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Alternative fuel: Electricity Answer Key

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

Emissions from Hybrid and Plug-In Electric Vehicles:

Besides the emission from the car's tailpipe, what else needs to be considered?

Emissions associated with the production of electricity also need to be considered.

Electricity Sources and Emissions:

Summarize the data presented in the Annual Emissions per Vehicle graph:

All electric cars release fewer emissions. Most of the electricity is produced using natural gas and nuclear power.

Direct and Well-to-Wheel Emissions:

What are direct emissions?

Direct emissions are emissions that come from a vehicle's tailpipe and through evaporation from the vehicle's fuel system during the fueling process.

How are direct emissions different for different types of electric vehicles?

EV (all-electric vehicles):

All-electric vehicles produce zero direct emissions.

PHEV (Plug-In Hybrid Electric Vehicle) in all electric mode:

PHEV's produce zero tailpipe emissions when they are in all-electric mode, but can produce evaporative emissions.

PHEV, when using ICE (internal combustion engine):

PHEV's produce tailpipe emissions when they are use their ICE, but the direct emissions are usually lower than a conventional vehicle.

What are Well-to-wheel emissions?

Well-to-Wheel emissions include all the emissions related to fuel production, processing, distribution and use.

Why are well-to-wheel emissions important to consider with electric vehicles?

Most electric power plants produce emissions, there are also extra emissions during extraction, processing and distribution of the primary energy sources that are used for electricity production.

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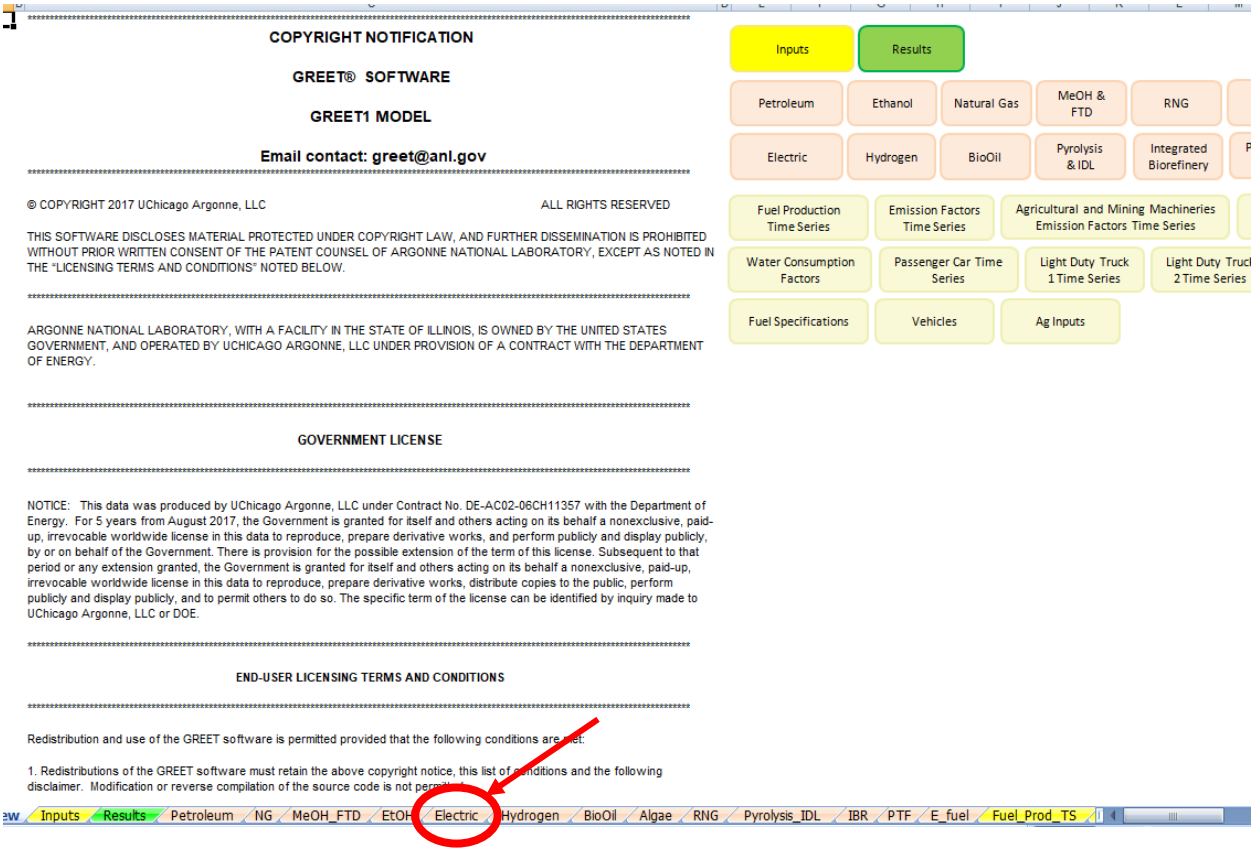
Use the GREET excel database to complete the chart below:

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. Click the “Electric” 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 12) Fuel-Cycle Energy Use, Water Consumption, and Emissions. Scroll down to the second half of the table. The data you are recording is the Energy Consumption, Water Consumption, and Total Emissions for what are the units? Each gallon of ethanol? (it says Btu or Gallons or Grams per mmBtu of electricity available)
7. Because we are interested in reducing carbon emissions and climate change, record 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.

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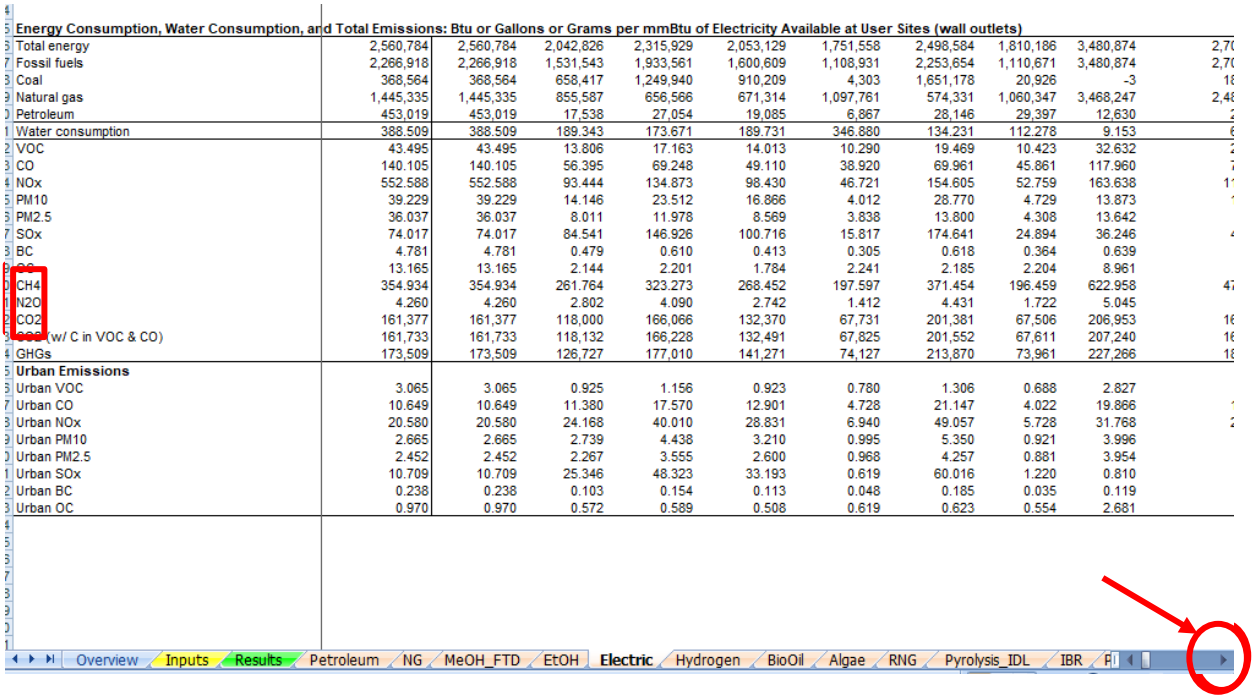

Energy Consumption, Water Consumption, and Total Emissions: Btu or Gallons or Grams per mmBtu of Electricity Available at User Sites (wall outlets)										
Total energy	2,560,784	2,560,784	2,042,826	2,315,929	2,053,129	1,751,558	2,498,584	1,810,186	3,480,874	2,70
Fossil fuels	2,266,918	2,266,918	1,531,543	1,933,561	1,600,609	1,108,931	2,253,654	1,110,671	3,480,874	2,70
Coal	368,564	368,564	658,417	1,249,940	910,209	4,303	1,651,178	20,926	-3	18
Natural gas	1,445,335	1,445,335	855,587	656,566	671,314	1,097,761	574,331	1,060,347	3,468,247	2,48
Petroleum	453,019	453,019	17,538	27,054	19,085	6,867	28,146	29,397	12,630	2
Water consumption	388.509	388.509	189.343	173.671	189.731	346.880	134.231	112.278	9.153	6
VOC	43.495	43.495	13.806	17.163	14.013	10.290	19.469	10.423	32.632	2
CO	140.105	140.105	56.395	69.248	49.110	38.920	69.961	45.861	117.960	7
NOx	552.588	552.588	93.444	134.873	98.430	46.721	154.605	52.759	163.638	11
PM10	39.229	39.229	14.146	23.512	16.866	4.012	28.770	4.729	13.873	1
PM2.5	36.037	36.037	8.011	11.978	8.569	3.838	13.800	4.308	13.642	
SOx	74.017	74.017	84.541	146.926	100.716	15.817	174.641	24.894	36.246	4
BC	4.781	4.781	0.479	0.610	0.413	0.305	0.618	0.364	0.639	
[illegible]	13.165	13.165	2.144	2.201	1.784	2.241	2.185	2.204	8.961	
CH4	354.934	354.934	261.764	323.273	268.452	197.597	371.454	196.459	622.958	47
N2O	4.260	4.260	2.802	4.090	2.742	1.412	4.431	1.722	5.045	
CO2	161,377	161,377	118,000	166,066	132,370	67,731	201,381	67,506	206,953	16
[illegible] (w/ C in VOC & CO)	161,733	161,733	118,132	166,228	132,491	67,825	201,552	67,611	207,240	16
GHGs	173,509	173,509	126,727	177,010	141,271	74,127	213,870	73,961	227,266	18
Urban Emissions										
Urban VOC	3.065	3.065	0.925	1.156	0.923	0.780	1.306	0.688	2.827	
Urban CO	10.649	10.649	11.380	17.570	12.901	4.728	21.147	4.022	19.866	1
Urban NOx	20.580	20.580	24.168	40.010	28.831	6.940	49.057	5.728	31.768	2
Urban PM10	2.665	2.665	2.739	4.438	3.210	0.995	5.350	0.921	3.996	
Urban PM2.5	2.452	2.452	2.267	3.555	2.600	0.968	4.257	0.881	3.954	
Urban SOx	10.709	10.709	25.346	48.323	33.193	0.619	60.016	1.220	0.810	
Urban BC	0.238	0.238	0.103	0.154	0.113	0.048	0.185	0.035	0.119	
Urban OC	0.970	0.970	0.572	0.589	0.508	0.619	0.623	0.554	2.681	

Overview | Inputs | Results | Petroleum | NG | MeOH_FTD | EtOH | Electric | Hydrogen | BioOil | Algae | RNG | Pyrolysis_IDL | IBR | P

8. Look through the data table and find the emissions for Illinois. 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.

Gas emission	State of IL
CH_4	211.58
N_2O	2.56
CO_2	117,003

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

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9. Fill in the row below for electric energy.
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 in 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.