

# **Car GHG**

A Software Analysis Tool for Vehicle Greenhouse  
Gas Emissions and Cost

**Advanced User Guide for Version 3.1x**

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# Preface to the Advanced User Guide

## Background Notes

Car GHG was previously branded (in versions 3.0x) under the name **PVC** which stood for “Plug-in Vehicle Competitiveness” – although most documentation has been updated, the term “PVC” may appear in certain areas, including the source code on GitHub... As such, it should be clear that the terms “Car GHG”, “CarGHG” & “PVC” (whenever it appears) are referring to the same thing

## Required Reading

- ❑ This guide pre-supposes familiarity with “User Guide for Version 3.1.x” and assumes that the reader has some experience with CarGHG. Topics in the User Guide will not be repeated in this document, except where it is related to the topic being discussed.
- ❑ This guide pre-supposes that the user is familiar with FASTSim\* and its models, or has otherwise acquired satisfactorily validated FASTSim models. This is not a guide for preparing FASTSim models for use in CarGHG.

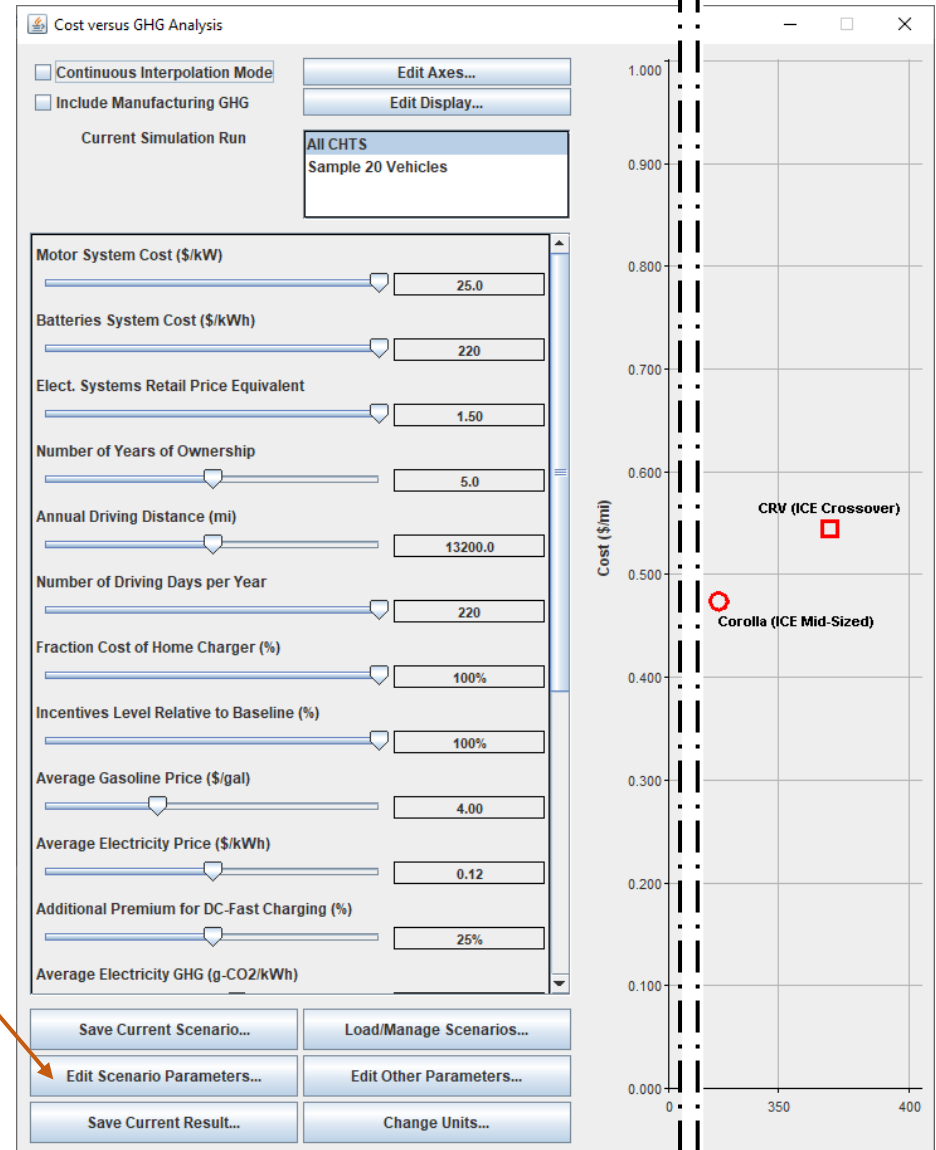
\* FASTSim is a tool to examine the energy use of different vehicles. Please see the NREL website for more information:  
<https://www.nrel.gov/transportation/fastsim.html>

# Editing Sliders

## Any of (Modules 4-6)

### Scenario Parameters (Slider Bars) Area

- By default, only relevant adjustable parameters for vehicle models within current analysis will be visible. For example, since there are no Diesel vehicles in the current set, there will be no slider bars for cost of a Diesel Engine nor the cost and GHG of Diesel fuel
- The **user has additional control** to adjust the min/max limit values, number of discrete choices, re-ordering and/or turning off slider bars via this button



# Editing Sliders

Close this window to return to the visualization view.  
Note that your changes will not be saved without clicking “Save Current Setup” below.

Setup Scenario Parameters

Show Slider Bar	Limiting Value	Current Limit	Baseline Value	Current Limit	Limiting Value	
<input type="checkbox"/> Gasoline ICE System Cost (\$/kW)			16.2			Edit...
<input checked="" type="checkbox"/> Motor System Cost (\$/kW)	6.0	6.0	15.0	25.0	25.0	Edit...
<input checked="" type="checkbox"/> Batteries System Cost (\$/kWh)	50	50	120	220	220	Edit...
<input type="checkbox"/> Average Retail Price Equivalent			1.50			Edit...
<input checked="" type="checkbox"/> Elect. Systems Retail Price Equivalent	1.05	1.05	1.50			Edit...
<input checked="" type="checkbox"/> Number of Years of Ownership	3.0	3.0	5.0	12.0	12.0	Edit...
<input checked="" type="checkbox"/> Annual Driving Distance (mi)	2640.0	2640.0	13200.0	26400.0	26400.0	Edit...
<input checked="" type="checkbox"/> Number of Driving Days per Year	22	22	220			Edit...
<input checked="" type="checkbox"/> Fraction Cost of Home Charger (%)	0%	0%	100%			Edit...
<input checked="" type="checkbox"/> Incentives Level Relative to Baseline (%)	0%	0%	100%			Edit...
<input checked="" type="checkbox"/> Average Gasoline Price (\$/gal)	1.00	1.00	4.00	10.00	10.00	Edit...
<input checked="" type="checkbox"/> Average Electricity Price (\$/kWh)	0.00	0.00	0.12	0.30	0.30	Edit...
<input checked="" type="checkbox"/> Additional Premium for DC-Fast Charging (%)	0%	0%	200%	300%	300%	Edit...
<input checked="" type="checkbox"/> Average Gasoline GHG (g-CO2/gal)	0	0	10680			Edit...
<input checked="" type="checkbox"/> Average Electricity GHG (g-CO2/kWh)	0	0	240	900	900	Edit...
<input checked="" type="checkbox"/> Manufacturing GHG Except Battery	Low End	Low End	50% Low End	High End	High End	Edit...
<input checked="" type="checkbox"/> Battery Mfg. GHG Relative to Baseline (%)	0.0%	0.0%	100.0%			Edit...
<input checked="" type="checkbox"/> Timing within Charging Events			Minimizing Cost	Minimizing GHG	Minimizing GHG	Edit...
<input checked="" type="checkbox"/> Fraction of PHEV Owners Not Charging (%)			0.0%	100.0%	100.0%	Edit...
<input checked="" type="checkbox"/> Minimum Time-Window for Charging (hr)	0.75	0.75	Overnight Only			Edit...
<input type="checkbox"/> BEV Replacement Vehicle			All T_JCE			Edit...
<input checked="" type="checkbox"/> BEV Range Anxiety (mi)			20.0	40.0	40.0	Edit...

Save Current Setup Change Order... Change Units...

These check marks can be selected and de-selected to show or hide slider bars.

These buttons allow the user to change the order in which the sliders appear, change the units displayed for each parameter, and save the current parameter setup.

# Editing Sliders

Click one of these buttons to edit slider values for the corresponding parameter.

Setup Scenario Parameters

Show Slider Bar

	Limiting Value	Current Limit	Baseline Value	Current Limit	Limiting Value	
<input type="checkbox"/> Gasoline ICE System Cost (\$/kW)			16.2			Edit...
<input checked="" type="checkbox"/> Motor System Cost (\$/kW)	6.0	6.0	15.0	25.0	25.0	Edit...
<input checked="" type="checkbox"/> Batteries System Cost (\$/kWh)	50	50	120	220	220	Edit...
<input type="checkbox"/> Average Retail Price Equivalent			1.50			Edit...
<input checked="" type="checkbox"/> Elect. Systems Retail Price Equivalent	1.05	1.05	1.50			Edit...
<input checked="" type="checkbox"/> Number of Years of Ownership	3.0	3.0	5.0	12.0	12.0	Edit...
<input checked="" type="checkbox"/> Annual Driving Distance (mi)	2640.0	2640.0	13200.0	26400.0	26400.0	Edit...
<input checked="" type="checkbox"/> Number of Driving Days per Year	22	22	220			Edit...
<input checked="" type="checkbox"/> Fraction Cost of Home Charger (%)	0%	0%	100%			Edit...
<input checked="" type="checkbox"/> Incentives Level Relative to Baseline (%)	0%	0%	100%			Edit...
<input checked="" type="checkbox"/> Average Gasoline Price (\$/gal)	1.00	1.00	4.00	10.00	10.00	Edit...
<input checked="" type="checkbox"/> Average Electricity Price (\$/kWh)	0.00	0.00	0.12	0.30	0.30	Edit...
<input checked="" type="checkbox"/> Additional Premium for DC-Fast Charging (%)	0%	0%	200%	300%	300%	Edit...
<input checked="" type="checkbox"/> Average Gasoline GHG (g-CO2/gal)	0	0	10680			Edit...
<input checked="" type="checkbox"/> Average Electricity GHG (g-CO2/kWh)	0	0	240	900	900	Edit...
<input checked="" type="checkbox"/> Manufacturing GHG Except Battery	Low End	Low End	50% Low End	High End	High End	Edit...
<input checked="" type="checkbox"/> Battery Mfg. GHG Relative to Baseline (%)	0.0%	0.0%	100.0%			Edit...
<input checked="" type="checkbox"/> Timing within Charging Events			Minimizing Cost	Minimizing GHG	Minimizing GHG	Edit...
<input checked="" type="checkbox"/> Fraction of PHEV Owners Not Charging (%)			0.0%	100.0%	100.0%	Edit...
<input checked="" type="checkbox"/> Minimum Time-Window for Charging (hr)	0.75	0.75	Overnight Only			Edit...
<input type="checkbox"/> BEV Replacement Vehicle			All T_JCE			Edit...
<input checked="" type="checkbox"/> BEV Range Anxiety (mi)			20.0	40.0	40.0	Edit...

Save Current Setup Change Order... Change Units...

This grid displays information about the current slider value settings. The Limiting Values on both ends represent the highest and lowest allowed limits of settings by the model. These cannot be exceeded. The Current Limit displays the current high and low settings on the sliders (these can be changed by clicking the "Edit..." button). The Baseline Value represents the value in the middle slider position.

# Editing Sliders

Upper and lower limiting values. Added values cannot exceed these values.

**Motor System Cost (\$/kW)**

**Limiting Value** 6.0

Values between Limit & Baseline

Add

Delete

6.0  
10.5

Edit Selected Value

**Baseline Value** 15.0

Values between Limit & Baseline

Add

Delete

20.0  
25.0

Edit Selected Value

**Limiting Value** 25.0

OK Cancel

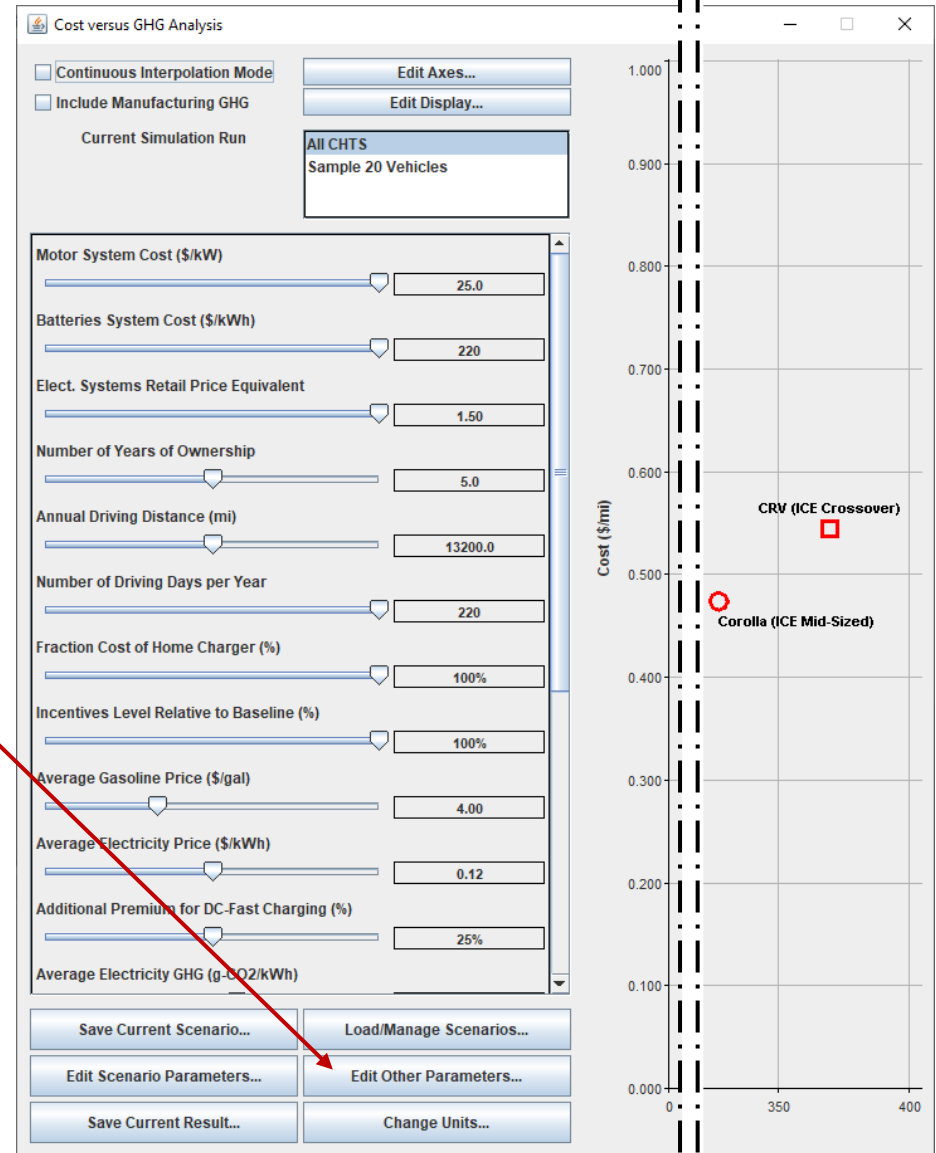
Use **these buttons** to add or delete values from the sliders.

- Values added in the sliders appear in **these boxes** and must be between the **Baseline Value** and the corresponding **Limiting Value** (depending on whether values being added are greater than or less than the **Baseline Value**).
- Values added will act as “notches” on the slider being adjusted, allowing those specific values to be displayed in the results.
- The highest value in the **bottom box** and lowest value in the **top box** will serve as the “ends” of the slider.
- Neither the **Limiting Values** nor the **Baseline Value** can be adjusted.

Click **“OK”** to save the changes. The sliders will now reflect the new values.

# Advanced Parameter Editing

## Any of (Modules 4-6)

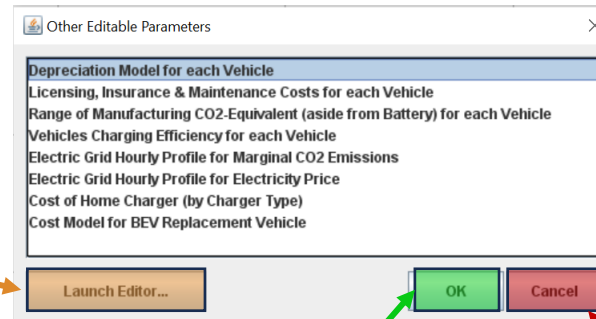


This button allows for editing other model parameters that aren't adjustable via sliders bars (such as vehicle depreciation).



# Advanced Parameter Editing

To edit the parameters present in this list, highlight it with the mouse by clicking on it and click “Launch Editor...” button. Each editor is tailor-made for the parameter to be edited and will be reviewed in the following slides.



Once editing parameters is complete, click “OK” to save the changes and return to the visualization view.

If you wish to discard the changes, clicking “Cancel” will return to the visualization view without saving any changes.

# Advanced Parameter Editing – Vehicle Depreciation

The Vehicle Depreciation panel is broken up by vehicle model in the selected analysis. The default values are based off of general residual value curves for vehicle resale. However, if specific information for the vehicle being studied is known, this is often more accurate than this default. This editor allows the user to change depreciation values on a per-vehicle basis with known points on a residual value curve. Points between known points are interpolated based on an exponential best-fit curve.

The screenshot shows a software interface titled "Vehicle Depreciation Models". It contains four sections, each for a different vehicle model: T\_ICE, F\_ICE, T\_PHEV10, and T\_PHEV20. Each section has a "Residual Value Curve" header, a "Number of Curve Data Points" input field (set to 2), and a table with three columns: "Years", "Typical Mileage (mi)", and "Residual Value". The table for each model contains two rows of data: (3.0, 41400, 65.0 %) and (5.0, 66000, 50.0 %). Below each table are two sub-sections: "Low Mileage" and "High Mileage", each with a "Resale by up to" and "at" input field. The "Low Mileage" section for T\_ICE and F\_ICE shows "Improves Resale by up to 20.0 % at 50.0 % of typical mileage". The "High Mileage" section for T\_ICE and F\_ICE shows "Reduces Resale by up to 20.0 % at 150.0 % of typical mileage". At the bottom of the dialog are "OK" and "Cancel" buttons.

Model	Years	Typical Mileage (mi)	Residual Value
T_ICE	3.0	41400	65.0 %
	5.0	66000	50.0 %
F_ICE	3.0	41400	65.0 %
	5.0	66000	50.0 %
T_PHEV10	3.0	41400	65.0 %
	5.0	66000	50.0 %
T_PHEV20	3.0	41400	65.0 %
	5.0	66000	50.0 %

This box defines the number of points that will be used for the residual value curve.

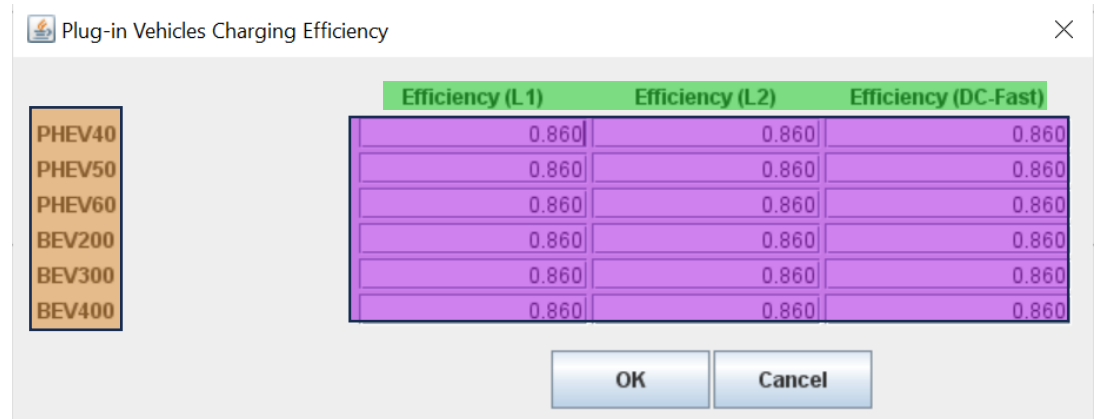
For each point on the curve, input the years, mileage, and residual value here. Values in between the known points are interpolated with a best-fit exponential curve.

If information is known about the affect of high- or low-mileage vehicles on the residual value, input it here.

Finally, click "OK" to save changes, or "Cancel" to discard them.

# Advanced Parameter Editing – Other Vehicle Parameters

The Plug-In Vehicles Charging Efficiency editor can be used to adjust the charging efficiency in the model. Efficiency can be changed **per vehicle**, **per charging type**, and should be expressed as a decimal (for example, 86% efficiency is expressed here as 0.860).



Plug-in Vehicles Charging Efficiency

	Efficiency (L1)	Efficiency (L2)	Efficiency (DC-Fast)
PHEV40	0.860	0.860	0.860
PHEV50	0.860	0.860	0.860
PHEV60	0.860	0.860	0.860
BEV200	0.860	0.860	0.860
BEV300	0.860	0.860	0.860
BEV400	0.860	0.860	0.860

OK Cancel

# Advanced Parameter Editing – Other Vehicle Parameters

The Vehicle Manufacturing GHG editor allows the user to adjust the expected CO2 emissions from manufacturing the vehicle. The expected lifetime driving distance expressed in miles should be entered at the top. Then, the range of GHG estimations for manufacturing can be entered in the boxes.

Vehicle Manufacturing GHG other than Battery

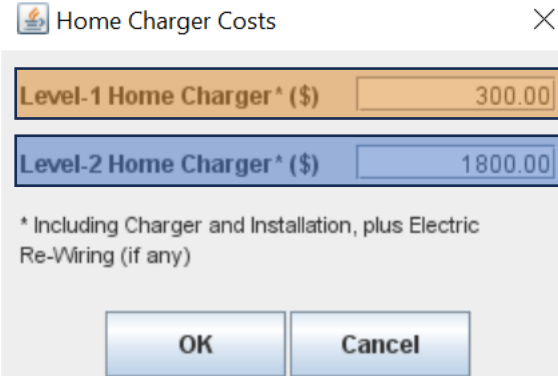
Vehicle Lifetime Driving Distance (mi)

	Low End (g-CO2/kg-vehicle)	High End (g-CO2/kg-vehicle)
ICE	4200	7800
HEV	4100	7500
PHEV40	4000	7300
PHEV50	4000	7300
PHEV60	4000	7300
BEV200	4000	7900
BEV300	4000	7900
BEV400	4000	7900

OK Cancel

# Advanced Parameter Editing – Other Vehicle Costs

- The home charger cost editor (top) allows the user to define the cost of installation for both **level 1** and **level 2** home chargers.



Home Charger Costs

Level-1 Home Charger\* (\$) 300.00

Level-2 Home Charger\* (\$) 1800.00

\* Including Charger and Installation, plus Electric Re-Wiring (if any)

OK Cancel

# Advanced Parameter Editing – Other Vehicle Costs

- The Licensing, Insurance, and Maintenance cost editor allows the user to adjust these costs for each vehicle. **Licensing/Registration** and **Insurance** are expressed on a per-year basis, while **Maintenance** is expressed on a per-mile basis.

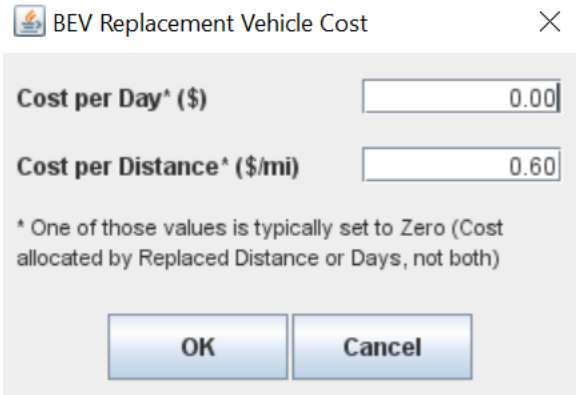
Licensing, Insurance & Maintenance Costs

	Licensing (\$/year)	Insurance (\$/year)	Maintenance (\$/mi)
ICE	285	880	0.090
HEV	285	880	0.075
PHEV40	285	880	0.045
PHEV50	285	880	0.045
PHEV60	285	880	0.045
BEV200	285	880	0.045
BEV300	285	880	0.045
BEV400	285	880	0.045

OK Cancel

# Advanced Parameter Editing – Other Vehicle Costs

- The Replacement Vehicle Cost editor (bottom) allows the user to express the cost of replacing a vehicle with a BEV. This can be expressed EITHER per day OR per mile. Typically, one of these should be set to \$0.00.



The screenshot shows a dialog box titled "BEV Replacement Vehicle Cost" with a close button (X) in the top right corner. Inside the dialog, there are two input fields: "Cost per Day\* (\$)" with a value of "0.00" and "Cost per Distance\* (\$/mi)" with a value of "0.60". Below these fields is a footnote: "\* One of those values is typically set to Zero (Cost allocated by Replaced Distance or Days, not both)". At the bottom of the dialog are two buttons: "OK" and "Cancel".

Parameter	Value
Cost per Day* (\$)	0.00
Cost per Distance* (\$/mi)	0.60

\* One of those values is typically set to Zero (Cost allocated by Replaced Distance or Days, not both)

OK Cancel

# Advanced Parameter Editing – Grid Parameters

- These editors allow the user to adjust the hourly parameters of the electric grid.
- The cost (left) and GHG (right) can be adjusted on a per-hour basis.
- As described in the tool-tip within the editor, these values are expressed as a proportion of the Grid-Average values; that is, the Grid-Average value for an hour will be multiplied by the value supplied for that hour.
  - Values above 1.0 increase the cost or GHG above the grid-average.
  - Values below 1.0 decrease the cost or GHG below the grid-average.

Electricity Cost Hourly Profile

Hour	Profile Value*
00:00	1.00000
01:00	1.00000
02:00	1.00000
03:00	1.00000
04:00	1.00000
05:00	1.00000
06:00	1.00000
07:00	1.00000
08:00	1.00000
09:00	1.00000
10:00	1.00000
11:00	1.00000
12:00	1.00000
13:00	1.00000
14:00	1.00000
15:00	1.00000
16:00	1.00000
17:00	1.00000
18:00	1.00000
19:00	1.00000
20:00	1.00000
21:00	1.00000
22:00	1.00000
23:00	1.00000

\* Values more than 1.0 imply (proportionally) More than the Grid-Average, while values less than 1.0 imply Less than the Grid-Average

OK Cancel

Grid GHG Hourly Profile

Hour	Profile Value*
00:00	1.00000
01:00	1.00000
02:00	1.00000
03:00	1.00000
04:00	1.00000
05:00	1.00000
06:00	1.00000
07:00	1.00000
08:00	1.00000
09:00	1.00000
10:00	1.00000
11:00	1.00000
12:00	1.00000
13:00	1.00000
14:00	1.00000
15:00	1.00000
16:00	1.00000
17:00	1.00000
18:00	1.00000
19:00	1.00000
20:00	1.00000
21:00	1.00000
22:00	1.00000
23:00	1.00000

\* Values more than 1.0 imply (proportionally) More than the Grid-Average, while values less than 1.0 imply Less than the Grid-Average

OK Cancel

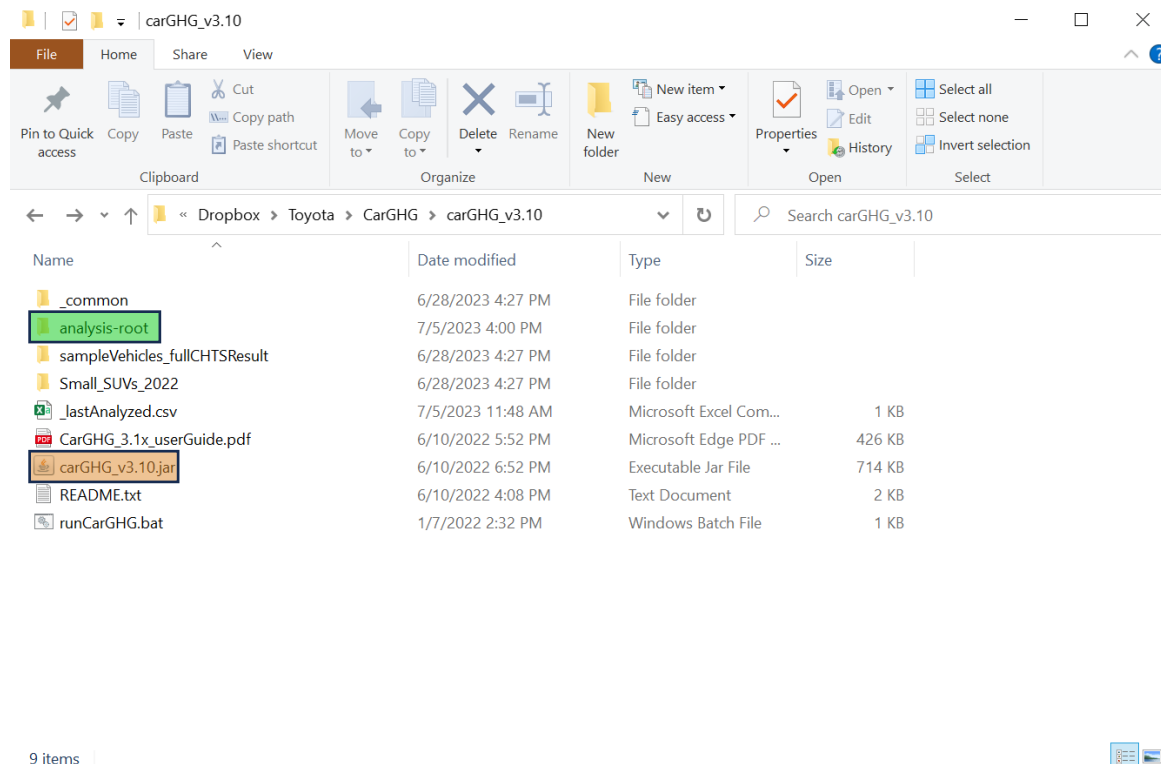


# Adding New FASTSim Models

This section of the guide will discuss adding FASTSim models to your analysis. Don't forget that this guide does not cover the process of developing or validating FASTSim models. CarGHG relies on the accuracy of the FASTSim models to generate accurate results. If you are confident in the accuracy of your models, you can add them for use in FASTSim.

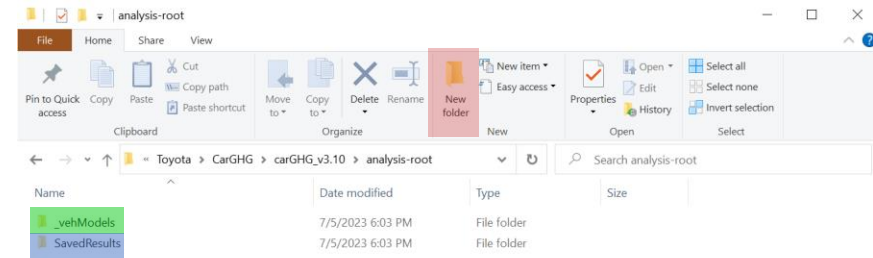
First, create a root folder for your analysis. This folder can have any name that does not start with an underscore character (for example, “myAnalysis” is a valid name, but “\_myAnalysis” is not). In this guide, the folder will be known as “analysis-root”.

- To ensure that you are in the correct folder location, look for the **carGHG launch JAR file**.



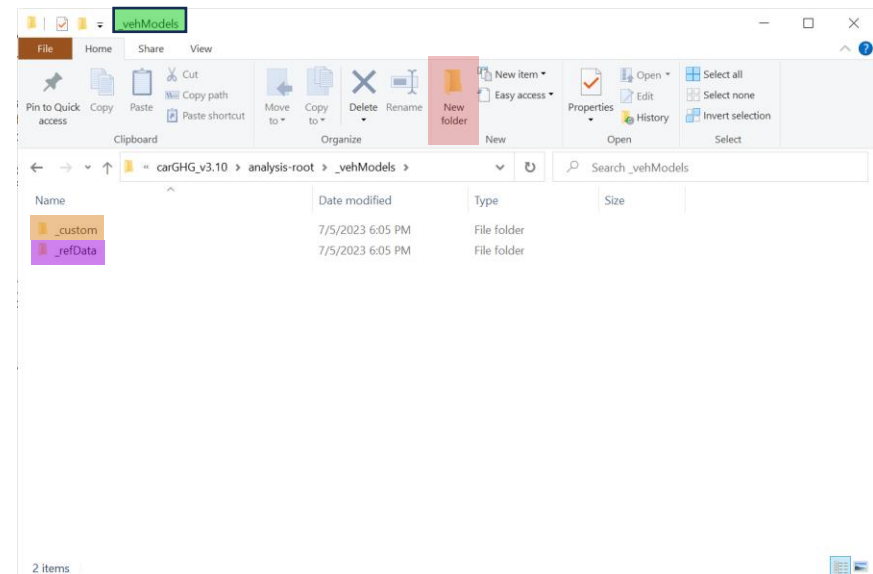
# Adding New FASTSim Models

Within the analysis-root folder, create two new folders called “vehModels” and “SavedResults”.



Within the newly-created “vehModels” folder, create two more new folders called “custom” and “refData”.

- It is intended that “refData” contains a PDF document explaining the creation and verification of the underlying FASTSim models being used in the analysis.
- Creating and displaying these files is not yet implemented into CarGHG.

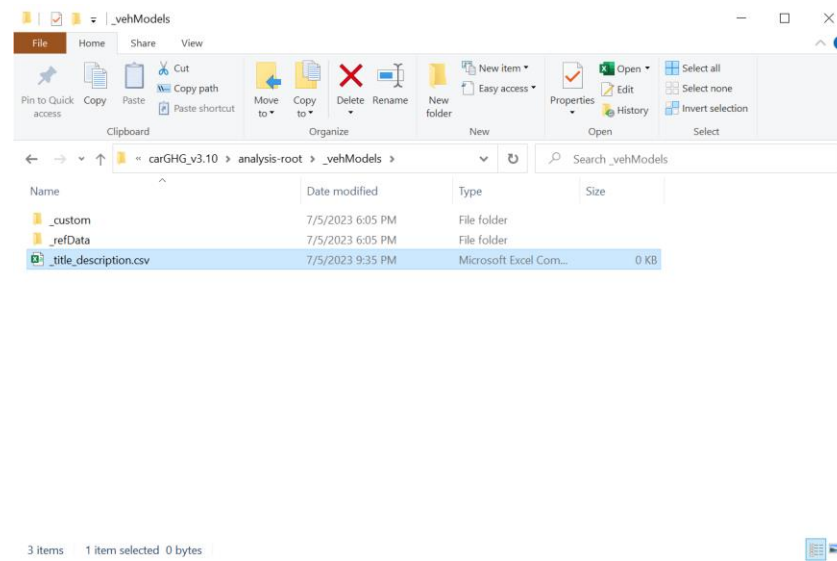


# Adding New FASTSim Models

Still within the `_vehModels` folder, create a new file called “`_title_description.csv`”.

Open it with a text editor (such as Notepad or similar) and enter the following (example below):

- Line 1: A short title or short description of the analysis. **Commas should NOT be used.**
- Line 2: A longer description of the analysis. Commas may be used if you wish.



\_title\_description.csv - Notepad

File Edit Format View Help

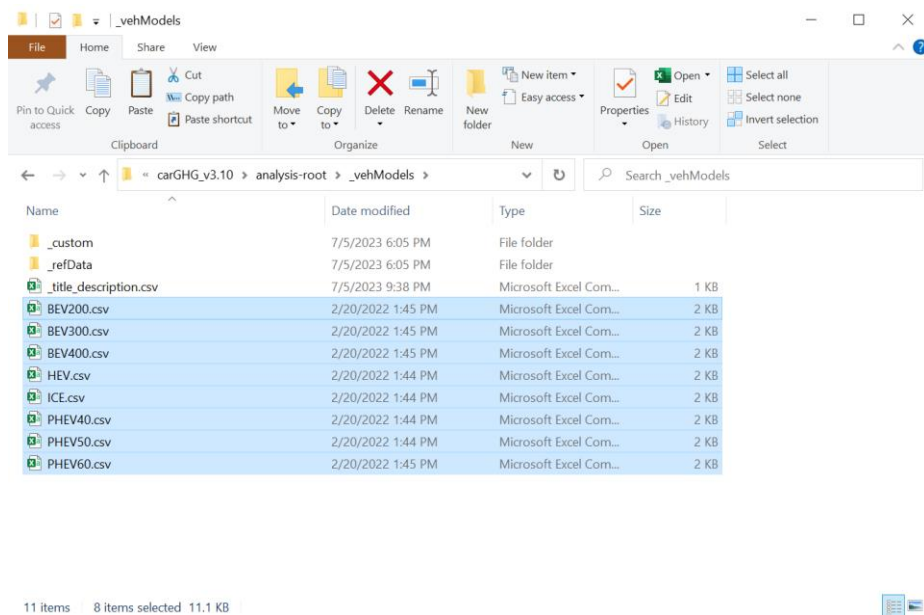
Example Analysis Title

This is the description line for the analysis description. Any punctuation can be used here, even commas

# Adding New FASTSim Models

Copy all of the **FASTSim models** that will be part of the analysis to the **\_vehModels** folder.

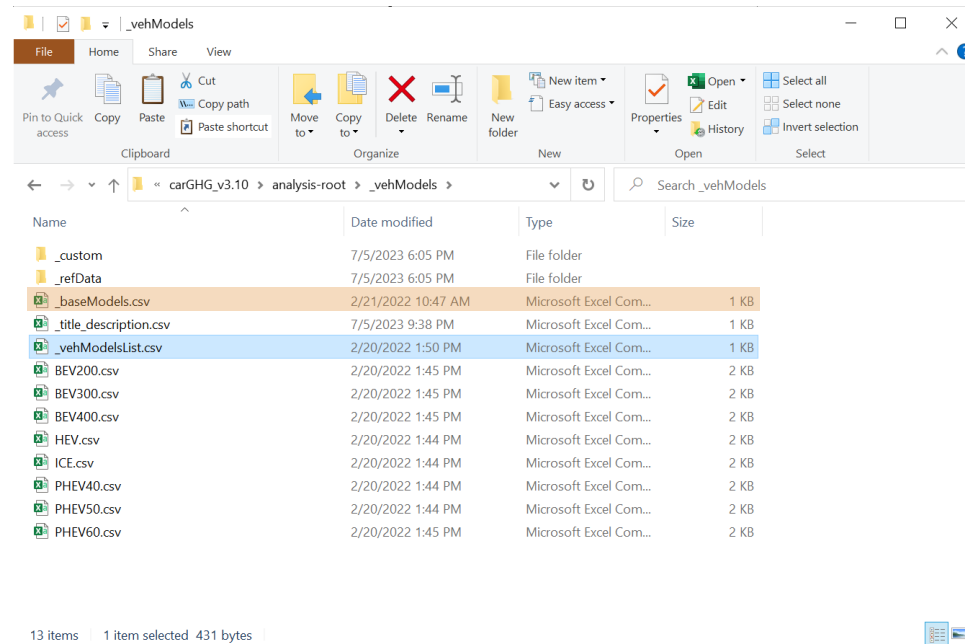
- The FASTSim models must be accurate and validated for results generated by CarGHG to be accurate. CarGHG has no way to check the accuracy of FASTSim models. Results cannot be guaranteed if the FASTSim models are not accurate and validated.
- All models should be named in the format “ShortName.csv” (see example on right).
  - The names used on these models will be referenced later in **\_vehModelList.csv** (see data dictionary)



# Adding New FASTSim Models

Still in the `_vehModels` folder, create a new file called “`_vehModelsList.csv`”. This file must be filled out according to the following slide. An example of a filled-out file is shown below. Finally, download the “`_baseModel.csv`” file and place it in the `_vehModels` folder.

- The values of `_baseModel.csv` will be explained in a later slide.



```
shortName,isVirtualVehicle,shortNameOfVehicleDerivedFrom,baseScenarioUSDollarsToBuy,nominalAERMiles,firstYearTotEqIncentives,mfgGHG_gCO2perKWhBattery
ICE,FALSE,-,32600,0,0,0
HEV,FALSE,-,33850,0,0,132900
PHEV40,FALSE,-,42950,40,10000,64700
PHEV50,TRUE,PHEV40,0,50,10000,64700
PHEV60,TRUE,PHEV40,0,60,10000,64700
BEV200,TRUE,PHEV40,0,200,11000,56700
BEV300,TRUE,PHEV40,0,300,11000,56700
BEV400,TRUE,PHEV40,0,400,11000,56700
```

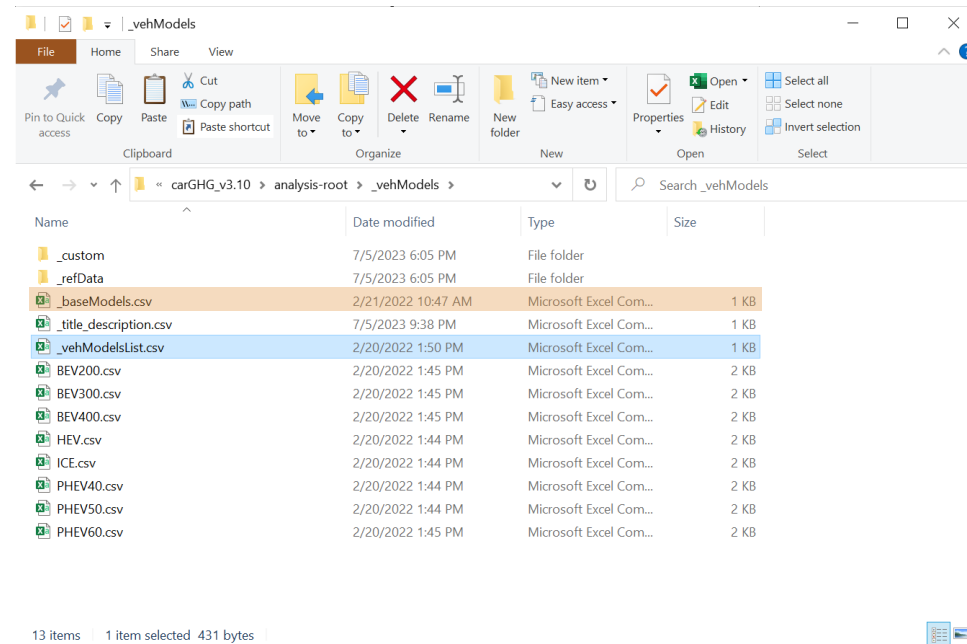
# \_vehModelsList.csv Data Dictionary

Parameter Name	Data Type/Class	Notes
shortName	String	The short name by which this vehicle model will be referenced. This value must match the filename of the vehicle FASTSim model (for example, if the shortName of a model is 'BEB20', the name of the FASTSim model for that vehicle must be 'BEB20.csv').
isVirtualVehicle	Boolean	Marks whether the model in question is a 'virtual vehicle' or not. Virtual vehicles are models that do not have their own curves, but are rather based off of the performance curve of another model, with certain parameters scaled to account for increased battery sizes.
shortNameOfVehicleDerivedFrom	String (shortName)	If isVirtualVehicle is FALSE, this should be set to '-' denoting a blank. If isVirtualVehicle is TRUE, this should be the shortName of the vehicle that is forming the basis model for the virtual vehicle.
baseScenarioUSDollarToBuy	Float	If isVirtualVehicle is FALSE, this is the value to purchase the vehicle when all model parameters are set to their base value. If isVirtualVehicle is TRUE, this value is ignored and can be set to 0.
nominalAERMiles	Float	The nominal all-electric range (AER) of the vehicle. If a non-electric vehicle is being modeled, set to 0.
firstYearTotEqIncentives	Float	The value (in first-year dollars) of the value of incentives gained throughout the ownership of the vehicle in the baseline scenario.
mfgGHG_gCO2perKWhBattery	Float (optional)	The grams of CO2 produced to manufacture 1 kWh of the battery that is being used in this vehicle. If included, a value is required for all vehicles. For non-electric vehicles, set to 0.

# Adding New FASTSim Models

Still in the `_vehModels` folder, create a new file called “`_vehModelsList.csv`”. This file must be filled out according to the following slide. An example of a filled-out file is shown below. Finally, download the “`_baseModel.csv`” file and place it in the `_vehModels` folder.

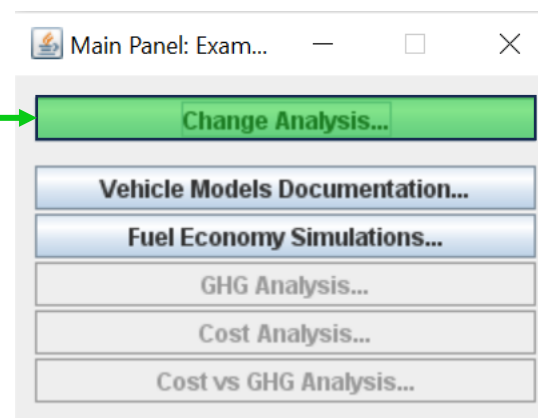
- The values of `_baseModel.csv` will be explained in a later slide.



```
shortName,isVirtualVehicle,shortNameOfVehicleDerivedFrom,baseScenarioUSDollarsToBuy,nominalAERMiles,firstYearTotEqIncentives,mfgGHG_gCO2perKWhBattery
ICE,FALSE,-,32600,0,0,0
HEV,FALSE,-,33850,0,0,132900
PHEV40,FALSE,-,42950,40,10000,64700
PHEV50,TRUE,PHEV40,0,50,10000,64700
PHEV60,TRUE,PHEV40,0,60,10000,64700
BEV200,TRUE,PHEV40,0,200,11000,56700
BEV300,TRUE,PHEV40,0,300,11000,56700
BEV400,TRUE,PHEV40,0,400,11000,56700
```

# Adding New FASTSim Models

You should now be ready to run your analysis. Launch CarGHG and select “**Change Analysis...**”



You can confirm that CarGHG has identified your analysis by selecting your **analysis title**. The **custom description** should also appear. Click “**Launch**” to load the analysis and run Modules 2 and 3 according to the Primary User Guide to view your results.

