**Bren School of Environmental
Science & Management**

Energy, Technology & the Environment – ESM288
4th Assignment

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Fossil Fuels, Biofuels, Clean Energy Revolution

The deadline for this assignment is **Monday, 7 December 2020, 11:59pm**. There is a submission link on GauchoSpace. You may request a deadline extension, if needed.

All required equations, physical units and constants can be found on the course slides. Contact me if you have questions (geyer@bren.ucsb.edu, office hours: by appointment).

Exercise 1: Carbon Dioxide from Fossil Fuels

Calculate the atmospheric carbon dioxide concentration (in ppm_{volume}) that would be reached if all fossil fuel reserves proved in 2019 would be combusted. Use the following data and assumptions:

- In 2019 the global atmospheric carbon concentration was 410 ppm_{volume}.
- Proved reserves and carbon content of fossil fuels can be found on the lecture slides.
- Assume the following densities: Crude oil 0.84 kg/liter, natural gas 0.82 kg/cubic meter.
- Assume complete combustion of all fossil fuels.
- Conversion of atmospheric CO_2 concentrations into total masses of atmospheric CO_2 and vice versa can be found on the lecture slides.
- Assume that all uptake of fossil CO_2 in the environment would follow the current pattern.

Exercise 2: Ethanol from Corn

a) Calculate the ratio of energy output over total energy input for a liter of ethanol from corn based on the following data:

- Average agricultural production of corn is 7.85 tonnes per hectare (per year).
- Total energy input into corn production is 22.1 GJ per hectare.
- Ethanol production at distillery yields 380 liters per tonne of corn.
- Energy requirements of the distillery are 13.7 GJ per 1000 liters of ethanol.
- Total energy requirements of transportation are 0.63 GJ per 1000 liters of ethanol.
- Gross calorific content of ethanol is 30 MJ per kg.
- Density of ethanol is 789 kg per cubic meter.

b) How do total CO_2 emissions from ethanol production and combustion compare to CO_2 emissions from gasoline production and combustion. Use the following additional information:

- CO_2 emissions from agricultural corn production are 1237 kg per hectare.
- CO_2 emissions from transportation are 262 kg per hectare.
- CO_2 emissions from ethanol distillation are 2721 kg per hectare.
- CO_2 emissions from gasoline production and combustion are 2.82 kg per liter.
- Gross calorific content of gasoline is 48 MJ per kg.
- Density of gasoline is 730 kg per cubic meter.

c) Do some literature and internet research on CO_2 emissions from indirect land use change (iLUC) due to directing corn from food and feed to ethanol. What are values for iLUC GHG emissions (in gCO2eq/MJ fuel energy) found in literature and other sources?

Exercise 3: A Clean Energy Revolution

Please write up your vision of a clean energy revolution in the United States. Envision a future in which the environmental impacts from energy production and use in the U.S. are dramatically lower than they are today. Make your vision compelling by discussing the technological, operational, and sociological feasibility of your ideas and proposals. You can talk about economic feasibility as well if you want, but it is not required. Maximum word count is 1,000.