Alternative fuel: Natural Gas Answer Key

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

Natural Gas Vehicle Emissions:

What are the benefits of using natural gas vehicles?

> Natural gas helps reduce some engine emissions.

Life Cycle Emissions and Petroleum Use:

What do CNG and LNG stand for?

> CNG = compressed natural gas & LNG = liquified natural gas

What is the difference in emissions between CNG and LNG?

> CNG and LNG are very similar, one difference is that CNG production uses less petroleum and emits fewer GHGs because compressing gas requires more energy than liquifying it.
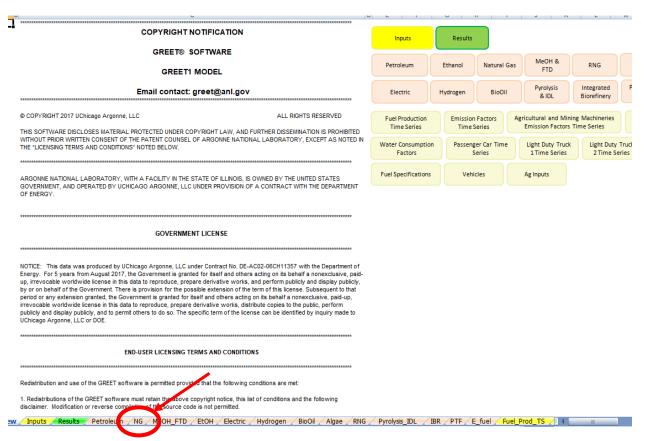
What is RNG?

> RNG = renewable natural gas

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"

TE TeachEngineering

CU Engineering
UNIVERSITY OF COLORADO BOULDER

Name: **Date:**   **Class:**

5. To use the GREET database, you have to click on the tab at the bottom of the screen. Natural gas is abbreviated NG, so click the "NG" 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. Record the data listed in table 4.1 for "Natural Gas as Stationary Fuels". This table tells you the energy use, water consumption, and total emissions for what are the units? Each gallon of ethanol? (it says Btu or Grams per mmBtu of 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, and Emissions: Btu or Grams per mmBtu of Fuel Throughput at Each Stage

4.1) Energy Use, Water Consumption, and Total Emissions

	Natural Gas as Stationary Fuels	Natural Gas for Electricity generation	NGL to Oil Sands	NGL (based on Shale Gas) to Steam Crackers	Natural Gas to Liquefied Natural Gas (as an intermediate fuel) Feedstock	Fuel	Flare gas to Liquefied Natural Gas (as an intermediate fuel) Feedstock	Fuel	NG or FG to Compressed Natural Gas Feedstock	Fuel	Natural Gas to Liquefied Natural Gas (as a transportation fuel) Feedstock	Fu
Loss factor						1.017		1.019		1.001		1.0
Total energy	100,740	86,028	78,275	69,018	70,781	127,627	70,781	130,777	104,983	44,281	70,351	123,2
Fossil fuels	100,004	85,404	77,739	68,534	70,273	126,705	70,273	29,429	104,220	34,695	69,846	122,3
Coal	1,280	1,085	929	842	884	1,602	884	1,616	1,325	15,778	878	1,5
Natural gas	94,685	80,338	63,485	63,867	65,378	118,849	65,378	20,505	98,839	18,302	65,051	114,3
Petroleum	4,039	3,980	13,325	3,825	4,011	6,255	4,011	7,308	4,056	615	3,917	6,4
Water consumption	3.185	3.098	3.972	3.769	2.213	0.728	0.311	0.550	3.222	4.066	3.020	0.8
VOC	10.323	8.576	6.825	6.578	6.762	1.851	6.762	-0.771	10.729	0.321	6.715	1.0
CO	32.051	23.099	13.221	12.853	13.809	7.315	13.809	-21.621	34.116	1.082	13.560	6.5
NOx	40.092	29.493	25.327	17.318	18.537	30.694	18.537	-19.717	42.538	1.983	18.198	10.7
PM10	0.476	0.452	0.693	0.418	0.432	1.562	0.432	-2.397	0.482	0.323	0.426	0.5
PM2.5	0.427	0.406	0.640	0.376	0.388	1.449	0.388	-2.526	0.432	0.144	0.383	0.5
SOx	11.487	11.286	11.101	11.043	11.086	9.647	11.086	10.822	11.542	4.327	11.073	1.9
BC	0.139	0.134	0.150	0.127	0.131	0.182	0.131	-3.747	0.141	0.013	0.129	0.0
OC	0.151	0.143	0.360	0.131	0.136	0.663	0.136	0.529	0.153	0.030	0.134	0.3
CH4	151.608	126.235	98.558	98.433	96.523	102.338	96.523	56.535	174.236	15.722	99.198	135.9
N2O	1.418	0.796	0.052	0.100	0.132	0.053	0.132	-1.181	1.561	0.042	0.132	0.0
CO2	6,208	5,415	5,230	4,491	4,604	7,528	4,605	-58,965	6,394	2,721	4,569	7,1
CO2 (w/ C in VOC & CO)	6,291	5,478	5,272	4,532	4,647	7,545	4,647	-59,001	6,481	2,724	4,612	7,1
GHGs	11,215	9,476	8,243	7,511	7,578	10,629	7,578	-57,618	12,122	3,207	7,623	11,2

4.2) Urban Emissions: Grams per mmBtu of Fuel Throughput at Each Stage

Loss factor						1.017		1.019		1.001		
VOC	0.599	0.366	0.103	0.079	0.053	0.067	0.053	0.078	0.653	0.025	0.117	0.0
CO	2.886	1.653	0.151	0.138	0.220	0.130	0.220	0.146	3.170	0.202	0.339	0.5
NOx	3.447	1.989	0.222	0.198	0.274	1.345	0.274	1.577	3.782	0.437	0.426	1.0

Tabs: Overview   Inputs   Results   Petroleum   **NG**   MeOH_FTD   EtOH   Electric   Hydrogen   BioOil   Algae   RNG   Pyrolysis_IDL   IBR   P

8. Record the amount of CO2, N2O, CH4 in the emissions for the "Natural Gas as Stationary Fuels" in the table below. If you would like to move through the data table to see the other data that is collected, use the arrow that has the red circle around it in the picture above.

Natural Gas	
Type of emission	**Total amount of emission**
CH$_4$	151.6
N$_2$O	1.4
CO$_2$	6,208

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$_2$O = nitrous oxide

CO$_2$ = carbon dioxide

TeachEngineering   Engineering
                                                  UNIVERSITY OF COLORADO **BOULDER**

9. In the table below, fill in the row for natural gas.
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. Circle 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.

Answers will vary based on student presentations.

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:

The expectation is that they will choose hydrogen, but it does depend on students' presentations.

Evidence and reasoning for this recommendation:

Evidence used would be the low greenhouse gas emissions.

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