Name: Date: Class:

Alternative fuel: Ethanol

Instructions: Read this webpage (https://afdc.energy.gov/vehicles/flexible_fuel_emissions.html) and then answer the questions below.

Ethanol Vehicle Emissions:

How is ethanol used? By itself or mixed with other substances?

Life Cycle Emissions:

What is a life cycle analysis?

What are the greenhouse gas (GHG) emissions?

How can the carbon dioxide emission be offset?

How does the emission with ethanol compare to the emission with gasoline?

Evaporative and Tailpipe Emissions:

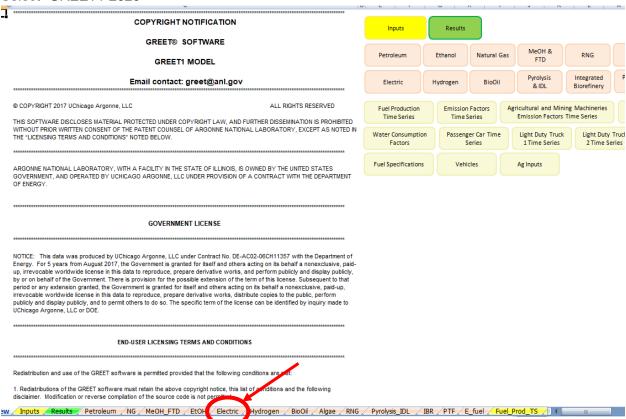What are the emissions of primary concern?

Use the GREET excel database to complete the chart below:
1. Open this link: https://greet.es.anl.gov/greet_1_series
2. Click the link underneath "GREET 1 Series (Fuel-Cycle Model) or this link **GREET_2020rev1.zip**
3. Open the GREET folder
4. Select "GREET1-2020"

5. To use the GREET database, you have to click on the tab at the bottom of the screen. Ethanol is abbreviated EtOH, so click the "EtOH" tab. The red arrow above is pointing to it.
6. There is a lot of information on this database. Scroll all the way down to 4) Summary of Energy Consumption, Water Consumption, and Emissions. The data you are looking for is listed in table 4.1. This table tells you the energy consumption, water consumption, and total emissions for the use of ethanol fuel.
7. Because we are interested in reducing carbon emissions and climate change, you will be looking at the values for methane (CH4), carbon dioxide (CO2), and nitrous oxide (N2O). There are other variables in this chart, but we will focus just on these three. There is a red box around them in the table below.

4) Summary of Energy Consumption, Water Consumption,
4.1) Energy Consumption, Water Consumption, and Total En

	mbined Ethanol	Poplar Ethanol: Fermentation Poplar	Ethanol	Poplar Ethanol: Gasification Poplar	Ethanol	Poplar Ethanol: Combined Poplar	Ethanol	Switchgrass Ethanol: Fermentation Switchgrass	Ethanol	Switch G Switchg
Loss factor	1.001		1.001		1.001		1.001		1.001	
Total energy	1,438,540	99,541	1,520,732	102,063	1,550,085	99,541	1,520,732	673,685	1,406,994	62
Fossil fuels	-42,891	98,539	-42,891	101,035	29,174	98,539	-42,891	95,281	1,471	8
Coal	-58,941	1,741	-58,941	1,785	2,753	1,741	-58,941	3,991	-53,309	
Natural gas	-7,767	26,365	-7,767	27,033	9,263	26,365	-7,767	54,730	29,396	5
Petroleum	23,817	70,432	23,817	72,216	17,158	70,432	23,817	36,560	25,384	3
Water consumption	117.779	4.475	117.779	4.588	35.952	4.475	117.779	9.882	150.380	
VOC	34.368	4.925	34.390	5.050	21.449	4.925	34.390	6.439	35.934	
CO	155.480	20.892	155.820	21.421	19.829	20.892	155.820	12.316	157.046	1
NOx	232.113	51.924	234.347	53.239	123.650	51.924	234.347	34.448	225.493	3
PM10	12.946	2.904	12.996	2.978	3.090	2.904	12.996	2.283	13.051	
PM2.5	3.948	2.631	3.993	2.698	2.621	2.631	3.993	1.873	3.990	
SOx	212.699	12.104	174.928	12.410	41.433	12.104	174.928	37.915	278.209	3
BC	0.364	1.618	0.370	1.659	0.402	1.618	0.370	0.467	0.360	
	0.768	0.514	0.783	0.527	0.950	0.514	0.783	0.316	0.766	
CH4	4.309	10.084	4.674	10.340	20.044	10.084	4.674	11.941	8.551	1
N2O	10.805	7.026	11.031	7.204	10.538	7.026	11.031	19.882	11.928	1
CO2	-3,779	8,152	-3,781	8,358	2,090	8,152	-3,781	3,699	-808	
CO2 (w/ C in VOC & CO)	-3,428	8,200	-3,429	8,408	2,188	8,200	-3,429	3,738	-449	
GHGs	-435	10,364	-365	10,627	5,582	10,364	-365	9,365	2,969	
4.2) Urban Emissions										
	1.001							1.001		
Urban VOC	13.312	0.227	13.312	0.233	13.348	0.227	13.312	0.154	13.349	
Urban CO	-0.352	0.275	-0.352	0.282	0.310	0.275	-0.352	0.318	-0.194	
Urban NOx	-0.152	0.599	-0.152	0.615	1.269	0.599	-0.152	0.779	0.144	
Urban PM10	-0.133	0.051	-0.133	0.052	0.051	0.051	-0.133	0.053	-0.112	
Urban PM2.5	-0.092	0.041	-0.092	0.042	0.043	0.041	-0.092	0.043	.077	
Urban SOx	-5.931	0.261	-5.931	0.267	0.262	0.261	-5.931	0.535	-5.9 9	
Urban BC	-0.004	0.005	-0.004	0.005	0.004	0.005	-0.004	0.005	-0.00	
Urban OC	0.002	0.009	0.002	0.009	0.023	0.009	0.002	0.012	0.006	

Overview / Inputs / Results / Petroleum / NG / MeOH_FTD / **EtOH** / Electric / Hydrogen / BioOil / Algae / RNG / Pyrolysis_IDL / IBR / F

8. There are many different plants that are used to make ethanol. Look through the data table and find the type of ethanol that you think is best in regards to the amount of CO2, N2O, CH4 in the emissions. To move through the data table, use the arrow that has the red circle around it in the picture above. Record the data in the table below. This is what you will share when the group comes back together. (there are extra lines in the data table, you can use them if it is helpful to record information while trying to determine which version of ethanol you want to use - circle the one that you will share)

Gas emission	Ethanol type				
CH_4					
N_2O					
CO_2					

The abbreviations in GREET are defined below:

VOC = volatile organic compounds

CO = carbon monoxide

NO_X = nitric oxide

PM10 = particulate matter with a diameter of 10 micrometers or less

PM2.5 = particulate matter with a diameter of 2.3 micrometers or less

SO_X = sulfur oxides
BC = black carbon (particulate matter/ soot & contributes to climate change)
OC = organic carbon (respiratory effects)
CH_4 = methane
N_2O = nitrous oxide
CO_2 = carbon dioxide

9. Fill in the row below for ethanol.
10. When everyone is finished learning about the energy sources, share what you have learned with the group. Each individual should summarize the questions they answered and share the GREET emissions that were calculated. Notes should be taken in the table below so that the information can be shared with your poster group.
11. Highlight the energy source you will use to heat your building (remember that we are assuming that the technology for this will be in place) and complete the information below the table.

Energy Source	Information about energy source	GREET values
Ethanol		
Electric		
Biodiesel		
Natural Gas		
Propane		
Hydrogen		

Type of fuel that will be recommended for use in heating your building structure:

Evidence and reasoning for this recommendation:

12. Return to the "Energy Source" document and continue to step 2.