NOVEMBER 8, 2022, FOR THE GREET WORKSHOP

BATTERY AND ELECTRIC VEHICLE DEEP DIVES

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Demonstrations using GREET 1 & 2

- Vehicle Cycle – Battery Electric Vehicle (GREET 1 and 2)
  - BEV 400 vs. BEV 200
  - And comparison against all other powertrains

- Total Life Cycle - Plugin Hybrid Electric Vehicle (GREET 1 and 2)
  - PHEV 20 using US grid vs. California electrical grid
  - And comparison against all other powertrains

- Vehicle and Total Energy Cycle - Plugin Hybrid Electric Vehicle (GREET . NET)
  - Examine PHEV 40 using US and California grid

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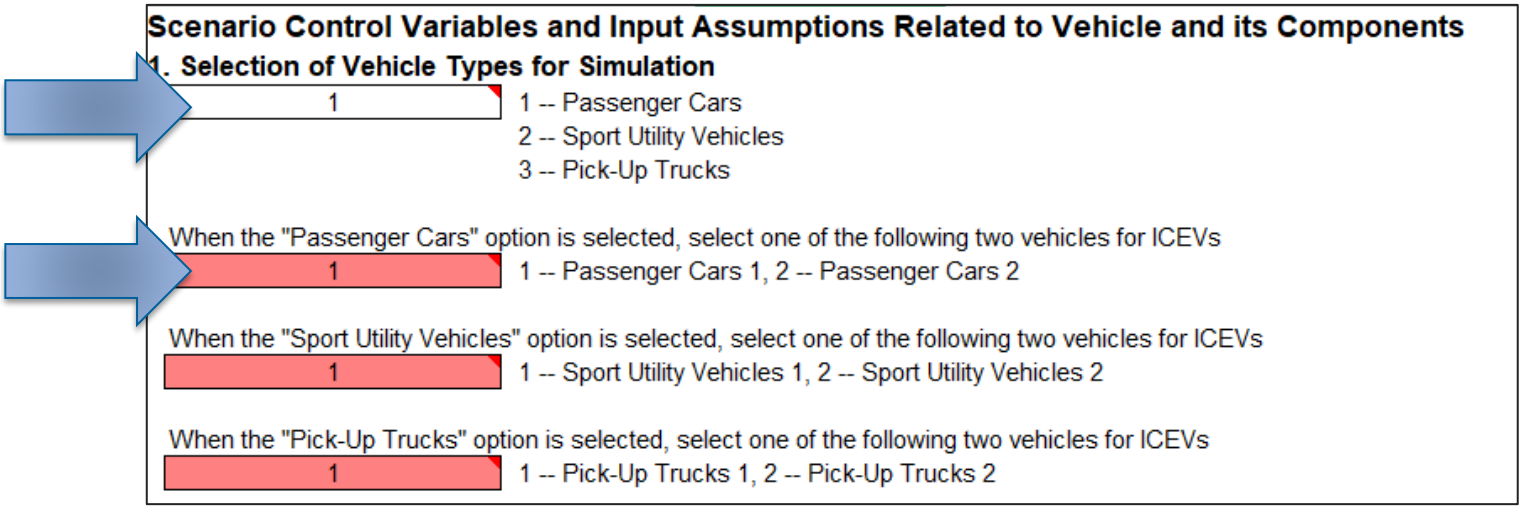
Demonstrations – Vehicle Cycle, Vehicle Selection

- Use GREET 2, but make sure GREET 1 is open
- Select [Vehi_Inputs] Tab
- Select 1 – Passenger Cars
- Select 1 – Passenger Cars 1
- Press F9



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Demonstrations – Vehicle Cycle, Examine BEV Specs

- In GREET 2, look at [Car] Tab, check values

Scenario Control Variables and Input Assumptions Related to Passenger Car and its Components

1. Specification of Total Vehicle Weight, pounds

	ICEV: Conventional Material	ICEV: Lightweight Material	HEV: Conventional Material	HEV: Lightweight Material	PHEV: Conventional Material	PHEV: Lightweight Material	EV: Conventional Material	EV: Lightweight Material	FCV: Conventional Material	FCV: Lightweight Material
Passenger Car 1	3,183	2,692	3,429	2,839	3,858	3,121	4,150	3,287	3,644	2,930
Passenger Car 2	3,170	2,476	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Selected Passenger Car	3,183	2,692	3,429	2,839	3,858	3,121	4,150	3,287	3,644	2,930

2. Vehicle Battery and Fluids Weight, pounds per vehicle

2.1) Battery Weight

	ICEV: Conventional Material	ICEV: Lightweight Material	HEV: Conventional Material	HEV: Lightweight Material	PHEV: Conventional Material	PHEV: Lightweight Material	EV: Conventional Material	EV: Lightweight Material	FCV: Conventional Material	FCV: Lightweight Material
Passenger Car 1 - Lead-Acid	36.0	23.4	22.1	14.4	22.1	14.4	22.1	14.4	22.1	14.4
Passenger Car 1 - Ni-MH			89.1	75.3	635.3	495.8	2,853.2	2,162.3	105.6	94.1
Passenger Car 1 - Li-Ion			43.2	36.5	341.9	266.9	1,174.0	889.7	48.8	43.5
Passenger Car 2 - Lead-Acid	27.3	24.9	0	0	0	0	0	0	0	0
Passenger Car 2 - Ni-MH			0	0	0	0	0	0	0	0
Passenger Car 2 - Li-Ion			0	0	0	0	0	0	0	0
Selected Passenger Car - Lead-Acid	36.0	23.4	22.1	14.4	22.1	14.4	22.1	14.4	22.1	14.4
Selected Passenger Car - Ni-MH			89.1	75.3	635.3	495.8	2,853.2	2,162.3	105.6	94.1
Selected Passenger Car - Li-Ion			43.2	36.5	341.9	266.9	1,174.0	889.7	48.8	43.5

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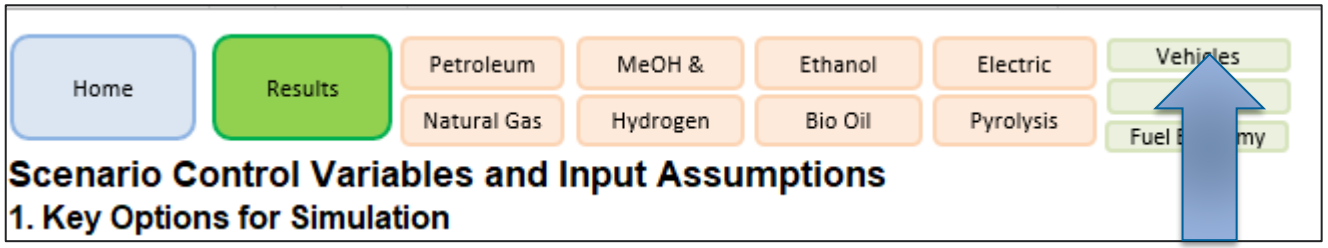
Demonstrations – Vehicle Cycle, Examine BEV Specs

- Go to GREET 1, [Inputs] Tab
- Click “Vehicles” button, or go to section 12 “Vehicle Operations”
- Check Rated All-Electric Range for BEVs



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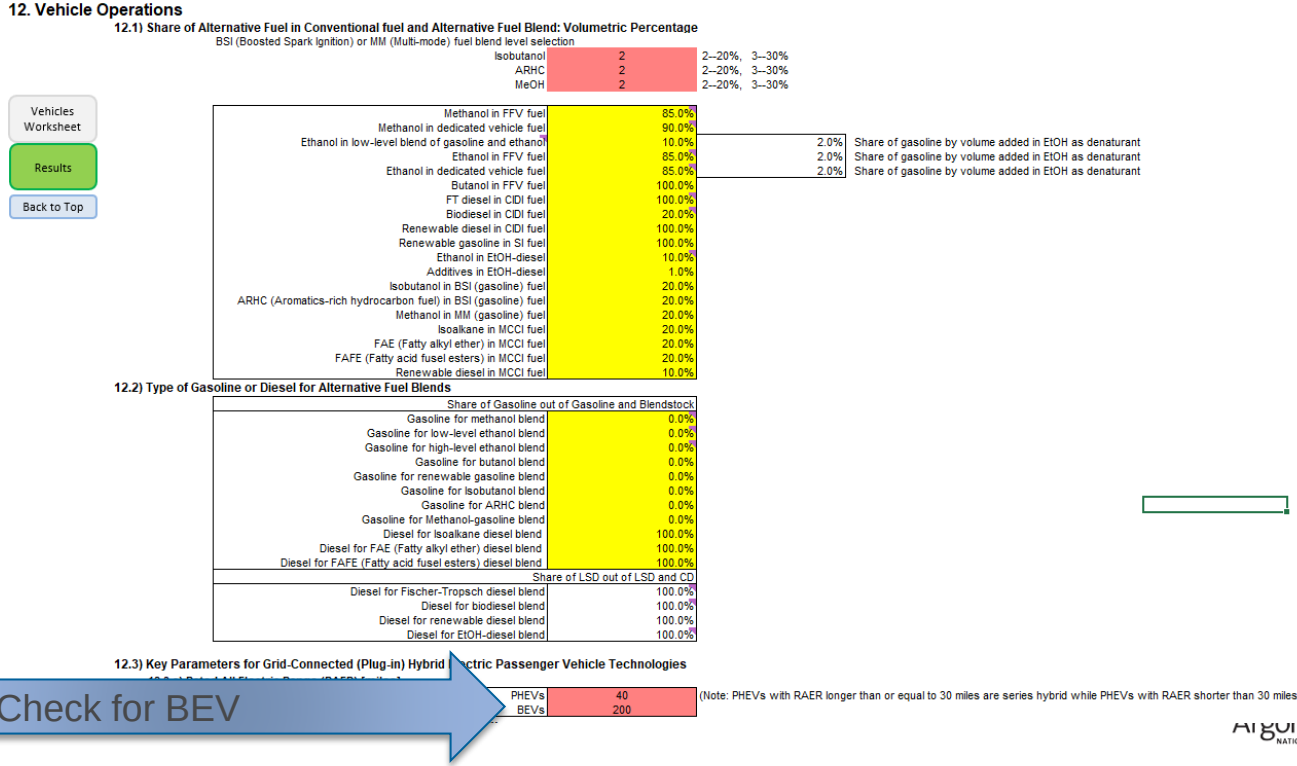
Demonstrations – Vehicle Cycle, Examine BEV Specs

- Go to GREET 1, [Inputs] Tab
- Click “Vehicles” button, or go to section 12 “Vehicle Operations”
- Check Rated All-Electric Range for BEVs (make it 200)



Demonstrations – Vehicle Cycle, Examine Vehicle Cycle Results

- Go to GREET 2, [Vehi_Sum] Tab
- Examine Results
- Focus on BEV Results

1.7) EV: Conventional Material

	mmBtu or grams per vehicle lifetime				
	Components	ADR	Batteries	Fluids	Total (No Credits)
Total energy	65.634	14.416	95.238	2.824	178.111
Fossil fuels	58.098	12.649	83.616	2.769	157.131
Coal	22.243	3.007	23.853	0.099	49.202
Natural gas	27.315	9.549	48.731	2.071	87.666
Petroleum	8.539	0.092	11.032	0.600	20.264
Water consumption	7,371	731	12,846	55	21,003
CO2	4,278,434	874,883	6,061,561	82,340	11,297,218
CO2 (VOC, CO, CO2)	4,316,239	881,150	6,082,984	167,461	11,447,834
CH4	10,557.987	2,300.628	27,630.581	469.440	40,958.636
N2O	182.366	22.148	173.138	4.198	381.850
GHGs	4,720,270	955,755	6,995,338	182,596	12,853,960

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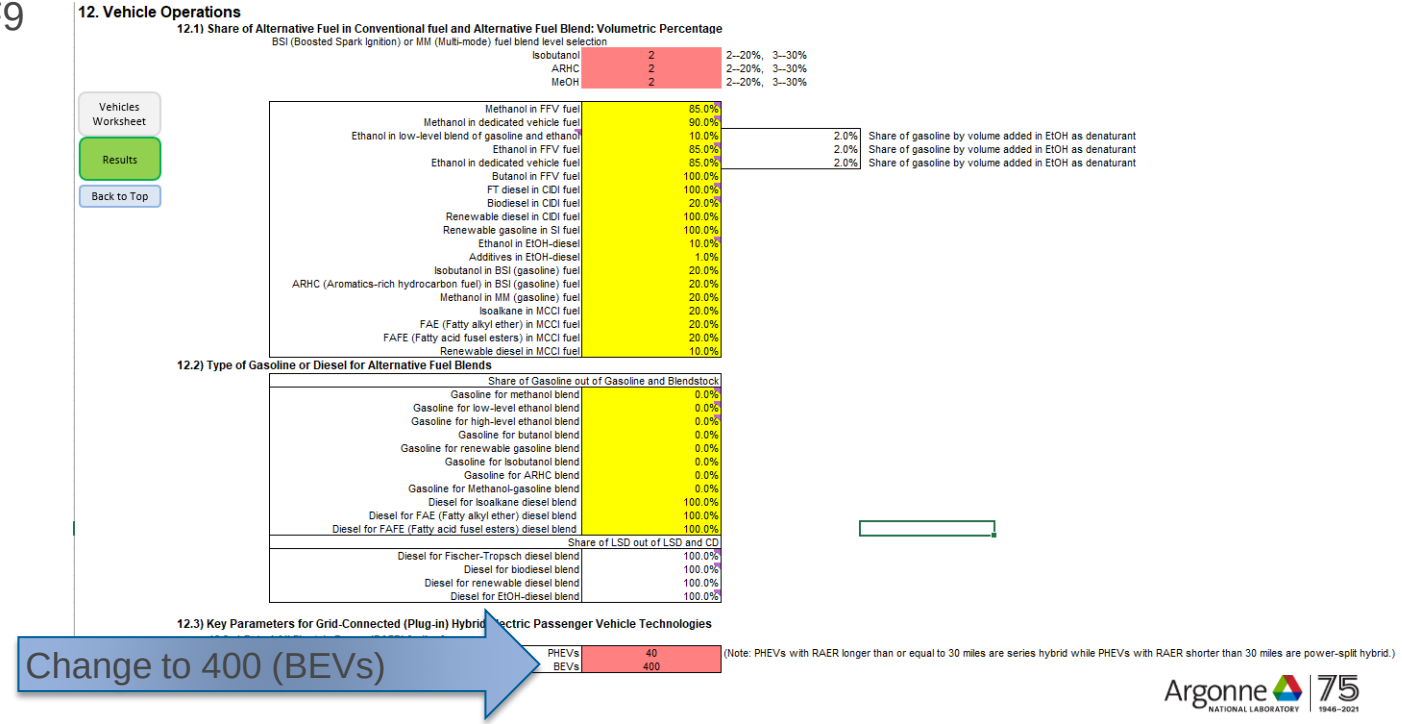
Demonstrations – Vehicle Cycle, Change BEV Specs

- Go to GREET 1, [Inputs] Tab
- Click “Vehicles” button, or go to section 12 “Vehicle Operations”
- Change Rated All-Electric Range to 400 for BEVs
- Press F9



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Demonstrations – Vehicle Cycle, Examine Vehicle Cycle Results

- Go to GREET 2, [Vehi_Sum] Tab
- Examine Results
- Focus on BEV Results

1.7) EV: Conventional Material

	mmBtu or grams per vehicle lifetime				
	Components	ADR	Batteries	Fluids	Total (No Credits)
Total energy	65.619	14.416	83.898	2.824	166.757
Fossil fuels	58.089	12.649	74.652	2.769	148.159
Coal	22.254	3.007	19.996	0.099	45.355
Natural gas	27.304	9.549	44.460	2.071	83.385
Petroleum	8.531	0.092	10.196	0.600	19.419
Water consumption	7,370	731	10,279	55	18,436
CO2	4,278,431	874,883	5,316,925	82,340	10,552,580
CO2 (VOC, CO, CO2)	4,316,270	881,150	5,334,443	167,461	10,699,324
CH4	10,556.381	2,300.628	25,843.984	469.440	39,170.433
N2O	181.696	22.148	147.087	4.198	355.129
GHGs	4,720,078	955,755	6,172,516	182,596	12,030,946

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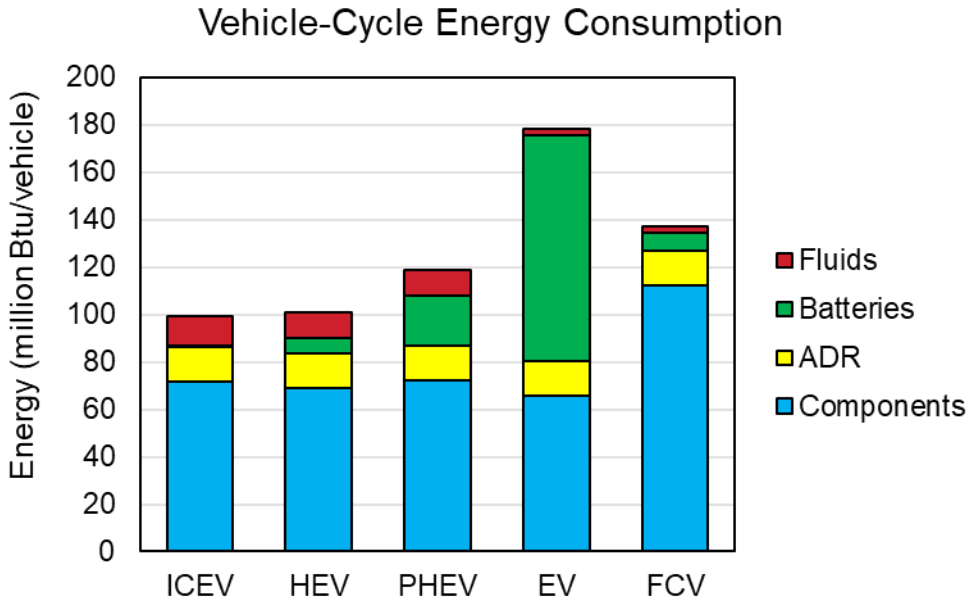
Demonstrations – Vehicle Cycle, Examine Vehicle Cycle Results

- Go to GREET 2, [Vehi_Sum] Tab
- Examine Results (BEV 200; can do the same for BEV 400)
- Graph below based on results in [Vehi_Sum] tab
-



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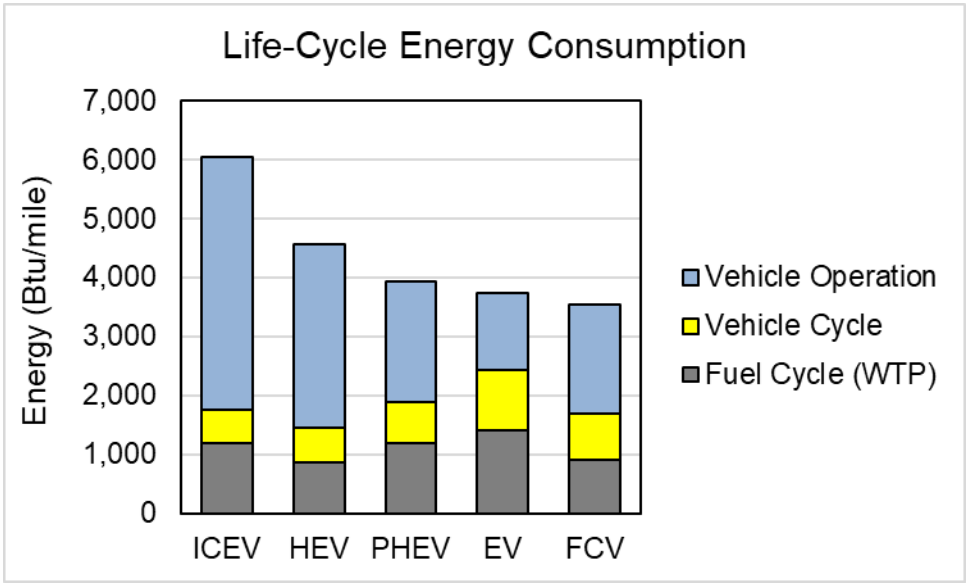
Demonstrations – Life Cycle, Examine Life Cycle Results

- Go to GREET 2, [TEC_Results] Tab
- Examine Results (BEV 200; can do the same for BEV 400)
- Graph below based on results in [TEC_Results] tab
-



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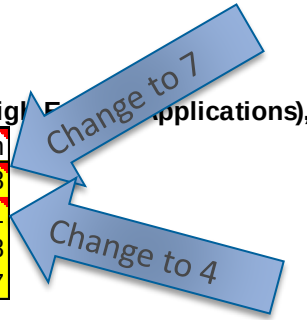
Demonstrations – Vehicle Cycle, Change PHEV Battery Size

- Go to GREET 2, [Car] Tab
- Click “Vehicles” button, or go to section 12 “Vehicle Operations”
- Change Li-Ion Battery weights of PHEV to 7 and 4 kWh
- Press F9

4.2) Passenger Car Battery Size in Peak Battery Energy (High E… …pplications), kWh

	Ni-MH	Li-Ion
PHEV: Conventional Material	18	18
PHEV: Lightweight Material	11	11
EV: Conventional Material	28	28
EV: Lightweight Material	17	17



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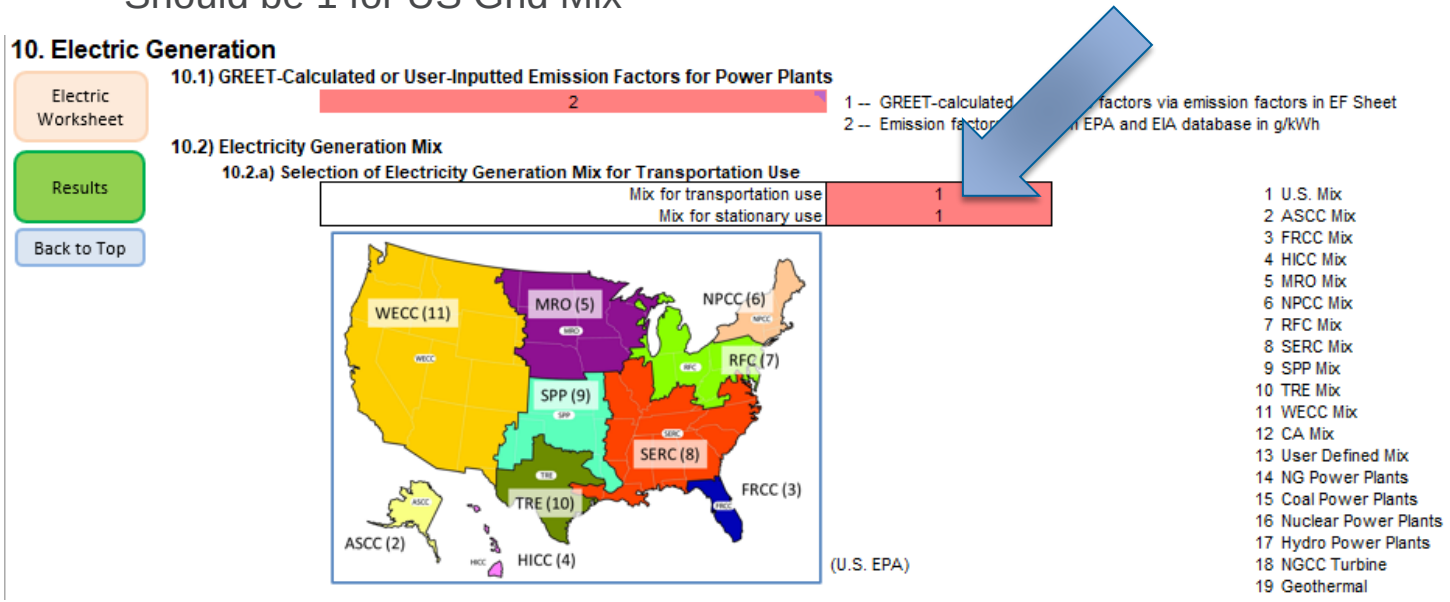
Demonstrations – Total Life Cycle, Examine Electrical Grid Specs

- Go to GREET 1, [Inputs] Tab
- Click “Electric” button, or go to section 10 “Electric Generation”
- Check Electricity Generation Mix
- Should be 1 for US Grid Mix



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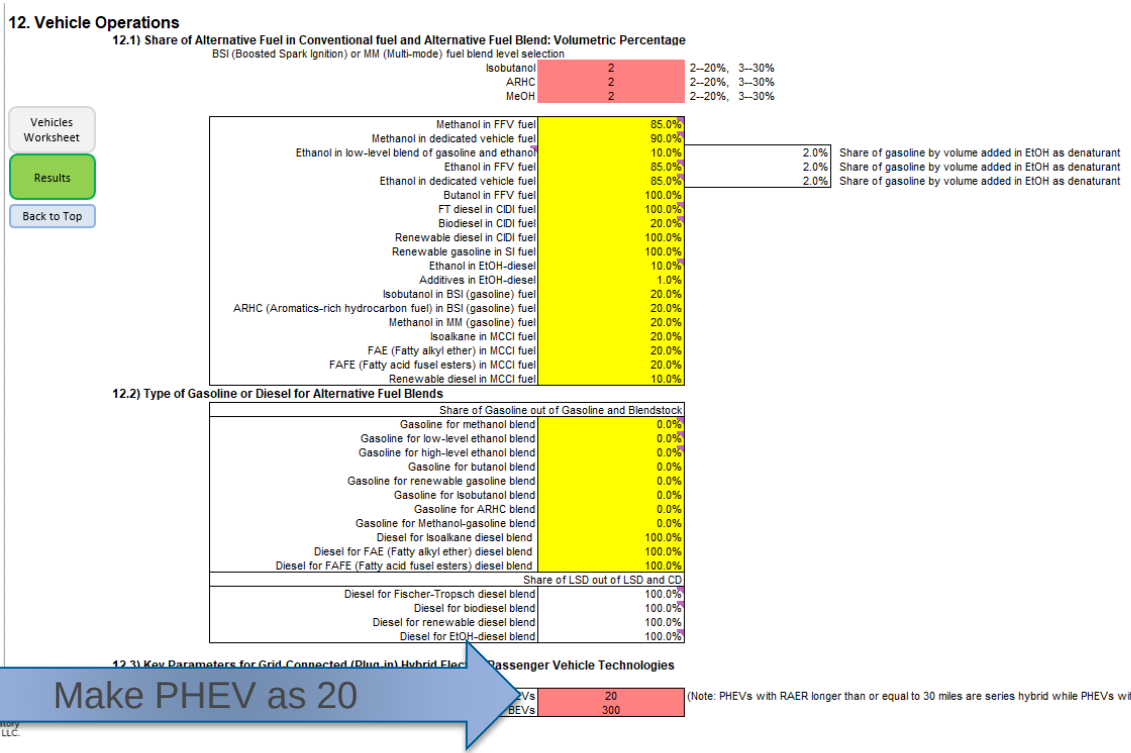
Demonstrations – Vehicle Cycle, Examine PHEV Specs

- Go to GREET 1, [Inputs] Tab
- Click “Vehicles” button, or go to section 12 “Vehicle Operations”
- Check Rated All-Electric Range for PHEVs (make it 20)



Make PHEV as 20

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Demonstrations – Total Life Cycle, Examine Total Energy Cycle Results with US Grid

- Go to GREET 2, [TEC_Results] Tab
- Examine Results
- Focus on PHEV Results

Grid-Connected SI PHEV: CG and RFG, Conventional Material				
	Btu/mile or g/mile			
Item	WTP	Vehicle Cycle	Vehicle Operation	Total
Total energy	1,030	638	2,621	4,288
Fossil fuels	886	570	2,388	3,844
Coal	168	189	141	498
Natural gas	549	279	158	986
Petroleum	169	102	2,090	2,361
Water consumption	0.185	0.061	0.000	0.246
CO2 (VOC, CO, CO2)	81	41	172	293
CH4	0.368	0.106	0.005	0.479
N2O	0.007	0.001	0.003	0.011
GHGs	94	45	172	311

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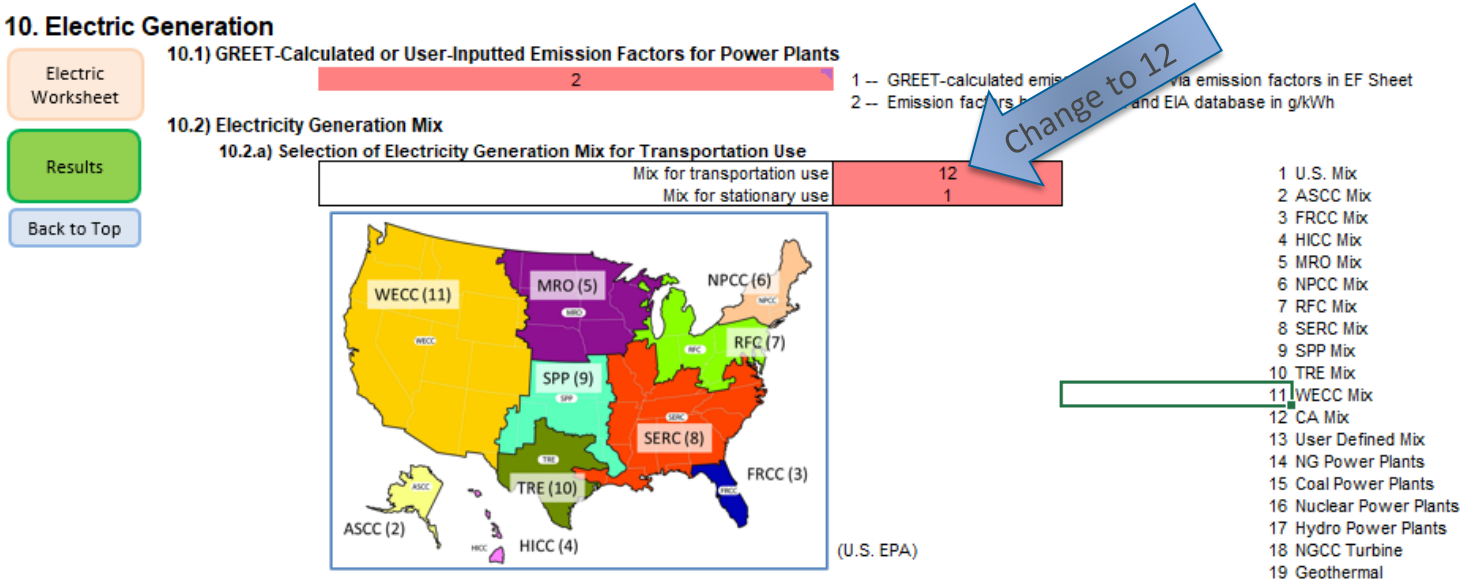
Demonstrations – Total Life Cycle, Change Electrical Grid Assumption

- Go to GREET 1, [Inputs] Tab
- Click “Electric” button, or go to section 10 “Electric Generation”
- Change Electricity Generation Mix to 12 (California Mix)
- Press F9



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Demonstrations – Total Life Cycle, Examine Total Energy Cycle Results with California Grid

- Go to GREET 2, [TEC_Results] Tab
- Examine Results
- Focus on PHEV Results

Grid-Connected SI PHEV: CG and RFG, Conventional Material				
	Btu/mile or g/mile			
Item	WTP	Vehicle Cycle	Vehicle Operation	Total
Total energy	928	638	2,621	4,186
Fossil fuels	773	570	2,342	3,685
Coal	50	189	28	266
Natural gas	560	279	226	1,065
Petroleum	164	102	2,088	2,354
Water consumption	0.191	0.061	0.000	0.253
CO2 (VOC, CO, CO2)	62	41	172	274
CH4	0.344	0.106	0.005	0.454
N2O	0.007	0.001	0.003	0.011
GHGs	74	45	172	291

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