# Assignment 3: Energy Growth Rates and Carbon Emission Factors

Instructions: Use Microsoft Excel for Problems 1 & 2. “Building Charts Tutorial” is posted on Canvas. Refer to the conversion factors sheet on Canvas when appropriate. **Show your work.** For the Excel problems, you do not need to submit the Excel file; instead, you should write out the equations you used, the solution process, and the graphs.

## Problems on Growth Rates

**Question 1**

Electricity Growth Rates:

1. Download an Excel spreadsheet of electricity end use data from EIA’s Monthly Energy Review (MER). Go to <https://www.eia.gov/totalenergy/data/monthly/>, expand “Electricity” and look for Table 7.6. Use the “Annual Data” tab of the spreadsheet to determine the annual growth rate for electricity consumption in the period 1950-1973 (in Excel).

(HINT: use the data from all years in this window, not just start and end years).

1. What was the doubling time? Determine what the electricity consumption would be in 2021 if consumption had continued to grow at the same rate as it did from 1950 to 1973 (HINT: use your trendline equation from Q1a).
2. Efficiency was responsible for the lower growth rate after 1973. Find the actual US electricity consumption (total end use all sectors) in 2021 in Table 7.6.

*Note: If you’re having difficulty finding the spreadsheet for Table 7.6 in the EIA MER, try copying and pasting this link into your browser* *<https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T07.06&freq=m>*

**Question 2**

Gasoline Growth Rates:

1. From Table 3.5 of EIA’s MER, Petroleum Products Supplied, determine the growth rate in motor gasoline supply from 1949 to 1973. Go to <https://www.eia.gov/totalenergy/data/monthly/>, expand “Petroleum” and look for Table 3.5. Use the “Annual Data” tab of the spreadsheet.
2. Determine the growth rate in motor gasoline supply from 1980 – 1990. Compare this rate with the rate from 1949 – 1973.
3. What key factor accounts for the lower growth rate during 1980 – 1990? Consider the following statistics reported in the Transportation Energy Data Book (<https://tedb.ornl.gov/>) when making your **qualitative assessment**: the population trend (Table 9.01), VMT/Capita trend (Table 9.02) and fuel economy trend (Table 4.09).

*Note: If you’re having difficulty finding the spreadsheet for Table 3.5 in the EIA MER, try copying and pasting this link into your browser* [*https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T03.05&freq=m*](https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T03.05&freq=m)

## Problems on Carbon Emission Factors

**Question 3**

Investors from a new company are asking for you to fund research for a new fuel that is supposed to be a “low carbon” substitute for gasoline. Analysis shows that the new fuel has a carbon mass fraction (FC) of 0.62 and a higher heating value of 31.8 MJ/kg. Is this new fuel better or worse than gasoline from a carbon intensity perspective? Show your work. (Calculate carbon intensities [Carbon Emissions Factors] for both gasoline and the new fuel)

**Question 4**

Carbon Emission Factors from Molecular Formulas:

1. 100% ethanol (C2H5OH) has a higher heating value of [29.7 MJ/kg](https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html). Using ethanol’s molecular formula, calculate the mass fraction of carbon. What is ethanol’s carbon intensity (Carbon Emission Factor)?
2. Butanol (C4H9OH) has a higher heating value of [37.3 MJ/kg](https://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html). What is butanol’s carbon intensity (Carbon Emission Factor)? How does it compare to ethanol’s?

**Question 5**

In 2017, the Trump Administration opened the Arctic National Wildlife Refuge (ANWR) for drilling. The ANWR Drilling plan authorized that 1.56 million acres of the 19-million-acre refuge (the Federal 10-02 area) be open for oil leasing. The entire ANWR coastal plain, which includes federal, state, and native property, was included in the opened 1.56 million acres. Supporters of the plan argued that it would revive Alaska’s struggling economy and help the U.S. secure energy independence. Opponents of the move argued that drilling in the refuge poses serious environmental implications such as habitat destruction and subsequently a decrease in the area’s resiliency to climate change. The U.S. Geological Survey (USGS) estimated that anywhere between [5.7 – 16 billion barrels of technically recoverable crude oil exist in the ANWR coastal plain](https://pubs.usgs.gov/fs/fs-0028-01/fs-0028-01.pdf). Although just recently in 2021, the U.S. House passed a reconciliation package that walks back the sale of ANWR lands for drilling, for the purposes of this problem lets explore the potential of this resource for meeting US demand for oil.

* <https://www.latimes.com/environment/story/2019-09-12/interior-finalizes-plan-to-open-alaskas-arctic-national-wildlife-refuge-to-oil-drilling>
* https://www.reuters.com/business/environment/us-house-panel-passes-reconciliation-bill-protecting-arctic-reserve-drilling-2021-09-10/

For the sake of this problem, assume that **13 billion barrels** of crude oil are technically recoverable.

1. Estimate how long in years this oil could meet projected US crude oil consumption of both domestic and imported crude oil. Use the rate of total crude oil supply for 2021 given in the Annual Energy Outlook Reference Case Table 11 (<https://www.eia.gov/outlooks/aeo/data/browser/#/?id=11-AEO2020&sourcekey=0>)
2. Do you support drilling of ANWR? Briefly state your position (you can list your arguments in bullet form).