Laboratory 4 Assignment

(Due Friday February 23 at 5:00pm)

Your consulting firm has been hired by Wellesley College to assess the rooftop solar power potential of south-facing roof of Keohane Sports Center Field House. In order to provide a sense of performance across an entire year, you should **use the hourly data for all of 2012**.

About the roof:

- The roof is tilted 18˚ from horizontal and faces (aspect) 175˚ (nearly due South)

Approach:

1. Use Google Earth (https://earth.google.com/web) to estimate how much roof area could be reasonably dedicated to solar panels. (I'm happy to help!)
    - Locate and zoom into the KSC building
    - Use the Measure tool to determine the usable area of the roof: 

    1a. What is your estimated useable roof area?

2. Use the data in **Lab 4 Data - All 2012.RData** to calculate the energy that the roof would have produced across all of 2012. Values should be in kilowatts (kW) for power and kilowatt-hours (kWh) for total energy.
    - We're dealing with more than one day here, and therefore the dataset for all of 2012 includes the object `DOY` (day of year). You'll need to incorporate `DOY` into the `sun_elevation` and `sun_azimuth` functions in order to calculate sun angles for each hour. *See lab handout.*
    - Examine two scenarios for the roof of Field House:

        (1) Assume that the panels are installed lying directly on the roof and have the same tilt as the roof (cheaper).

        (2) Change the tilt and aspect of the panels to try improve energy capture (more expensive). Find values of tilt and aspect that approach the optimum.

If the tilt and aspect of the roof is not optimal, it's possible to install solar panels at a specific angle. In some cases this is worth the cost, in other cases not!

2a. Create figures of the power (in kW) produced for panels that are lying directly on the roof vs. those that are positioned optimally.

2b. Calculate the total energy (in kWh) across the entire year for panels that are lying directly on the roof vs. those that are positioned optimally.

2c. Create figures that shows the <u>cumulative</u> production of energy (in kWh) produced for panels that are lying directly on the roof vs. those that are positioned optimally.

- You'll need to apply use the **<u>cumsum</u>** function on the object that contains modeled electrical power. This will show the sum of each value and all the values that came before it.
- Note that the cumulative sum of power values represent *total energy* (kWh). Each power value represents the average power (kW) that was "flowing" during that hour. They therefore also represent the total energy (kWh) accumulated over the course of a single hour and can be added together to determine total energy.
- Can you combine this into a single overlay plot?

3. Prepare a brief "consulting report" that which summarizes your results and makes informed conclusions about the potential for solar power on campus. Be sure to refer to the relevant results and figure(s) produced for the questions above, and highlight any relevant patterns regarding the production of solar power. Be sure to address the following:

    - Variability in solar power across the year (i.e. consistency/reliability).
    - The degree to which the KSC roof is oriented optimally (or not), and the amount of energy that could be gained if panels were oriented optimally.
    - What is the potential for solar power to meet the needs of the college? (Note that Wellesley College **typically consumes about 2,800 kW on average**)

Please upload the following for your assignment:

- **Your "consulting report" as a single PDF with relevant figures included and properly captioned**
- **"Knitted" pdf(s) of R Markdown code**