**TIM 155: Problem Set 3**

Due Tuesday, August 16,before class is over.

It can be turned in by hand or via email to bhaddad@ucsc.edu

This question examines the US strategy to meet its greenhouse gas reduction commitments under the 2015 Paris Agreement.

1. The United States has both an intention and a “best efforts” target for reducing greenhouse gasses by 2025. With respect to the Paris Agreement, what are these targets and where are they found? (1 point)
2. What is the U.S. Intended Nationally Determined Contribution and where can it be found (besides our homework file!) (1 point).

1. Take a look at table ES-1 of the US Greenhouse Gas Inventory for 2015. Our interest is in net emissions. What were net US emissions in 2005? Calculate the target range of emissions for 2025 in million metric tonnes of CO2 equivalent (MMT CO2)? (1 point)
2. By 2013, how close have we come to achieving our 2025 goal? Express this as percentage reduced between 2005 and 2013, as well as MMT CO2e reduced. How far do we need to go to get to our target between 2013 and 2025? Express this as both a percentage and as MMT CO2e. (1 point)
3. What has caused US GHG emissions to fall since 2005? Review the major categories of GHG emissions and identify which have been reduced the most. Helpful data can be found in Chapter 3 of the US Climate Action Report (e.g., Fig. 3-11, Table 3-8, and others). (1 point)
4. How does the US plan to meet its Paris Agreement commitments? You can find references to the US plans in its INDC report and in the US 2014 Climate Action Report (although note that since this report came out before the Paris Agreement was finalized, its time frame is different). (1 point)
5. Do you think the US will be able to meet the commitment it made in its INDC report? This should be the longest section of your homework. In the US INDC report, look for the set of bullet points following the phrase “At this time:”. Choose **one** of these bullet points and do some background research on quantities, trends, and plans for GHG reductions. You may need to identify data and analytical sources outside of the materials provided in class. Based on your analysis do you believe this sector will achieve the percentage reduction goal by 2025? (1 point)
6. Based on Ch. 13 of the Global Energy Assessment (GEA), do you believe carbon capture and storage (CCS) will play a major role in helping the US meet its GHG reduction commitments? Why or why not? Provide and justify your best guess as to how many MMT CO2e could be captured using CCS by 2025. (1 point).

**SAM Model Questions**

1. In a couple of paragraphs describe what the NREL System Advisor Model (SAM) is. (1 point)
2. In class we downloaded the SAM system onto our laptops. One of the SAM models is called the *detailed PV model*. Begin a new project involving detailed PV for a residential home. Select a weather file that you think most closely approximates Santa Cruz weather. Explain why you chose it. (1 point)
3. In your weather data, take a look at the direct normal (beam) irradiance. It should be measured in kWh/m2/day. Now compare this irradiance level to levels in 5 other U.S. states, in the northeast, southeast, midwest, northwest, and southwest. What does this tell you about the likely expansion of PV power in these other parts of the country? (1 point)
4. Now take a look at the article written by Stephanie Pappas (alumna of UCSC’s Science Writing program) - http://www.livescience.com/41747-best-solar-panels.html. Her first recommended solar panel is a Kyocera model. Select the exact model from the SAM module menu. There seems to be a minor discrepancy between the article’s claim about the panel’s efficiency and SAM’s listed nominal efficiency – what is it? (*Side note – Stephanie’s article is a year old so there is likely a better panel on the market now.*) (1 point)
5. Now look at the System Design page. We are going to specify the desired array size, so click that radio button. Let’s select 4.5 kWdc on the assumption that the residence will not utilize more than 4.5 kWdc even if all the major appliances were turned on simultaneously. What does kWdc mean? We also need to specify a DC-AC ratio, which is also known as the array-to-inverter ratio. This is our expectation of what will cause the solar array to not generate its maximum theoretical power. The larger this ratio, the more panels one needs to install. Why is that? Typical ratios range from 1.1 to 1.25. Select a ratio in this range and explain why you chose it for Santa Cruz. (1 point)
6. Select an inverter that brings you close to your DC-AC ratio. You can do this by selecting an inverter from the inverter menu, and then checking the DC-AC ratio on the System Design page. Which inverter did you choose? (1 point)
7. We will ignore shading and snow and other losses. Under Financial Parameters, let’s assume we have the cash to purchase and install this equipment without debt. Enter the correct information for an all-cash purchase of a solar system. Under Incentives, check the DSIRE Incentives Database for any additional incentives provided by the city of Santa Cruz. What incentives are there and do they *directly* effect the cost or value of the system?

Under Electricity Rates, we will study the neighborhoods in Santa Cruz that are part of PG&E Region T. Choose and enter a tariff (cost of power) plan. (1 point)

1. When we look at the Electricity Load default data we notice that there is greater electricity use in summer than in winter. Does this match Santa Cruz electricity load? Explain. Instead, let’s edit the load profile using actual data from Professor Haddad’s house. It is in the homework reading list. (Note: December data will be a year older than the rest.)

Now run a simulation of this home’s energy production, consumption, and costs. Click on “untitled” and rename your work “<YOUR NAME> TIM 155 Homework.” On the same menu, create a report and submit it along with your homework. Returning to the SAM model, look at the Summary section (of your report) and provide information on payback period and total cost. Look at the Profiles section and click on *Electricity to/from grid (kWh)*. If the goal is to have a house that is electricity-neutral, do you think this system is sized properly, too small or too large? Explain. (1 point)