

Simulations of Vehicle Cycle through the GREET 2 Model

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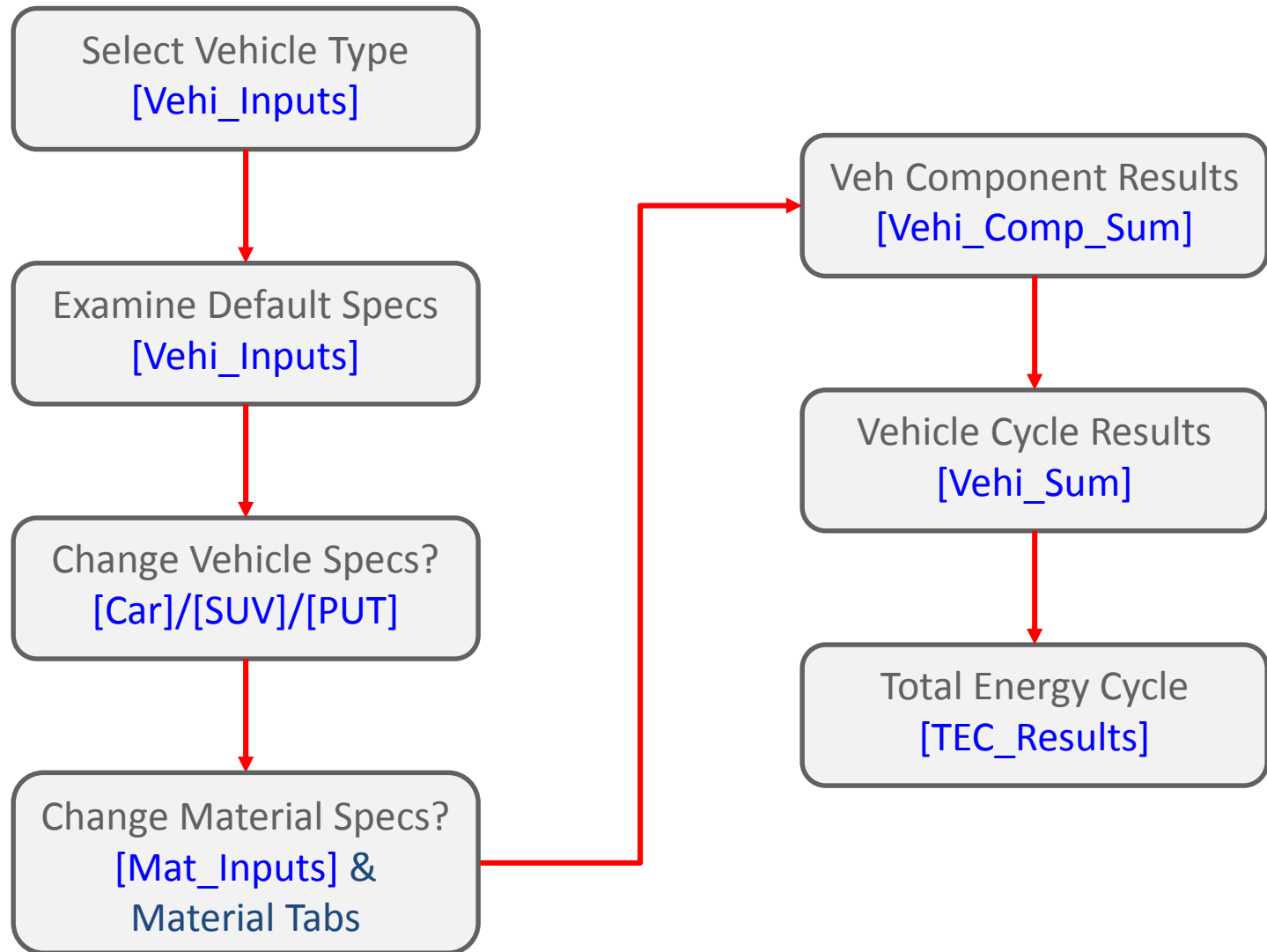
The GREET Training Workshop

Argonne National Laboratory

October 15-16, 2015



Typical Flow for Vehicle Simulation in GREET 2 Model



Color Scheme for the GREET 2 Model



- Clear cells are primarily for calculations and secondary assumptions



- Yellow cells are key input assumptions that users can change for their own simulations

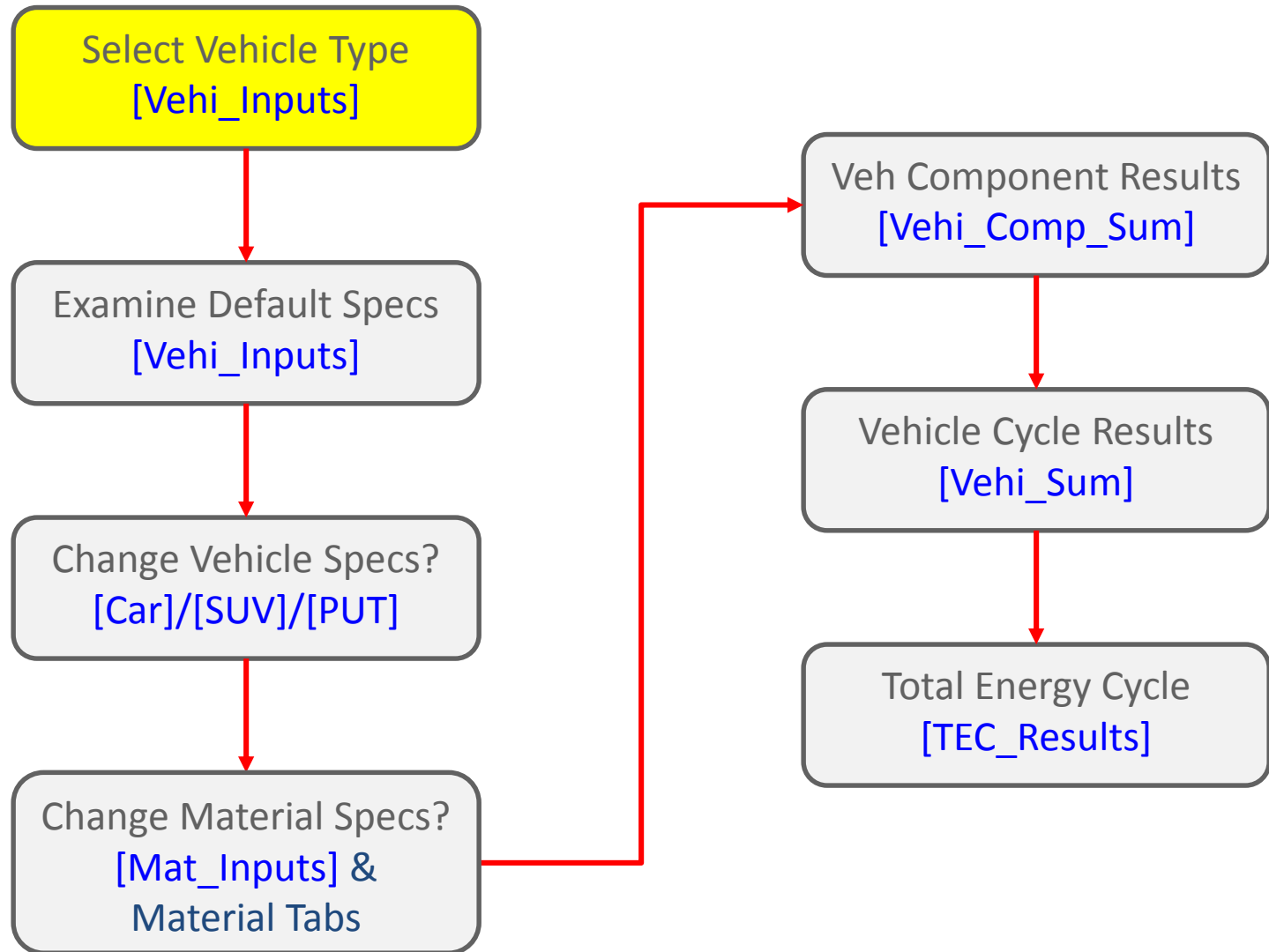


- Peach cells are key options that users can select for their own simulations from drop-down menu

- DO NOT
 - Change values in **white** cells unless you know well enough



Typical Flow for Vehicle Simulation in GREET 2 Model



Select Vehicle Type Using *[Vehi_Inputs]* Tab

Scenario Control Variables and Input Assumptions Related to Vehicle and its Components

1. Selection of Vehicle Types for Simulation

- 1 -- Passenger Cars
- 2 -- Sport Utility Vehicles
- 3 -- Pick-Up Trucks

When the "Passenger Cars" option is selected, select one of the following two vehicles for ICEVs

- 1 -- Passenger Cars 1, 2 -- Passenger Cars 2

When the "Sport Utility Vehicles" option is selected, select one of the following two vehicles for ICEVs

- 1 -- Passenger Cars 1, 2 -- Passenger Cars 2

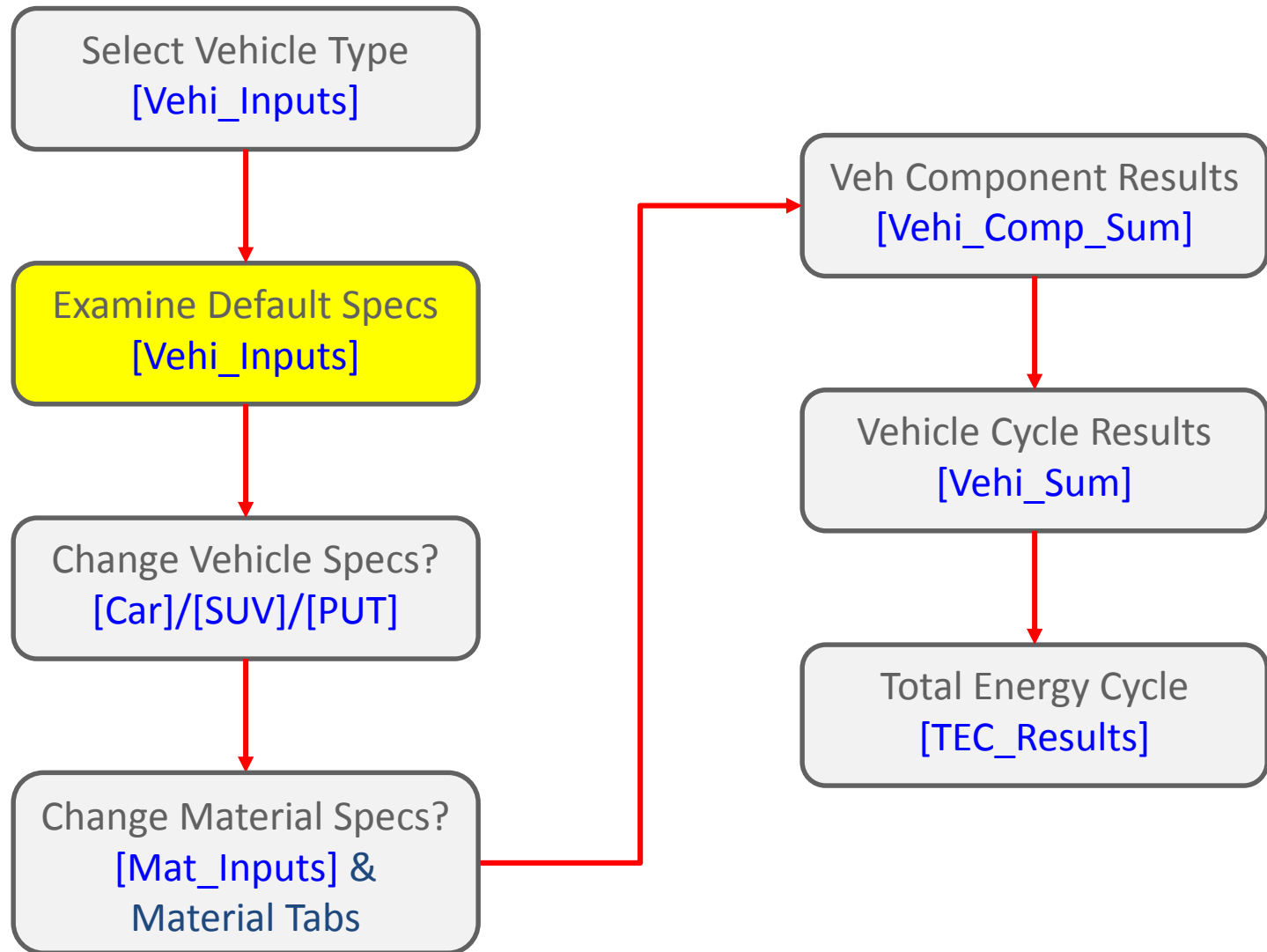
When the "Pick-Up Trucks" option is selected, select one of the following two vehicles for ICEVs

- 1 -- Pick-Up Trucks 1, 2 -- Pick-Up Trucks 2

- Select vehicle type from the first drop down menu
- Identify use of either Option 1 or 2 for the type of vehicle selected
 - Note Option 2 models only include conventional and lightweight versions of internal combustion engine vehicles



Typical Flow for Vehicle Simulation in GREET 2 Model



Examine Default Vehicle Specs Using [Vehi_Inputs] Tab

- Two vehicle weight scenarios: conventional and lightweight
- Five different powertrain types are presented
 - ICEV, HEV, PHEV, EV, FCV
- Details of Battery and Fluids presented for each vehicle category
- All *intermediate*: **DO NOT MAKE CHANGES HERE**

2. Specification of Total Vehicle Weight, pounds

ICEV:	FCV:
Conventional Material	Lightweight Material
2,980	2,400

3. Vehicle Battery and Fluids Weight, pounds per vehicle

3.1) Battery Weight

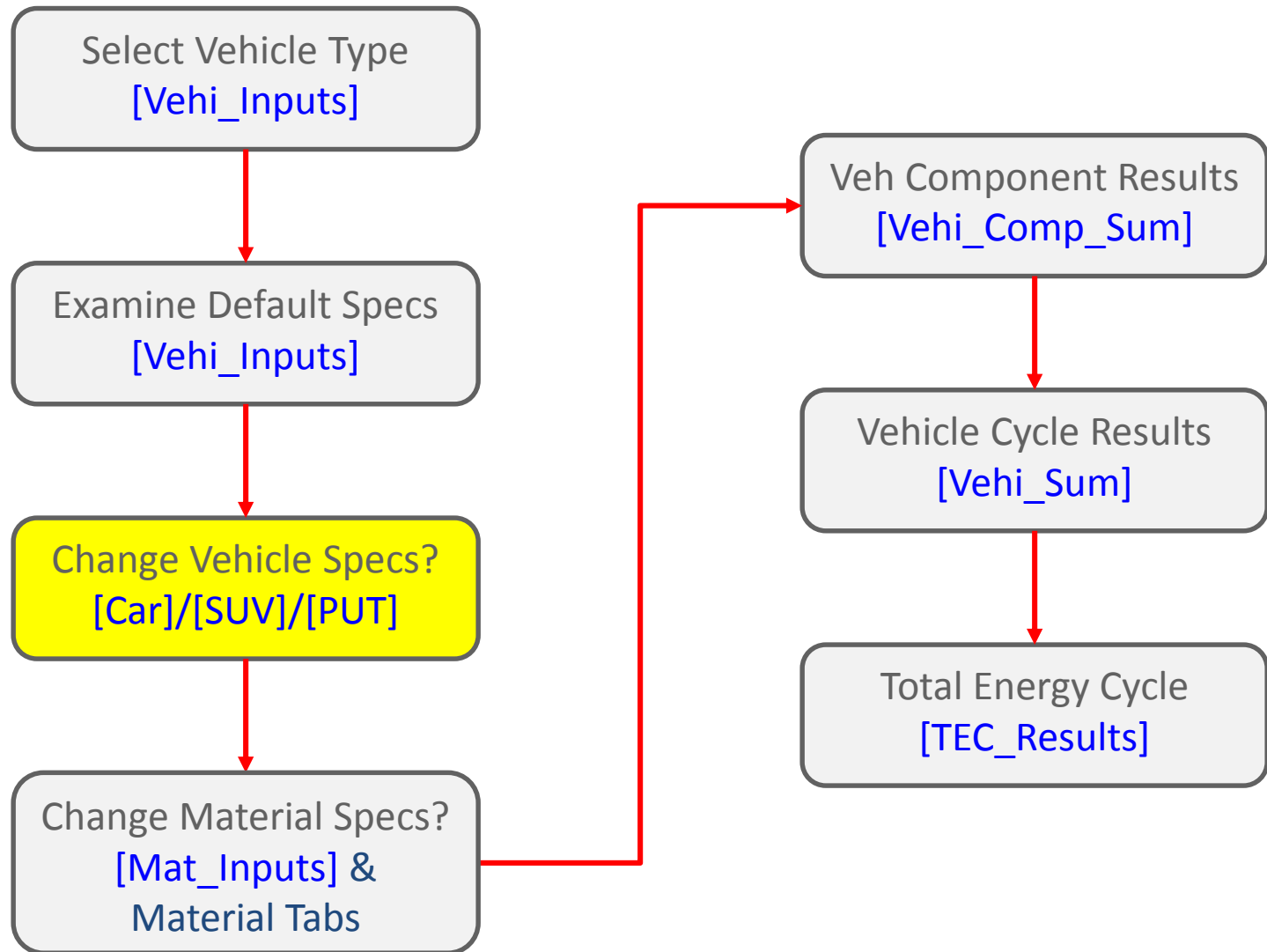
	ICEV:	FCV:
	Conventional Material	Lightweight Material
Lead-Acid	36.0	14.4
Ni-MH		55.1
Li-Ion		30.9

3.2) Fluids Weight

	Engine Oil	Power Steering Fluid	Brake Fluid	Transmission Fluid	Powertrain Coolant	Windshield Fluid	Adhesives
ICEV: Conventional Material	8.5	0.0	2.0	24.0	23.0	6.0	30.0
ICEV: Lightweight Material	8.5	0.0	2.0	24.0	23.0	6.0	30.0
FCV	0.0	0.0	2.0	1.8	15.8	6.0	30.0

* Not all vehicles are shown for presentation clarity.

Typical Flow for Vehicle Simulation in GREET 2 Model



Change Vehicle Specs Using [Car, SUV, PUT] Tab

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	2,980	1,820	3,220	2,030	3,310	2,120	4,270	2,680	3,630	2,400
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	2,980	1,820	3,220	2,030	3,310	2,120	4,270	2,680	3,630	2,400

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			77.2	46.8	748.7	457.6	949.7	572.8	90.9	55.1
Passenger Car 1 - Li-Ion			43.2	26.2	374.8	229.0	463.0	279.2	50.9	30.9
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			77.2	46.8	748.7	457.6	949.7	572.8	90.9	55.1
Selected Passenger Car - Li-Ion			43.2	26.2	374.8	229.0	463.0	279.2	50.9	30.9

2.2) Fluids Weight

	Engine Oil	Power Steering Fluid	Brake Fluid	Transmission Fluid	Powertrain Coolant	Windshield Fluid	Adhesives
Passenger Car 1 - ICEV (CM)	8.5	0.0	2.0	24.0	23.0	6.0	30.0
Passenger Car 1 - ICEV (LW)	8.5	0.0	2.0	24.0	23.0	6.0	30.0
Passenger Car 1 - HEV	8.5	0.0	2.0	1.8	23.0	6.0	30.0
Passenger Car 1 - PHEV	8.5	0.0	2.0	1.8	23.0	6.0	30.0
Passenger Car 1 - EV	0.0	0.0	2.0	1.8	15.8	6.0	30.0
Passenger Car 1 - FCV	0.0	0.0	2.0	1.8	15.8	6.0	30.0
Passenger Car 2 - ICEV (CM)	9.2	0.0	1.1	9.7	30.1	10.6	0.0
Passenger Car 2 - ICEV (LW)	8.4	0.0	1.1	7.3	29.3	10.6	0.0
Passenger Car 2 - HEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Car 2 - PHEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Car 2 - EV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Car 2 - FCV	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Selected Passenger Car - ICEV (CM)	8.5	0.0	2.0	24.0	23.0	6.0	30.0
Selected Passenger Car - ICEV (LW)	8.5	0.0	2.0	24.0	23.0	6.0	30.0
Selected Passenger Car - HEV	8.5	0.0	2.0	1.8	23.0	6.0	30.0
Selected Passenger Car - PHEV	8.5	0.0	2.0	1.8	23.0	6.0	30.0
Selected Passenger Car - EV	0.0	0.0	2.0	1.8	15.8	6.0	30.0
Selected Passenger Car - FCV	0.0	0.0	2.0	1.8	15.8	6.0	30.0

Total Vehicle and Component Weights are Key Assumptions to be Provided by the User [Car, SUV, PUT]

■ Total vehicle weight (lb)

	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	2,980	1,820	3,220	2,030	3,310	2,120	4,270	2,680	3,630	2,400
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	2,980	1,820	3,220	2,030	3,310	2,120	4,270	2,680	3,630	2,400

■ Component weight distribution (battery and fluids examined separately)

	ICEV: Conventional Material
Powertrain System	26%
Transmission System	6%
Chassis (w/o battery)	24%
Traction Motor	0%
Generator	0%
Electronic Controller	0%
Fuel Cell Auxiliary System	0%
Body: including BIW, interior, exterior, and glass	44%

■ Fuel cell weight is calculated by inputting stack power (kW)

70	Conventional Material
54	Lightweight Material

■ Stack and auxiliary system weight (lb)

226	Stack: Conventional Material
546	Auxiliary System: Conventional Material
174	Stack: Lightweight Material
421	Auxiliary System: Lightweight Material

Material Compositions Can be Adjusted by the User for Each Component

- Material composition by component [Car, SUV, PUT]

	ICEV: Conventional Material
Body	
Steel	68%
Wrought Aluminum	1%
Copper/Brass	2%
Magnesium	0%
Glass	7%
Carbon Fiber-Reinforced Plastic	0%
Average Plastic	18%
Rubber	1%
Others	4%

- Vehicle composition aggregated by material [Mat_Inputs]

	ICEV: Conventional Material
Steel	62%
Stainless Steel	0%
Cast Iron	11%
Wrought Aluminum	2%
Cast Aluminum	5%
Copper/Brass	2%
Magnesium	0.02%
Glass	3%
Average Plastic	11%
Rubber	2%
Platinum	0.001%
Others	2%

Fuel Is Not Examined in the Vehicle-Cycle, While All Other Fluids Are

■ Total Fluid Weight (lb) [Car, SUV, PUT]

	Engine Oil	Power Steering Fluid	Brake Fluid	Transmission Fluid	Powertrain Coolant	Windshield Fluid	Adhesives
Passenger Car - ICEV	8.5	0.0	2.0	24.0	23.0	6.0	30.0
Passenger Car - HEV	8.5	0.0	2.0	1.8	23.0	6.0	30.0
Passenger Car - PHEV	8.5	0.0	2.0	1.8	23.0	6.0	30.0
Passenger Car - EV	0.0	0.0	2.0	1.8	15.8	6.0	30.0
Passenger Car - FCV	0.0	0.0	2.0	1.8	15.8	6.0	30.0

■ Fluid Replacement (per vehicle lifetime) [Vehi_Inputs]

Engine Oil	Power Steering Fluid	Brake Fluid	Transmission Fluid	Powertrain Coolant	Windshield Fluid	Adhesives
40	0	3	1	3	20	0

Both Ni-MH and Li-Ion Can Be Simulated as Motive Batteries

- Total battery weight (lb) inputted for lead-acid [Car, SUV, PUT]

	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			77.2	46.8	748.7	457.6	949.7	572.8	90.9	55.1
Passenger Car 1 - Li-Ion			43.2	26.2	374.8	229.0	463.0	279.2	50.9	30.9

- Motive battery weight for HEV & FCV is calculated by inputting peak battery power (kW) [Car, SUV, PUT]
- Motive battery weight for PHEV & EV is calculated by inputting peak battery energy (kWh) [Car, SUV, PUT]

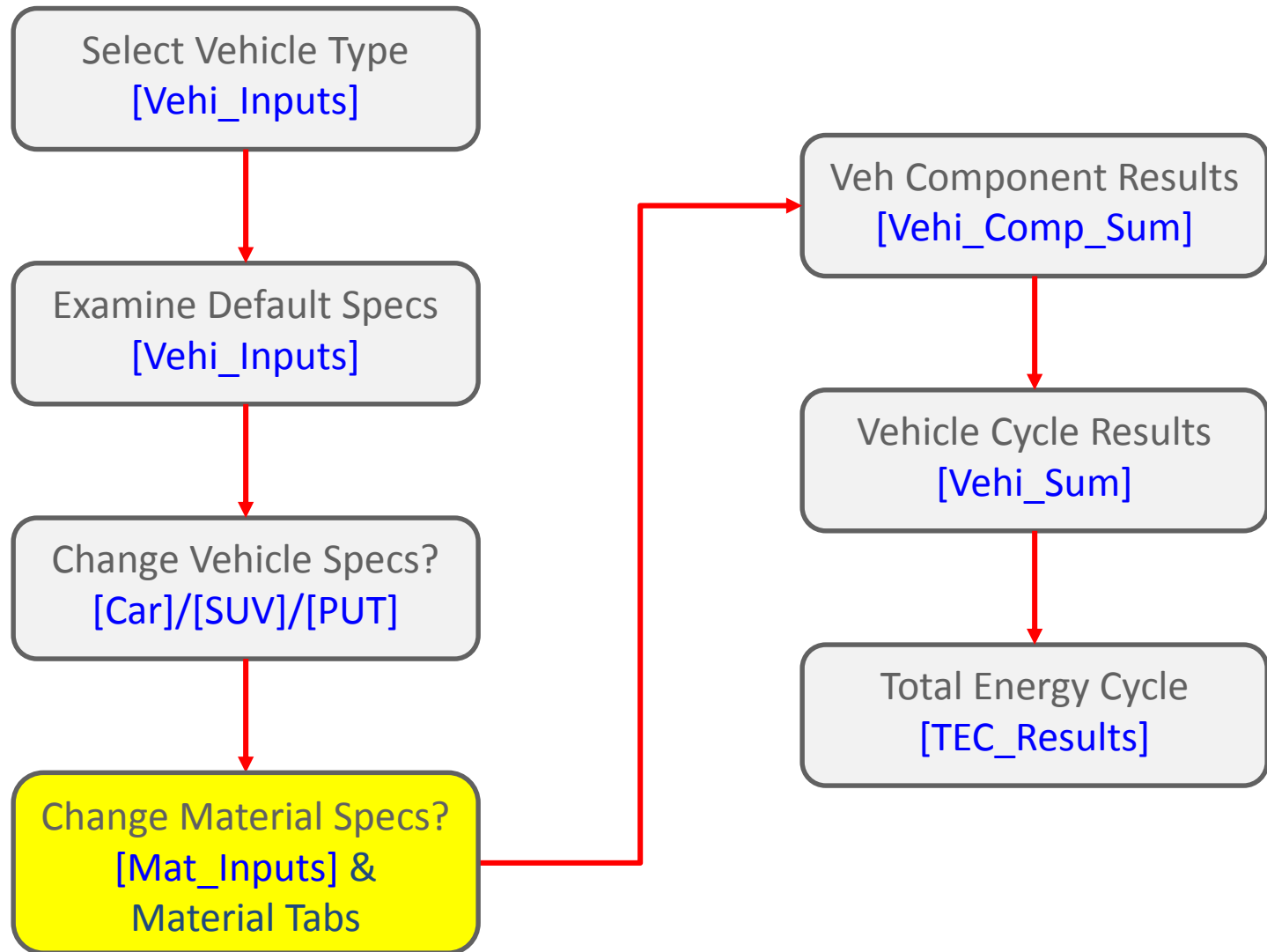
	Ni-MH	Li-Ion
HEV: Conventional Material	28	28
HEV: Lightweight Material	17	17
FCV: Conventional Material	33	33
FCV: Lightweight Material	20	20

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

- Battery replacement (per vehicle lifetime) [Vehi_Inputs]

	Lead-Acid	Ni-MH	Li-Ion
ICEV	2		
HEV	2	0	0
PHEV	2	0	0
EV	2	0	0
FCV	2	0	0

Typical Flow for Vehicle Simulation in GREET 2 Model



Changing Material Specs [Mat_Inputs]

- If you have access to different data for the energy intensity, fuel source, or process emissions of a material in GREET you can edit the source file
 - ONLY FOR ADVANCED USERS

- Material production energy intensity, Wrought Aluminum example

5.3) Energy Use of Wrought Aluminum: mmBtu per ton of material product

0.577	Bauxite Mining
17.835	Bauxite Refining: Bayer Process
1.486	Anode Production
46.778	Alumina Reduction: Hall-Heroult Process
1.006	Primary Ingot Casting
1.092	Scrap Preparation (Recycled Wrought Al)
4.460	Secondary Ingot Casting (Recycled Al)
3.629	Hot Rolling
3.022	Cold Rolling
5.453	Stamping
5.897	Extrusion

- Material specific electricity portfolio, Wrought Aluminum example

4.11.c) Electric Generation Mixes for Alumina Reduction: Hall-Heroult Process (Aluminum Smelting)

	Wrought Aluminum				
	US Mix	NA smelter mix	US smelter mix	US market-weighted mix	User Defined Mix
Residual oil	0.3%	0	0	0.004	0.0%
Natural gas	27.3%	0.041	0.104	0.112	4.1%
Coal	38.5%	0.143	0.359	0.195	14.3%
Nuclear power	18.3%	0.005	0.014	0.013	0.5%
Biomass	0.9%	0	0	0	0.0%
Others	14.7%	0.811	0.523	0.676	81.1%

Recycled Content of Key Materials *[Mat_Inputs]*

- Share of primary (virgin) vs. secondary (recycled)
 - Steel, wrought aluminum, cast aluminum, lead, nickel
 - Very important especially when considering aluminum since the difference in production energy intensity is significant

4.1) Share of Virgin and Recycled Materials Used in Vehicle, % by wt

	Virgin Material	Recycled Material
Steel	73.6%	26.4%
Wrought Aluminum	89.0%	11.0%
Cast Aluminum	15.0%	85.0%
Lead	27.0%	73.0%
Nickel	56.0%	44.0%
Magnesium	66.7%	33.3%

Changing Material Specs, Material Tabs **[Magnesium]**

- You can edit process fuel shares
 - ONLY FOR ADVANCED USERS

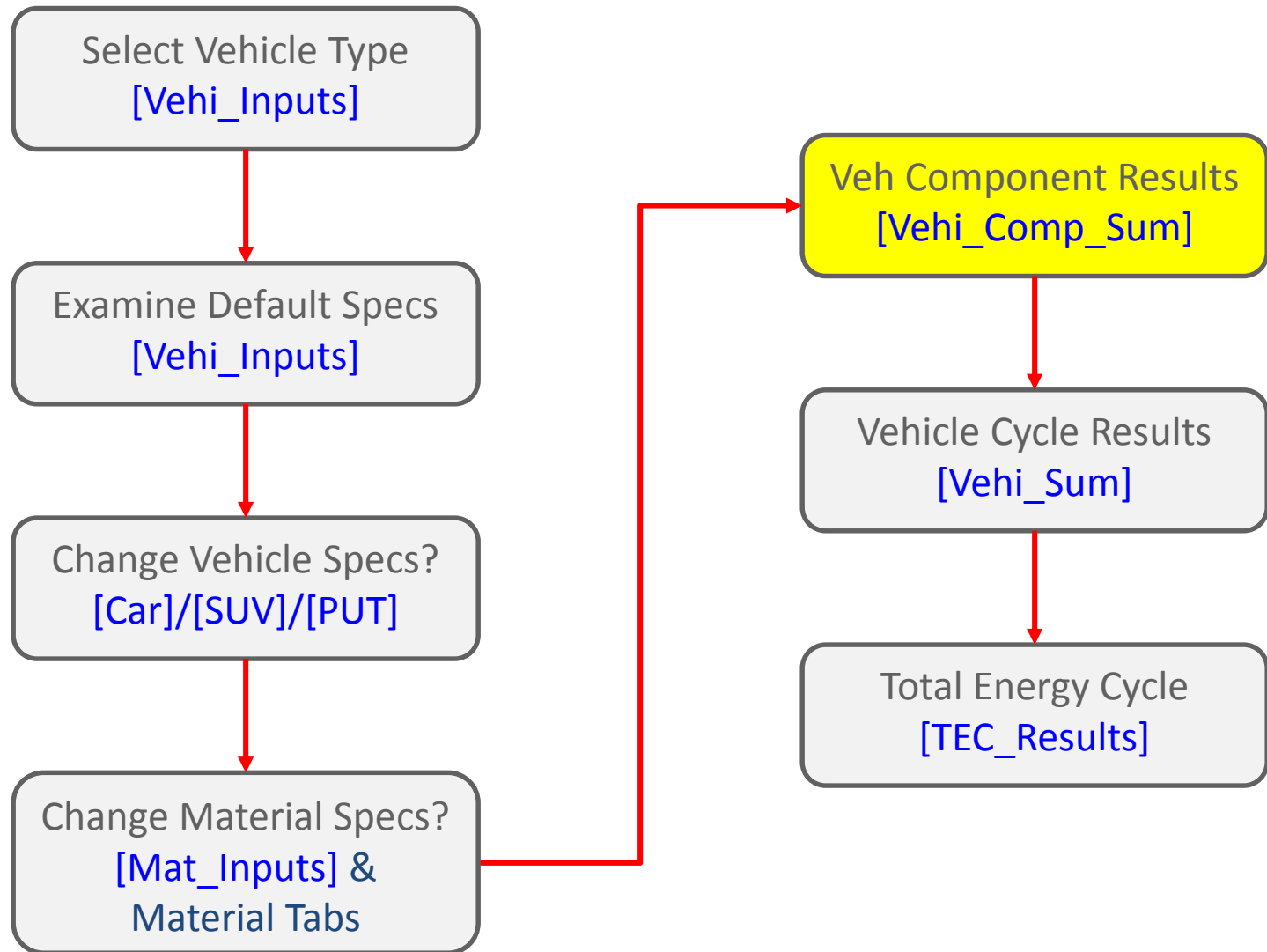
	Magnesium via Electrolytic production		Magnesium via Thermal production	
	Combustion Emissions	Non-Combustion Emissions	Combustion Emissions	Non-Combustion Emissions
Energy inputs: mmBtu per ton of material product, except as noted	146.275		225.260	
Urban emission share	0.0%		0.0%	
Shares of process fuels				
Resid. oil	0.0%		0.0%	
Diesel	0.5%		0.8%	
Natural gas	64.6%		0.0%	
Coal	0.0%		54.5%	
Coke			6.0%	
Coke oven gas			22.2%	
Electricity	34.9%		16.6%	

- You can edit process emissions
 - ONLY FOR ADVANCED USERS

Total Emissions: grams per ton of product			
VOC	1,947.760		9,057.958
CO	7,681.602		8,972.248
NOx	10,218.822		30,687.508
PM10	1,478.952		6,147.297
PM2.5	706.350		2,571.275
SOx	11,291.443		82,446.737
BC	103.102		97.110
OC	222.017		178.705
CH4	32,407.078		38,551.096
N2O	322.557		240.356
CO2	13,747,263	1,723,651	22,862,292
SF6		1,496.855	4,590,355
			1,496.855



Typical Flow for Vehicle Simulation in GREET 2 Model



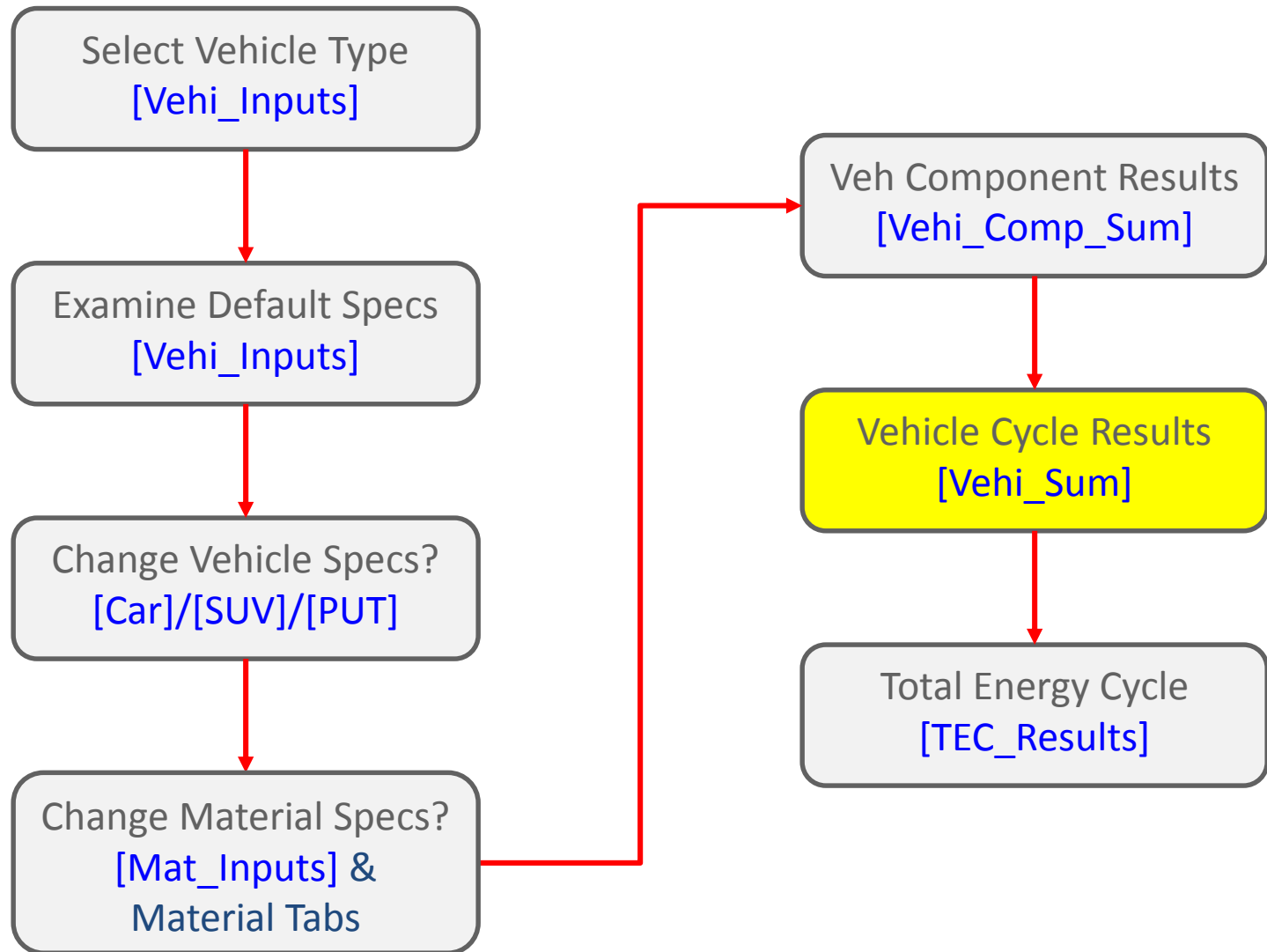
Component Results on [Vehi_Comp_Sum] Tab

3.8) FCV: Conventional Material

	mmBtu or grams per vehicle lifetime							
	Body	Powertrain System	Transmission System	Chassis (w/o battery)	Traction Motor	Generator	Electronic Controller	Fuel Cell Auxiliary
Energy use								
Total energy	32.902	33.033	2.350	20.525	2.645		2.606	43.998
Fossil fuels	30.615	30.433	1.856	19.156	2.216		2.244	39.877
Coal	14.243	5.758	1.002	10.163	1.021		0.437	9.939
Natural gas	13.660	20.708	0.683	7.076	0.994		1.395	25.348
Petroleum	2.711	3.966	0.170	1.918	0.201		0.413	4.590
Water consumption	4,302	3,086	779	2,675	664		530	5,357
Total Emissions								
VOC	1,871.203	315.463	99.555	1,822.137	93.690		48.919	729.916
CO	13,008.443	1,257.178	658.234	8,851.034	621.783		201.171	3,853.260
NOx	2,153.965	2,029.829	135.455	1,530.570	167.908		138.046	2,705.377
PM10	1,142.804	690.979	90.693	785.710	85.682		60.793	820.946
PM2.5	502.014	216.073	42.937	370.467	40.876		26.298	347.667
SOx	9,307.265	2,071.376	1,561.452	4,899.483	2,803.468		1,004.587	8,146.073
BC	12.420	16.025	0.999	9.017	1.507		1.128	21.450
OC	26.285	33.940	1.766	18.488	2.378		2.053	44.197
CH4	5,844.369	4,989.314	281.719	2,964.629	342.575		452.655	6,614.797
N2O	54.723	50.666	2.292	24.216	2.985		5.128	67.345
CO2	2,258,679	2,052,840	165,990	1,596,732	186,607		136,128	2,843,020
CO2 (VOC, CO, CO2)	2,284,953	2,055,799	167,335	1,616,319	187,876		136,596	2,851,350
GHGs	2,488,652	2,233,355	181,352	1,712,236	202,357		155,401	3,092,759
Urban Emissions								
VOC	12.487	18.005	1.091	8.120	1.674		1.494	23.258
CO	76.930	89.168	4.961	46.630	6.381		5.813	117.092
NOx	108.045	121.633	7.542	68.145	8.971		8.149	161.015
PM10	22.260	17.606	2.689	13.994	4.070		1.723	28.568
PM2.5	8.462	7.523	0.703	5.657	0.773		0.498	10.795
SOx	377.587	328.232	33.220	244.624	35.193		22.749	475.500
BC	0.645	0.593	0.049	0.437	0.056		0.037	0.837
OC	1.754	1.526	0.132	1.197	0.148		0.095	2.178

- Examine energy and emissions at the component level

Typical Flow for Vehicle Simulation in GREET 2 Model

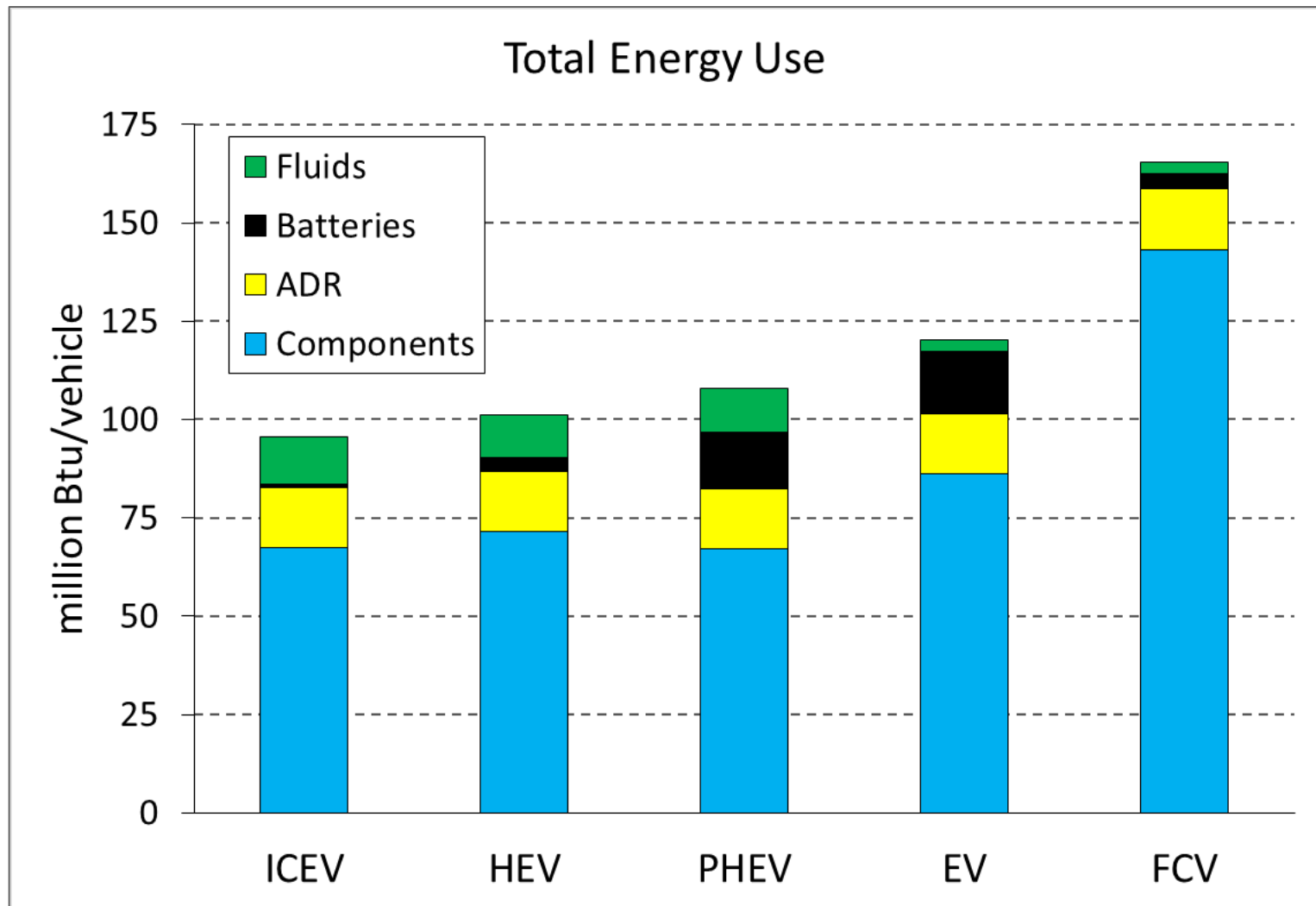


Vehicle Cycle Results on *[Vehi_Sum]* Tab

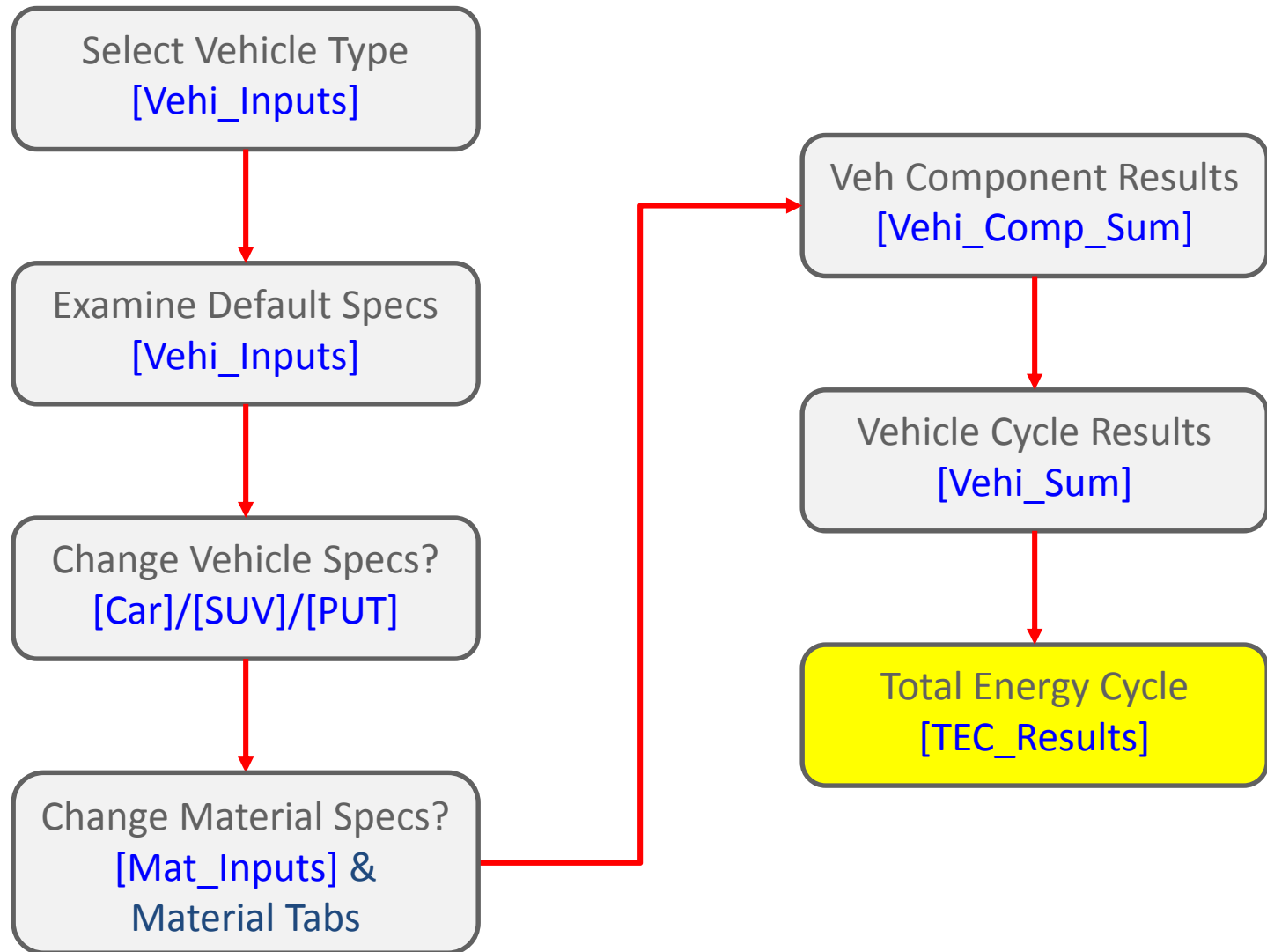
	mmBtu or grams per vehicle lifetime				
	Components	ADR	Batteries	Fluids	Total
Total energy	64.978	14.234	0.783	11.941	91.936
Fossil fuels	59.411	12.649	0.748	11.856	84.663
Coal	29.008	4.367	0.386	0.237	33.999
Natural gas	24.590	8.135	0.293	3.015	36.033
Petroleum	5.812	0.146	0.068	8.604	14.631
Water consumption	9,836	1,391	45	277	11,549
CO2	4,415,726	934,963	36,487	683,217	6,070,394
CO2 (VOC, CO, CO2)	4,464,366	941,097	36,625	770,710	6,212,798
CH4	10,311.626	2,096.606	188.409	1,179.434	13,776.076
N2O	90.832	20.664	0.743	16.237	128.476
GHGs	4,833,145	1,009,472	42,474	810,396	6,695,487

- Vehicle cycle energy and emissions results
- Stages include:
 - Components
 - Assembly, disposal, recycling
 - Batteries
 - Fluids

Sample Vehicle-Cycle Results for Conventional Material Vehicles [Vehi_Sum]



Typical Flow for Vehicle Simulation in GREET 2 Model



Total Energy-Cycle Major Assumptions Requires Use of Both GREET 1 and 2

- Lifetime VMT of vehicle:
 - Cars: 160,000 miles
 - SUV and Pickup Truck: 180,000 miles
- Fuel cycle assumptions are based on GREET 1
- Vehicle operation assumptions are based on GREET 1
 - Except fuel economy equations for lightweighting are built into GREET 2
- Fuel economy based on Autonomie simulations
 - LW vehicle assumptions from mass sensitivity analysis



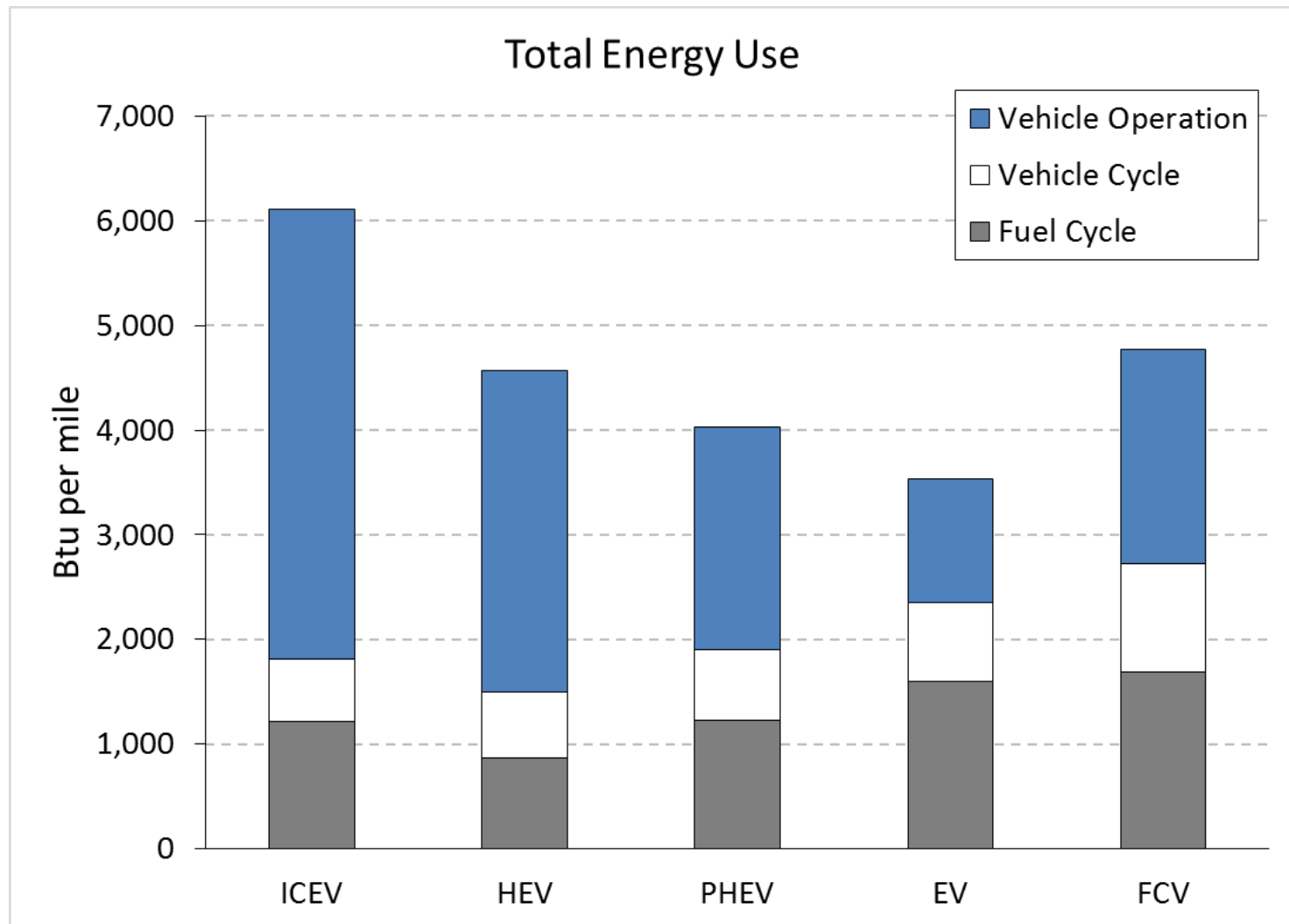
Confirm Vehicle Specs Using *[TEC_Results]* Tab

Gasoline Vehicle: CG and RFG, Conventional Material								
Item	Btu/mile or g/mile				Percentage of each stage			
	WTP	Vehicle Cycle	Vehicle Operation	Total	WTP	Vehicle Cycle	Vehicle Operation	Total
Total energy	814	575	2,989	4,378	18.6%	13.1%	68.3%	100.0%
Fossil fuels	777	529	2,790	4,096	19.0%	12.9%	68.1%	100.0%
Coal	63	212	0	276	22.9%	77.1%	0.0%	100.0%
Natural gas	487	225	0	713	68.4%	31.6%	0.0%	100.0%
Petroleum	227	91	2,790	3,108	7.3%	2.9%	89.8%	100.0%
Water consumption	0.170	0.072	0.000	0.242	70.2%	29.8%	0.0%	100.0%
CO2 (VOC, CO, CO2)	43	39	229	311	13.8%	12.5%	73.7%	100.0%
CH4	0.266	0.086	0.005	0.358	74.5%	24.1%	1.4%	100.0%
N2O	0.008	0.001	0.005	0.014	58.8%	5.8%	35.4%	100.0%
GHGs	53	42	231	326	16.3%	12.8%	70.8%	100.0%

- Energy and emissions results for total life cycle of vehicle
- Additional emission not shown include: SOx, NOx, PM, VOC, OC, BC
 - Total and urban shares



Sample Total Energy-Cycle Results for Conventional Material Vehicles *[TEC_Results]*



Demonstrations using GREET 1 & 2, and GREET .NET

- Vehicle Cycle – Plugin Hybrid Electric Vehicle (GREET 1 and 2)
 - PHEV 40 vs. PHEV 20
 - 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



Demonstrations



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

Scenario Control Variables and Input Assumptions Related to Vehicle and its Components

1. Selection of Vehicle Types for Simulation

1

- 1 -- Passenger Cars
- 2 -- Sport Utility Vehicles
- 3 -- Pick-Up Trucks

When the "Passenger Cars" option is selected, select one of the following two vehicles for ICEVs

1

- 1 -- Passenger Cars 1, 2 -- Passenger Cars 2

When the "Sport Utility Vehicles" option is selected, select one of the following two vehicles for ICEVs

1

- 1 -- Passenger Cars 1, 2 -- Passenger Cars 2

When the "Pick-Up Trucks" option is selected, select one of the following two vehicles for ICEVs

1

- 1 -- Pick-Up Trucks 1, 2 -- Pick-Up Trucks 2

Demonstrations - Vehicle Cycle, Examine PHEV Specs

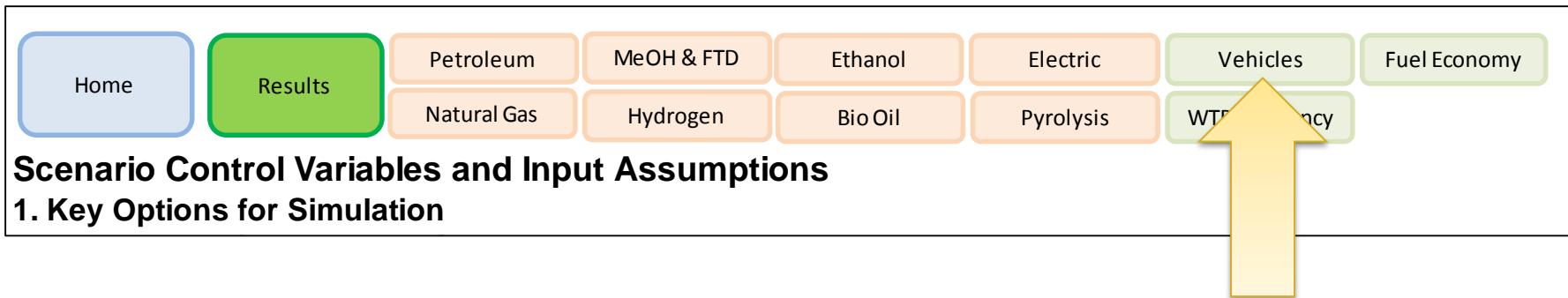
- In GREET 2, look at [\[Car\]](#) Tab, check values

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	2,980	1,820	3,220	2,030	3,310	2,120	4,270	2,680	3,630	2,400	
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	2,980	1,820	3,220	2,030	3,310	2,120	4,270	2,680	3,630	2,400	
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			77.2	46.8	748.7	457.6	949.7	572.8	90.9	55.1	
Passenger Car 1 - Li-Ion			43.2	26.2	374.8	229.0	463.0	279.2	50.9	30.9	
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			77.2	46.8	748.7	457.6	949.7	572.8	90.9	55.1	
Selected Passenger Car - Li-Ion			43.2	26.2	374.8	229.0	463.0	279.2	50.9	30.9	



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



The screenshot displays the GREET 1 software interface. At the top, there is a navigation bar with several buttons: 'Home' (blue), 'Results' (green), 'Petroleum' (orange), 'MeOH & FTD' (orange), 'Ethanol' (orange), 'Electric' (orange), 'Vehicles' (green), and 'Fuel Economy' (green). Below the 'Vehicles' button, there is a sub-menu with 'WTP Efficiency' (green). A large yellow arrow points upwards towards the 'Vehicles' button. Below the navigation bar, the text 'Scenario Control Variables and Input Assumptions' is visible, followed by '1. Key Options for Simulation'.

Home Results Petroleum MeOH & FTD Ethanol Electric Vehicles Fuel Economy

Natural Gas Hydrogen Bio Oil Pyrolysis WTP Efficiency

Scenario Control Variables and Input Assumptions

1. Key Options for Simulation

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 (should be 40)

Vehicles Worksheet

Results

Back to Top

12. Vehicle Operations

12.1) Share of Alternative Fuel in Conventional fuel and Alternative Fuel Blend: Volumetric Percentage

Methanol in FFV fuel	85.0%	
Methanol in dedicated vehicle fuel	90.0%	
Ethanol in low-level blend of gasoline and ethanol	10.0%	2.0%
Ethanol in FFV fuel	85.0%	2.0%
Ethanol in dedicated vehicle fuel	85.0%	2.0%
Butanol in FFV fuel	100.0%	
FT diesel in CIDI fuel	100.0%	
Biodiesel in CIDI fuel	20.0%	
Renewable diesel in CIDI fuel	100.0%	
Renewable gasoline in SI fuel	100.0%	
Ethanol in E-diesel	10.0%	
Additives in E-diesel	1.0%	

12.2) Type of Gasoline or Diesel for Alternative Fuel Blends

Share of Gasoline out of Gasoline and Blendstock	
Gasoline for methanol blend	0.0%
Gasoline for low-level ethanol blend	0.0%
Gasoline for high-level ethanol blend	0.0%
Gasoline for butanol blend	0.0%
Gasoline for renewable gasoline blend	0.0%
Share of LSD out of LSD and CD	
Diesel for Fischer-Tropsch diesel blend	100.0%
Diesel for biodiesel blend	100.0%
Diesel for renewable diesel blend	100.0%
Diesel for e-diesel blend	100.0%

12.3) Key Parameters for Grid-Connected (Plug-in) Hybrid Electric Passenger Vehicle Technologies

12.3.a) Rated All Electric Range (RAER) [miles]

40	(Note: PHEVs with RAER longer than 100 miles are not eligible for the federal tax credit.)
----	--

12.3.b) Grid-Connected (Plug-in) HEV and EV charger efficiency

85.0%

Demonstrations - Vehicle Cycle, Examine Vehicle Cycle Results

- Go to GREET 2, [\[Vehi_Sum\]](#) Tab
- Examine Results
- Focus on PHEV Results

1.5) PHEV: Conventional Material

	mmBtu or grams per vehicle lifetime				
	Components	ADR	Batteries	Fluids	Total
Total energy	67.050	15.268	14.465	11.013	107.796
Fossil fuels	61.733	13.810	12.026	10.940	98.509
Coal	30.697	5.090	4.653	0.259	40.699
Natural gas	25.329	8.515	5.429	2.942	42.215
Petroleum	5.707	0.205	1.944	7.739	15.596
Water consumption	10,322	1,394	3,801	264	15,782
CO2	4,790,760	1,033,853	919,303	624,940	7,368,855
CO2 (VOC, CO, CO2)	4,841,596	1,040,125	921,221	712,356	7,515,298
CH4	10,587.126	2,261.189	1,880.396	1,084.589	15,813.300
N2O	94.392	22.250	15.770	15.047	147.459
GHGs	5,216,869	1,113,857	1,004,525	748,881	8,084,133

Demonstrations - Vehicle Cycle, Change PHEV Specs to a 20 mile RAER

- Go to GREET 1, [\[Inputs\]](#) Tab
- Click “Vehicles” button, or go to section 12 “Vehicle Operations”
- Change Rated All-Electric Range to 20
- Press F9

Vehicles Worksheet

Results

Back to Top

12. Vehicle Operations

12.1) Share of Alternative Fuel in Conventional fuel and Alternative Fuel Blend: Volumetric Percentage

Methanol in FFV fuel	85.0%
Methanol in dedicated vehicle fuel	90.0%
Ethanol in low-level blend of gasoline and ethanol	10.0%
Ethanol in FFV fuel	85.0%
Ethanol in dedicated vehicle fuel	85.0%
Butanol in FFV fuel	100.0%
FT diesel in CIDI fuel	100.0%
Biodiesel in CIDI fuel	20.0%
Renewable diesel in CIDI fuel	100.0%
Renewable gasoline in SI fuel	100.0%
Ethanol in E-diesel	10.0%
Additives in E-diesel	1.0%

12.2) Type of Gasoline or Diesel for Alternative Fuel Blends

Share of Gasoline out of Gasoline and Blendstock	
Gasoline for methanol blend	0.0%
Gasoline for low-level ethanol blend	0.0%
Gasoline for high-level ethanol blend	0.0%
Gasoline for butanol blend	0.0%
Gasoline for renewable gasoline blend	0.0%
Share of LSD out of LSD and CD	
Diesel for Fischer-Tropsch diesel blend	100.0%
Diesel for biodiesel blend	100.0%
Diesel for renewable diesel blend	100.0%
Diesel for e-diesel blend	100.0%

12.3) Key Parameters for Grid-Connected (Plug-in) Hybrid Electric Passenger Vehicle Technologies

12.3.a) Rated All Electric Range (RAER) [miles]	40	(Note: PHEVs with RAER less than 40 miles are not modeled)
12.3.b) Grid-Connected (Plug-in) HEV and EV charger efficiency	85.0%	

Change to 20

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 Power Applications), kWh

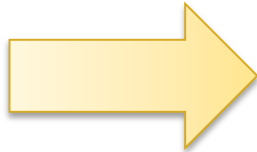
	Ni-MH	Li-Ion
PHEV: Conventional Material	18	18
PHEV: Lightweight Material	11	11
EV: Conventional Material	28	28
EV: Lightweight Material	17	17

Change to 7

Change to 4

Demonstrations - Vehicle Cycle, Examine Vehicle Cycle Results

- Go to GREET 2, [\[Vehi_Sum\]](#) Tab
- Examine Results
- Focus on PHEV Results



1.5) PHEV: Conventional Material

	mmBtu or grams per vehicle lifetime				
	Components	ADR	Batteries	Fluids	Total
Total energy	72.350	15.268	6.014	11.013	104.645
Fossil fuels	66.592	13.810	5.105	10.940	96.448
Coal	33.225	5.090	2.042	0.259	40.615
Natural gas	27.293	8.515	2.348	2.942	41.098
Petroleum	6.075	0.205	0.715	7.739	14.734
Water consumption	11,178	1,394	1,366	264	14,202
CO2	5,167,776	1,033,853	382,805	624,940	7,209,374
CO2 (VOC, CO, CO2)	5,222,682	1,040,125	383,596	712,356	7,358,760
CH4	11,434.554	2,261.189	824.775	1,084.589	15,605.107
N2O	101.800	22.250	6.712	15.047	145.808
GHGs	5,628,150	1,113,857	417,657	748,881	7,908,545

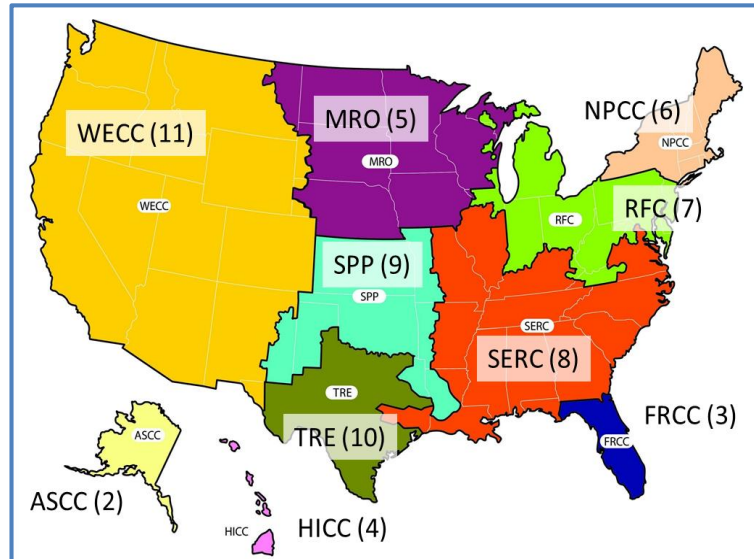
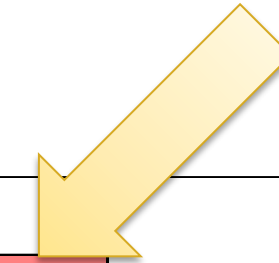
Demonstrations - Total Life Cycle, Examine Electrical Grid Specs

- 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

10.2) Electricity Generation Mix

10.2.a) Selection of Electricity Generation Mix for Transportation Use

Mix for transportation use	1
Mix for stationary use	1

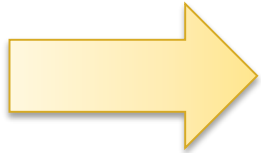


- 1 U.S. Mix
- 2 ASCC Mix
- 3 FRCC Mix
- 4 HICC Mix
- 5 MRO Mix
- 6 NPCC Mix
- 7 RFC Mix
- 8 SERC Mix
- 9 SPP Mix
- 10 TRE Mix
- 11 WECC Mix
- 12 CA Mix
- 13 User Defined Mix
- 14 NG Power Plants
- 15 Coal Power Plants
- 16 Nuclear Power Plants
- 17 Hydro Power Plants
- 18 NGCC Turbine
- 19 Geothermal

(U.S. EPA)

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				
Item	Btu/mile or g/mile			
	WTP	Vehicle Cycle	Vehicle Operation	Total
Total energy	1,080	654	2,557	4,291
Fossil fuels	975	603	2,355	3,933
Coal	292	254	188	734
Natural gas	493	257	92	842
Petroleum	190	92	2,075	2,357
Water consumption	0.252	0.089	0.000	0.341
CO2 (VOC, CO, CO2)	90	46	170	306
CH4	0.287	0.098	0.003	0.388
N2O	0.008	0.001	0.005	0.014
GHGs	100	49	172	321

Demonstrations - Total Life Cycle, Change Electrical Grid Assumption

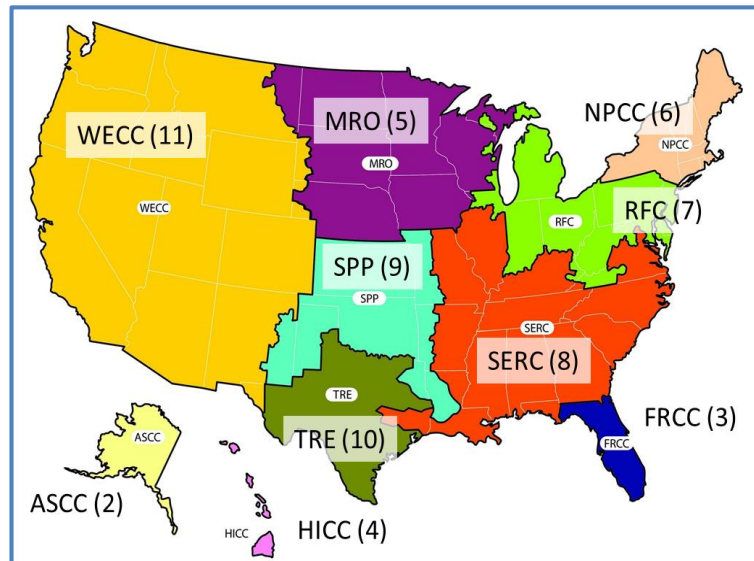
- Go to GREET 1, [\[Inputs\]](#) Tab
- Click “Electric” button, or go to section 10 “Electric Generation”
- Change Electricity Generation Mix to 12 (California Mix)
- Press F9

10.2) Electricity Generation Mix

10.2.a) Selection of Electricity Generation Mix for Transportation Use

Mix for transportation use	1
Mix for stationary use	1

Change to 12

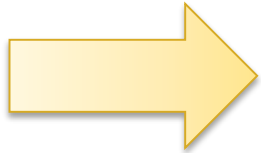


(U.S. EPA)

- 1 U.S. Mix
- 2 ASCC Mix
- 3 FRCC Mix
- 4 HICC Mix
- 5 MRO Mix
- 6 NPCC Mix
- 7 RFC Mix
- 8 SERC Mix
- 9 SPP Mix
- 10 TRE Mix
- 11 WECC Mix
- 12 CA Mix
- 13 User Defined Mix
- 14 NG Power Plants
- 15 Coal Power Plants
- 16 Nuclear Power Plants
- 17 Hydro Power Plants
- 18 NGCC Turbine
- 19 Geothermal

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				
Item	Btu/mile or g/mile			
	WTP	Vehicle Cycle	Vehicle Operation	Total
Total energy	974	654	2,557	4,185
Fossil fuels	867	603	2,332	3,802
Coal	85	254	32	371
Natural gas	601	257	227	1,085
Petroleum	181	92	2,072	2,345
Water consumption	0.306	0.089	0.000	0.395
CO2 (VOC, CO, CO2)	67	46	170	284
CH4	0.270	0.098	0.003	0.370
N2O	0.008	0.001	0.005	0.014
GHGs	77	49	172	299