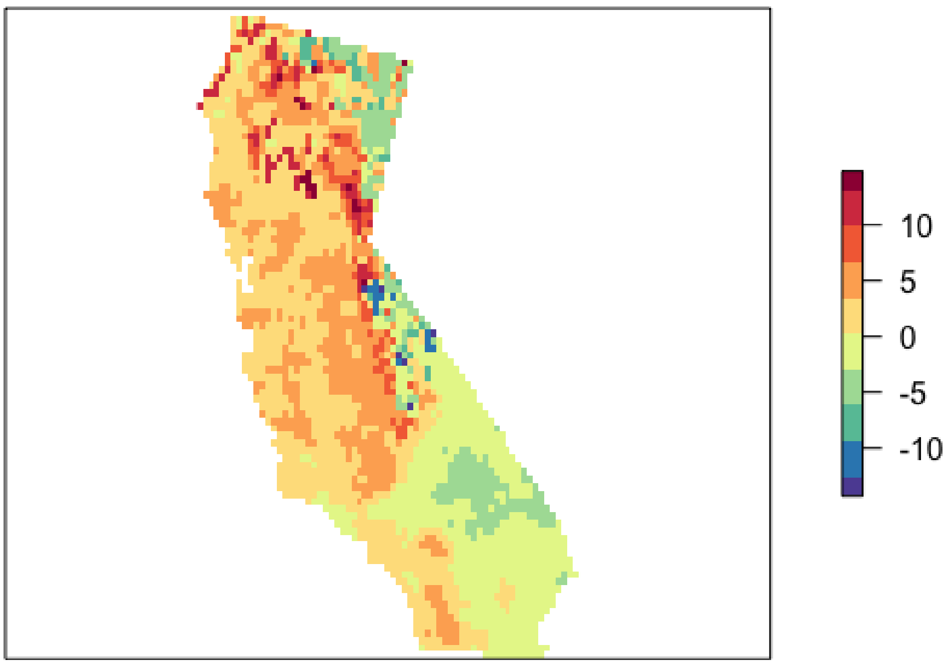

Figure 1. Percent change in solar energy output 2020 to 2050.

To make our final solar suitability map of California for 2020, we needed to average solar energy output by county (Figure 2).

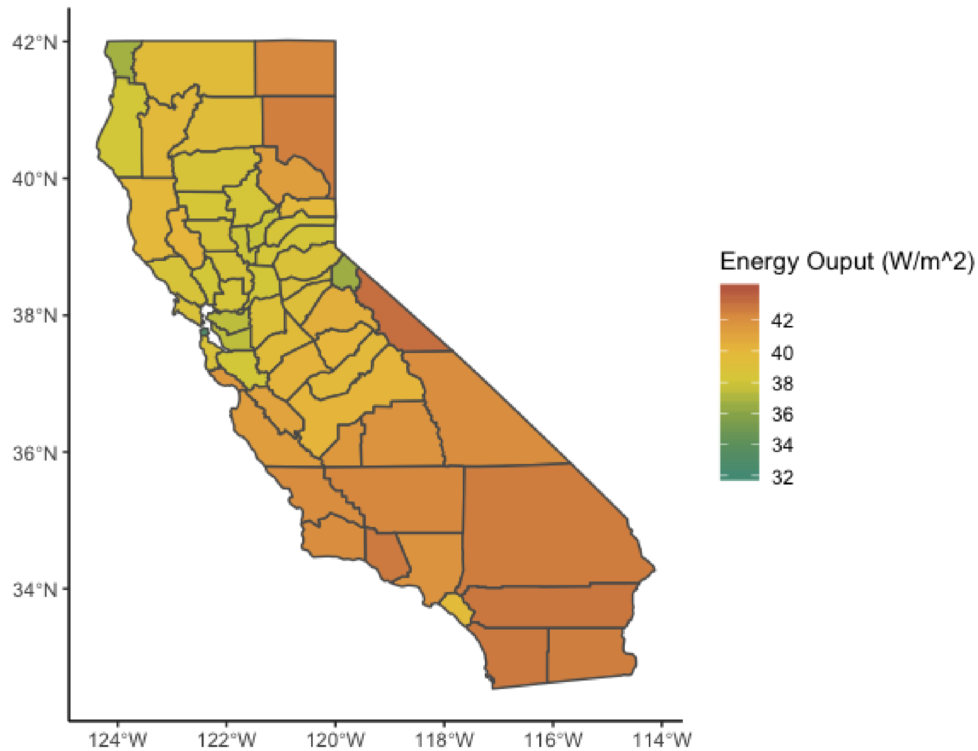

Figure 2. Average solar energy output by county in 2020.

Sensitivity Analysis on Solar Output

We tested the sensitivity of the year-round average energy output for the county with maximum output to the five different material parameters B, g, c_1, c_2, and c_3. We used the Latin hypercube method with 2000 iterations, and assumed all five parameters follow a normal distribution with 25% standard deviation.

Figure 3 shows the five parameter-output correlation plots. Figure 4 shows the partial rank correlation plot for the five parameters.

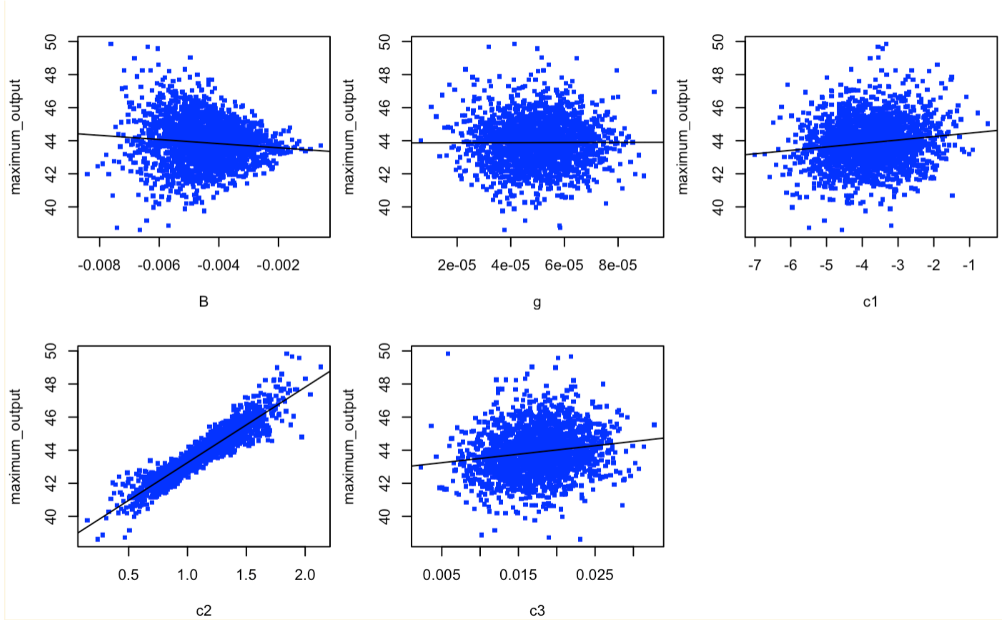

Figure 3. Parameter-output correlation plots for the five material parameters.

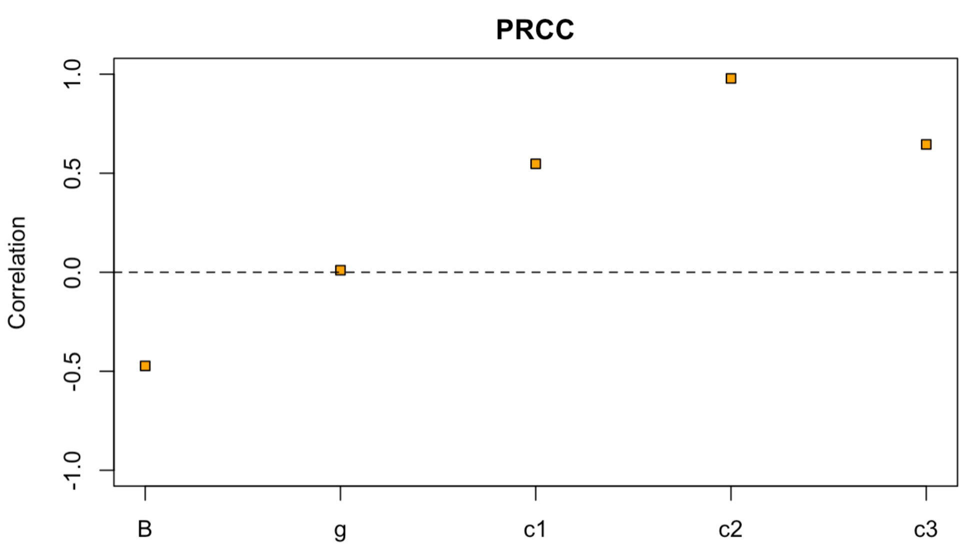

Figure 4. Partial rank correlation plot for the five parameters.

The analysis shows that the energy output is sensitive to B, c_1, c_2, and c_3 , but not very sensitive to g. The choice for PV panel material, PV panel design, and emprical equation would all affect the parameters. Hence, it is important to record the changes in B, c_1, c_2, and c_3 when using this model for a different type of solar farm.

Economic Submodel

For the economic submodel, we first downloaded assessed land value data from CA BOE, and calculated the unit land value ($c_{unitland}$, in $\$/m^2$) for each county. To do this, we calculated the area of each county, then divided the total value by the area.

Then, we got the instant cost ($c_{instant}$: $\$1585/kW$), the installed cost ($c_{installed}$: $\$1861/kW$), and the O&M cost ($c_{om}$: $\$8.12/MWh$) from the CA Energy Conmission. We assumed to install a $20000m^2$) (A) solar farm in every county (about 5 acres), which will operate for 10 years (t).

Finally, we took the energy generation from the solar energy submodel (gen_{unit}).

With all these inputs, we used the following equation to calculate the levelized cost of electricty (LCOE) using the following equation.

$$LCOE = \frac{(A * gen_{unit} * c_{instant} + A * gen_{unit} * c_{installed} + A * t * gen_{unit} * c_{om} + A * c_{unitland})}{A * t * gen_{unit}} \quad (1)$$

Figure 5 shows the result LCOE for each county in California.

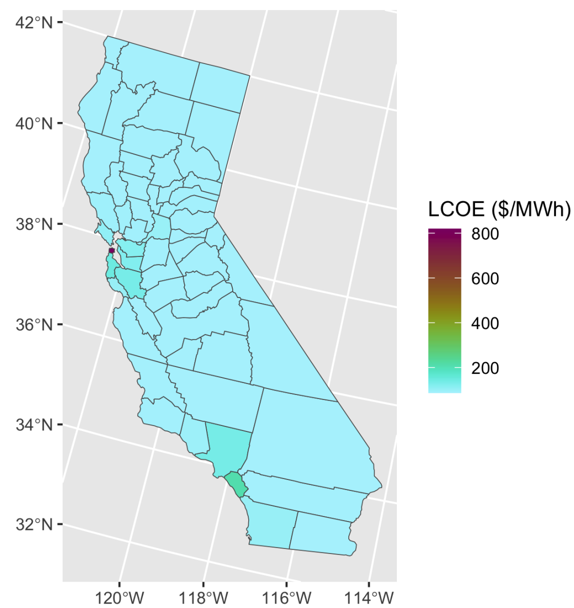

Figure 5. LCOE for assumed solar farm for each county in California.