FLEET PROCUREMENT ANALYSIS TOOL USER GUIDE

A tool designed to evaluate the financial viability and environmental impact of fleet vehicle procurements.

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ATLAS PUBLIC POLICY
WASHINGTON, DC USA

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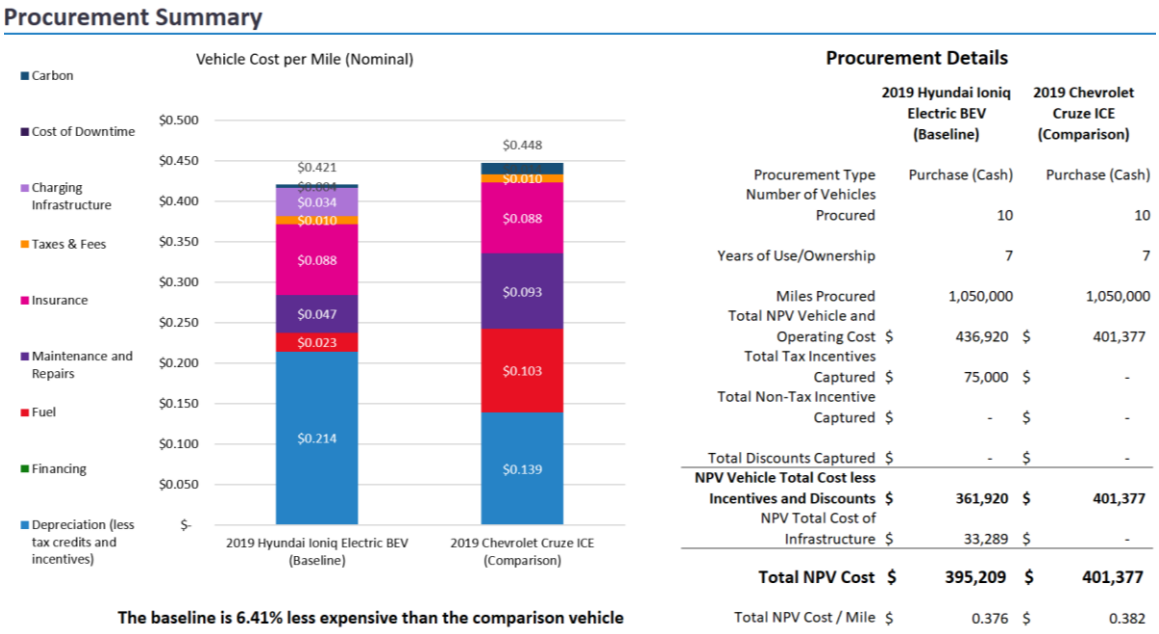
About the Fleet Procurement Analysis Tool

The Fleet Procurement Analysis Tool equips users with decision-relevant information on the financial viability and environmental impact of light-, medium-, and heavy-duty vehicle fleet procurements. The Microsoft Excel-based tool can evaluate a variety of procurement ownership structures, vehicle types, and procurement scenarios. The tool compares procurements side-by-side on a cost-per-distance-traveled basis and provides an analysis of cash flows and location-specific lifecycle emissions. The tool is highly flexible, supports customizable sensitivity variables, and produces user-friendly results summaries as shown below.



This tool was originally created with funding from the U.S. Department of Energy. Below is the contact information for all contributors to the design and development of the Fleet Procurement Analysis Tool.

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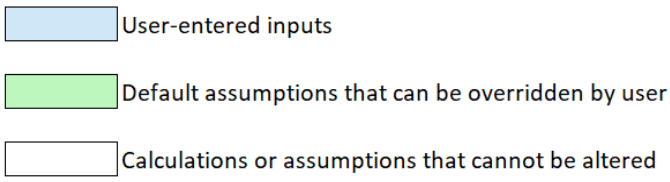
Overview of the Tool Structure

The Fleet Procurement Analysis Tool was built using Microsoft Excel and is contained in a standalone Excel workbook. It is divided into five functional areas, as follows:

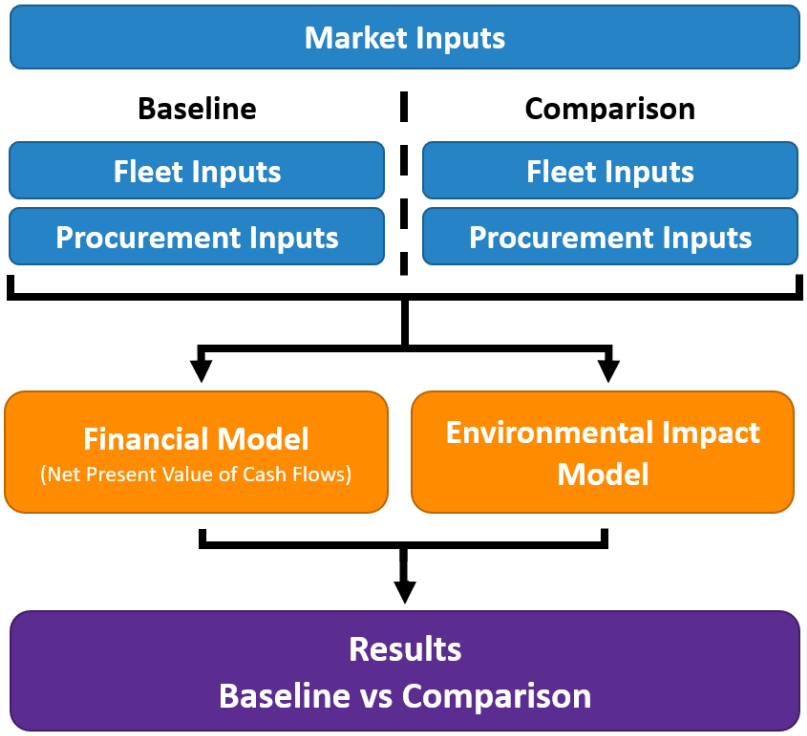
- **Instructions** (Green tab): Overview of tool architecture.
- **Initial Settings** (Green tab): Save or load settings for the tool. Also includes sensitivity configuration.
- **Inputs** (Blue tab): All the tool inputs.
- **Results** (Purple tab): A summary of the analysis and sensitivity results.
- **Financial Model** (Orange tab): The tables used to construct the financial analysis for the baseline and comparison procurements.
- **Environmental Model** (Orange tab): The calculations used for the emissions analysis.
- **Billing Model** (Orange tab): The calculations for the cost of electricity using specified electricity rates.
- **Data** (Black tab): Source data used to define default assumptions.
- **Data - Utility Rate Structures** (Black tab): Source data used for the Rate-Informed Electricity Cost feature.
- **Data - Vehicle Incentives** (Black tab): Source data to configure the default value for vehicle incentives.
- **Data – Vehicles** (Black tab): Source data to configure the default value for vehicle characteristics.
- **Version** (Black tab): Version history of the tool.
- **License** (Black tab): License information.

User inputs in the *Initial Settings* and *Inputs* sections are color-coded as follows:



When you first open the tool, all the inputs will be filled out, including User-entered inputs in order to make it easy to see the tool in action. Information flows from the *Inputs* section, through the *Financial Model* and *Environmental Model*, to the *Results*, as shown in the diagram on the *Instructions* tab in the tool and presented below.

Figure 1: Structure of the Fleet Procurement Analysis Tool



Advanced Procurement Comparison Analysis

The tool analyzes a potential vehicle procurement and compares it side-by-side with a baseline procurement. This way, you can assess the viability of a future procurement by comparing it to a past or alternative procurement. The tool supports the financial analysis of several ownership structures, from basic cash or loan purchases to sophisticated leasing structures.

More information on leasing structures can be found online at http://www.investopedia.com/terms/c/capitalleasemethod.asp.

The following are the ownership structures that the tool supports:

- **Purchase (Cash)**: Vehicles purchased with cash
- **Purchase (Loan)**: Vehicles purchased with debt financing
- **FMV (Closed-End) Lease**: Vehicles leased with Fair Market Value lease structure. Vehicles not purchased at end of lease term.
- **FMV (Closed-End) Lease w/ Cash Purchase**: Vehicles leased with Fair Market Value lease structure. Vehicles purchased at end of lease term with cash.
- **FMV (Closed-End) Lease w/ Loan Purchase**: Vehicles leased with Fair Market Value lease structure. Vehicles purchased at end of lease term with debt financing.

- **TRAC (Open-End) Lease**: Vehicles leased with Terminal Rental Adjustment Clause lease structure. Vehicles not purchased at end of lease term.
- **TRAC (Open-End) Lease w/ Cash Purchase**: Vehicles leased with Terminal Rental Adjustment Clause lease structure. Vehicles purchased at end of lease term with cash.
- **TRAC (Open-End) Lease w/ Loan Purchase**: Vehicles leased with Terminal Rental Adjustment Clause lease structure. Vehicles purchased at end of lease term with debt financing.
- **Tax-Exempt Lease Purchase (Cash)**: Vehicles leased with tax-exempt lease-purchase structure. Vehicles purchased at end of lease term with cash, typically a nominal amount ($1).

In addition to choosing an ownership structure, you can also customize inputs to incorporate fleet specific usage and costs, the vehicle pricing structure, incentives and discounts, and optional electric vehicle charging infrastructure.

Innovative Electricity Cost Evaluation

The rate informed electricity cost model allows users to generate a custom rate using utility rate structures and a simulated charging electricity demand curve. This module is designed for rates with a time of use component. Users can elect to simulate the effect of using management software to reduce peak power consumption, and/or scheduling charging when rates are cheapest.

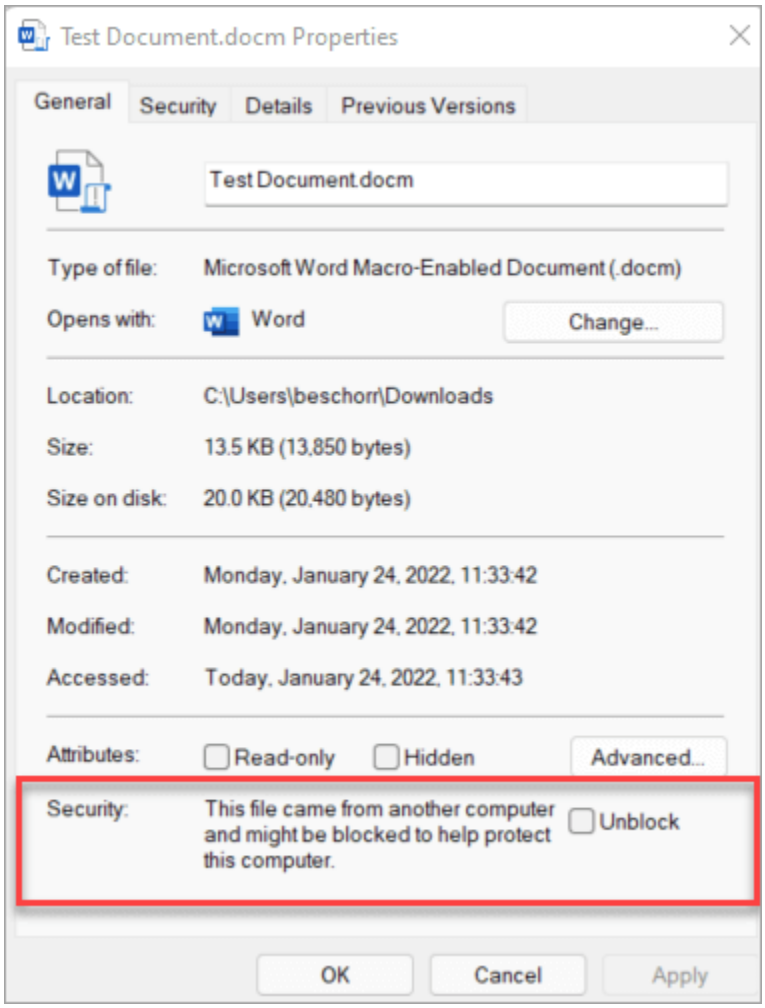
Getting Started

Step 1: Opening the Tool

To open the tool, double click on the file entitled “Fleet Procurement Analysis Tool.xlsm” Make sure to enable macros by clicking the “Enable Content” button that appears in the yellow bar at the top of the screen. Enabling macros is essential for the tool to behave as designed. Depending on your computer’s configuration, Windows may block the tool because it was downloaded from a website (see screenshot below).

You will need to unblock the file by right-clicking on the file in File Explorer and opening the properties box. Next, select the box that says Unblock (see screenshot below).

If you have trouble opening the file, contact your IT administrator or visit this website and adjust your computer's settings: https://support.microsoft.com/en-us/office/enable-or-disable-macros-in-microsoft-365-files-12b036fd-d140-4e74-b45e-16fed1a7e5c6,



Step 2: Initial Settings Tab

The "Initial Settings" tab enables you to save procurement scenarios for easy comparison or sharing with other users of the tool and to load previously saved scenarios. It also allows you to adjust input variable settings for the sensitivity analysis. This section should be filled out before going ahead to the other tabs.

Save/Load Settings

When starting a new procurement, give it a name in the "Procurement Name" field. Once you've completed filling out the Inputs tab, you can save a procurement to load later or to share by clicking on the "Save" button, and saving it with a name and in a location you specify. The tool will save all the procurement details in a simple text (TXT) format that can be loaded later or shared with other users of the tool. If you have received a procurement details file from another user or if you have previously saved a procurement file, you can load it into the tool by clicking the "Load" button and selecting the previously saved file. The format of this file is TXT and allows it to be read in any text editor, such as Microsoft Notepad or Word.

TIP: *To save inputs specific to your procurement, simply use the save function on the 'Initial Settings' tab. This way, you can manage multiple analyses with a single copy of the tool.*

Note: Loading inputs from an external file will overwrite any existing inputs in the tool.

Sensitivity Settings

The tool allows you to conduct sensitivity analyses on up to four user inputs. Sensitivity analyses are useful when you want to assess the effects of a single input holding all other inputs constant.

For each sensitivity variable, you can select any of the input fields via a dropdown menu selection. You can also set the minimum and maximum values for the sensitivity analysis. The minimum and maximum values must be compatible with the input field. For example, the minimum and maximum values must be evenly divisible by 10 for whole number input fields. The results of the sensitivity analysis are found in the *Results* tab.

You can adjust sensitivity settings at any point in time. To improve performance, you can set Excel to disable automatic calculations for data tables. In this case, you must select the "Update" button for the results to reflect the current sensitivity variables and settings.

Sensitivity Settings

Update sensitivity analysis results if Calculation Options is set to *Manual* or *Automatic Excerpt for Tables*

Update

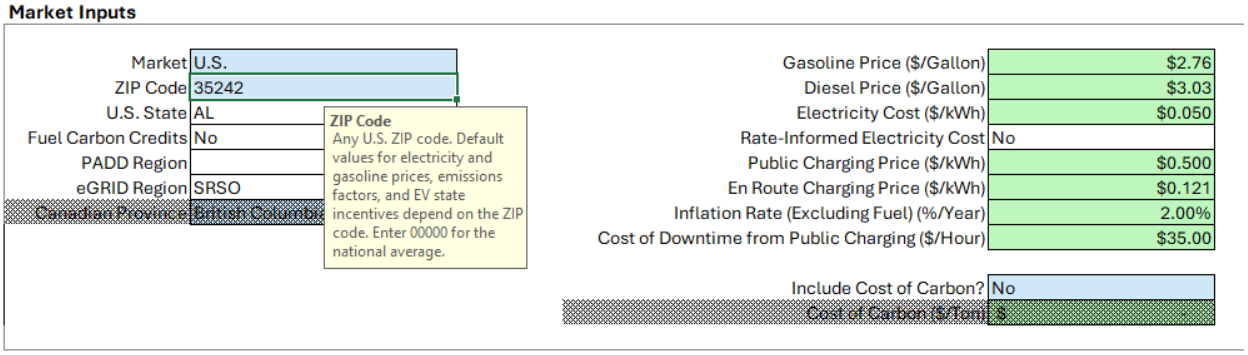
Variable	Input Field	Min Value	Max Value	Current Baseline Value	Current Comparison Value
Market Variables					
1	Electricity Cost ($/kWh)	0.09	0.22	0.0781	0.0781
Vehicle, Procurement, and Charging Variables					
2	Number of Vehicles to Procure (#)	5.00	30.00	10	10
3	Annual Vehicle Mileage (VMT/Year)	5000.00	25000.00	15000	15000
4	Expected Years of Use/Ownership (Years)	1.00	10.00	7	7

Step 3: Inputs Tab

In this section, you can enter inputs for the financial and environmental analyses. Inputs are grouped in four categories as follows:

- Market Inputs
- Vehicle Inputs
- Financial Inputs
- EV Infrastructure Inputs
- Rate Informed Electricity Costs

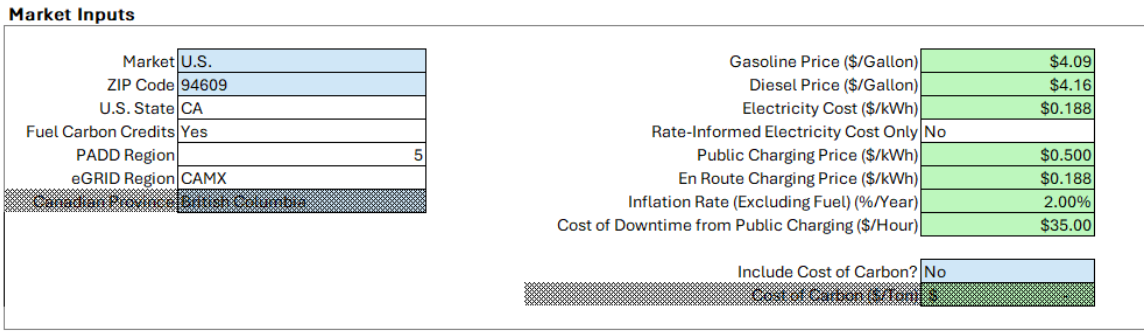
Note, hovering your mouse over any input will reveal user tips on how to understand the input, see below.



Market Inputs

In the Market Inputs section shown below, you can start by entering the market (U.S. or Canada). For the U.S. market, you next enter your ZIP code and you enter the province for the Canadian market. Changing the ZIP code or province will alter the assumptions for

gasoline, electricity costs, and electrical grid emissions.[1] Any of the input fields highlighted in green can be overwritten to reflect more recent or accurate information for your procurement. You can also include the cost of carbon in the financial analysis. For the U.S. market, the default cost of carbon is the 2020 social cost of carbon as defined by the U.S. federal government in 2016;[2] the default inflation rate is based on the Federal Reserve's medium-term target as of 2015.[3] For the Canadian market, the cost of carbon is from Environment and Climate Change Canada;[4] the default inflation rate is from the Canada National Energy Board.[5] Enter 00000 for the national average.



Vehicle Inputs

In this section, you can select the number and type of vehicles to procure. The tool automatically loads inputs for each vehicle type. You can also select from the '*Custom Vehicle' selections if the vehicles you're interested in are not listed in the dropdown selection menu. Any of the inputs in green cells can be edited. Vehicle costs (Insurance, Maintenance, and Repairs) are currently populated based on data for a single ZIP code and can be edited to reflect local costs, if possible. For the U.S. market, you can find out more about the vehicle you've selected by clicking the link at the bottom of the Vehicle Inputs box. For light-duty vehicles, the tool will direct you to www.fueleconomy.gov; for medium- and heavy-duty vehicles, the tool will direct you to more information on the vehicle.

Figure 2 shows the input window for the baseline vehicle. Vehicle inputs are mirrored between the Baseline and Comparison vehicle windows.

[1] ZIP code is mapped to U.S. EPA eGRID region using data from EPA's Power Profiler: https://www.epa.gov/egrid/power-profiler.

[2] See https://www.epa.gov/climatechange/social-cost-carbon.

[3] See https://www.federalreserve.gov/faqs/economy_14400.htm.

[4] See http://publications.gc.ca/collections/collection_2016/eccc/En14-202-2016-eng.pdf.

[5] See https://apps.neb-one.gc.ca/ftrppndc4/dflt.aspx?GoCTemplateCulture=en-CA.

Figure 2: Vehicle Inputs for Baseline Vehicles

Vehicle Inputs

Procurement 1 (Baseline)	
Number of Vehicles to Procure (#)	1
Vehicle Drivetrain Type	BEV
Vehicle Class	Passenger Vehicles (Light-Duty)
Vehicle Year	2022
Vehicle Make	Chevrolet
Vehicle Model	Bolt EUV
Fuel Economy Gasoline/Diesel City (MPG)	-
Fuel Economy Gasoline/Diesel Highway (MPG)	-
Fuel Economy Electric City (MPGe)	125.0
Fuel Economy Electric Hwy (MPGe)	104.0
Expected Years of Use/Ownership (Years)	7
Annual Vehicle Mileage (VMT/Year)	15,000
% of Annual Miles on Gasoline/Diesel	0%
% of Annual Miles City Driving	55%
Cost to Insure ($/Year)	$ 1,194
Use Drivetrain Default Maintenance and Repair Costs?	No
Maintenance and Repair Cost - Years 1 - 5 ($/Mile)	$ 0.0400
Maintenance and Repair Cost - Years 5+ ($/Mile)	$ 0.0520
Recurring Taxes and Fees ($/Year)	$ 10
Vehicle details from fueleconomy.gov	

Financial Inputs

This section enables you to customize the details and terms of the procurement along with inputs for anticipated income from utility programs and revenue from the sale of low carbon fuel credits. Fields that are not relevant for the current input selections are disabled, which are denoted by the cells formatted with a crosshatch in the graphic below. For example, if 'Purchase (Cash)' is selected as the vehicle ownership structure, then the tool will automatically disable options to customize 'Lease' and 'Loan' inputs.

As shown below, you can adjust vehicle prices, select an ownership structure, define a pricing approach, and incorporate any incentives or discounts. Two options are available for the pricing approach ('MSRP less discounts' and 'Dealer cost plus markup'). Procurement inputs can be different between the Baseline and Comparison vehicles.

Figure 3: Pricing and Incentives Inputs

Vehicle Financial Inputs

Procurement 1 (Baseline)		
Discount Rate for NPV Calculations (%)		0.00%
Pricing Approach (select one)	MSRP Less Discounts	
MSRP ($/Vehicle)	$	33,000
Value of Negotiated Discounts off MSRP ($/Vehicle)	$	-
Dealer Triple Net Price ($/Vehicle)	$	18,024
Dealer Markup ($/Vehicle)	$	200
Total Base Price	$	33,000
Value of Federal Tax Incentives ($/Vehicle)	$	-
Value of State Tax Incentives ($/Vehicle)	$	-
State Tax Incentive Cap ($)	$	-
Value of Non-tax Incentives ($/Vehicle)	$	5,500
Initial Tax, Title, and Registration Cost ($/Vehicle)	$	1,000
Initial Fee as Percent of Vehicle Base Price (%)		0%

The financial inputs window also contains options to include revenue or bill credits earned from demand response or grid services. Users can input their own, off-model calculated net income from a utility program that uses the vehicles battery, such as demand response or grid services. The monetary value added here is applied as a savings in the financial calculations. Note, this section is separate from the *Rate-Informed Electricity Cost* feature. Any net-metering services would best be modeled outside of the tool but revenues from residual grid exports can be included here.

Figure 4: Utility Program Revenue Inputs

Include Utility Value Stream (Demand Response or Grid Service)?	Yes	
Estimated Net Income from Utility Program (Nominal)		$0.00
Income Period	Annually	
Annual Change in Estimated Net Income (%)		0%
Include Fuel Carbon Credits?	No	

The Fuel Carbon Credit section of the financial inputs window allows users in California or Oregon to include the value of Low Carbon Fuel Standard (CA) or Clean Fuel Standard (OR) in the financial model as a savings. These inputs will only be active when the ZIP Code input in the market inputs window indicates that a user is in Oregon or California.

Figure 5: Fuel Carbon Credit Calculation

Include Fuel Carbon Credits?		Yes
Electricity Carbon Intensity (grams CO2e/MJ)		50
Start Year		2023
i. https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities		
ii. https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx		
Carbon Credit Value by Year (Nominal)	2023	$100.00
Any year after the maximum year is constant.	2024	$100.00
The maximum year is determined by the carbon credit	2025	$100.00
program in the state. For CA, the maximum	2026	$100.00
year is 2030.	2027	$100.00
	2028	$100.00
	2029	$100.00
	2030	$100.00
	2031	$100.00
	2032	$100.00

- **Electricity Carbon Intensity** is the carbon intensity (in grams CO_2e / MJ) of the electricity that will be used to charge the vehicle. That amount can range from negative values for waste-derived energy, to zero for renewables such as solar, or higher for grid values. Carbon intensities for various electricity sources are provided at the links on the spreadsheet.
- **Carbon Credit Value by Year** is the user projected market (or contract) value of carbon credits which can be provided in nominal dollars from 2022 until 2032. For TCO models that extend past 2032, the value of 2032 is repeated.

EV Infrastructure Use and Installation Inputs

This section allows you to include or exclude EV charging infrastructure use and costs from the procurement cost comparison analysis. You might exclude infrastructure if your site already has sufficient charging access, or if you do not wish to consider these costs when comparing the costs of an alternative procurement. The charging infrastructure ownership structure can be modeled as a cash- or debt-funded purchase. As with vehicle procurement inputs, the tool will automatically disable user inputs that are not needed given the current procurement configuration.

Figure 6: Charging infrastructure and installation inputs

EV Charging Infrastructure Use and Installation Inputs

Procurement 1 (Baseline)	
% Depot/Home Charging	100%
% Public Charging	0%
% En Route Charging	0%
Maximum Power for Public Charging Only (kW)	50.0
Procurement Includes EV Charging?	Yes
Charging Level	DC Fast Charging
Number of EV Charging Stations Needed (#)	5
Charging Equipment Cost ($/Station)	$ 3,800
Construction & Equipment Installation Cost ($/Station)	$ 20,000
Electric Utility Upgrades and Grid Interconnection Cost ($/Site)	$ -
Maintenance Cost ($/Station/Year)	$ 114
Ownership Structure	Purchase (Cash)
Loan	
Cash Upfront / Down Payment ($)	$ -
Loan Term (Years)	0
Interest Rate (APR - %)	0.00%

Rate-Informed Electricity Cost

The rate informed electricity cost model allows users to override the basic energy cost value used by the model with one that is calculated using utility rate structures and a simulated charging electricity demand curve. This module only supports rate structures that have a time of use component. Users can elect to simulate the effect of using management software to reduce peak power consumption, and/or scheduling charging when rates are cheapest.

Rate-Informed Electricity Cost

Procurement 1 (Baseline)

Use Rate-Informed Electricity Cost?	Yes
Use User-Defined Custom Rate Structure?	No
Custom Rate Structure Overrides Utility Rate	
Utility	Southern California Edison Co
Rate Structure Name	Time-Of-Use Agricultural and Pumping-Small to Medium: TOU-PA-2, Option CPP-Lite (at 220kV)
Peak Shave / Demand Charge Management?	No
Operating Days per Year	200
Max Charging Power (kW)	10
Charging Window Start Time	7:00 PM
Charging Window End Time	10:00 AM
Charging Time (hours)	15
Min Time (hours)	3
Automatically determine the interval within the charging window where average electricity cost is cheapest. This process will delay the charging start and often result in lower energy costs.	Optimize Time of Use Delay
Time of Use Delay (hours)	0
Charging Period Start Time (24hr)	7:00 PM
Charging Period End Time (24hr)	10:00 AM
Calculated Rate ($/kWh)	$0.132

- **Use User-Defined Custom Rate Structure** is a flag to determine whether the tool should use predefined rates from a number of electric utilities or a user-defined rate structure. If a user-defined rate structure is enabled, a separate tab will become visible to define the details of that rate structure.
- **Utility** is used to determine available rates to use when user-defined rate structure is disabled. Note, only the top utilities by commercial customer are included in the tool. For other utilities, you must use the user-defined rate structure.
- **Rate Structure Name** identifies the specific charging rate to be applied in the charging curve generated using the above parameters.
- **Calculated Rate** is the output of the module. It is the loaded cost per kWh of energy used by the vehicle(s) modeled in the analysis and supersedes the default electricity rate when the rate informed electricity cost module is selected.
- **Peak Shave / Demand Charge Management** Select yes to simulate the effect of a charging management software set to reduce the peak power load of the charging vehicles.
- **Vehicle Battery Capacity (kWh)** If not populated by the model using values stored in the model, the user must supply a value for the vehicles' battery capacity.

- **Operating Days per Year** The user must estimate how many days a year that the vehicle will be operating. Days operating is used to divide the annual miles model parameter into a daily milage figure, which is then used to estimate daily energy consumption.
- **Max Charging Power (kW)**. The maximum charging power capacity of the vehicle or charging equipment, whichever is lower
- **Charging Window Start Time**. The model only supports a single charging window, which is the interval of time where the vehicle is stationary at the depot or other location that it regularly charges. This is the time when the vehicle can be charging, however, depending on model parameters, it may not charge for that entire period. The start time input is the hour that defines the start of the charging interval and would typically be the point when a vehicle returns to its depot or other charging location.
- **Charging Window End Time**. The end time input is the hour when the charging window ends, or in other words, the vehicle is no available to charge. This is the point when the vehicle leaves its depot or other charging location. Charging window end time can be earlier than charging period start time. When this is the case, the charging period is assumed to be split between two days.
- **Optimize Time of Use Delay**. The model also allows the user to optimize their charging schedule to take advantage of lower time of use demand and energy rates. The model simulates the effect of either delaying plug in time, or setting a timer to delay charging start. Clicking the optimize Time of Use Delay button will cycle through possible charging time delays, checking for which delay produces the lowest average energy cost. Any shift in charging time is reflected in the Charging Period Start Time and Charging Period End Time fields. Users wishing to use this function should click the button after any parameter changes they make in the rate-informed electricity cost module.

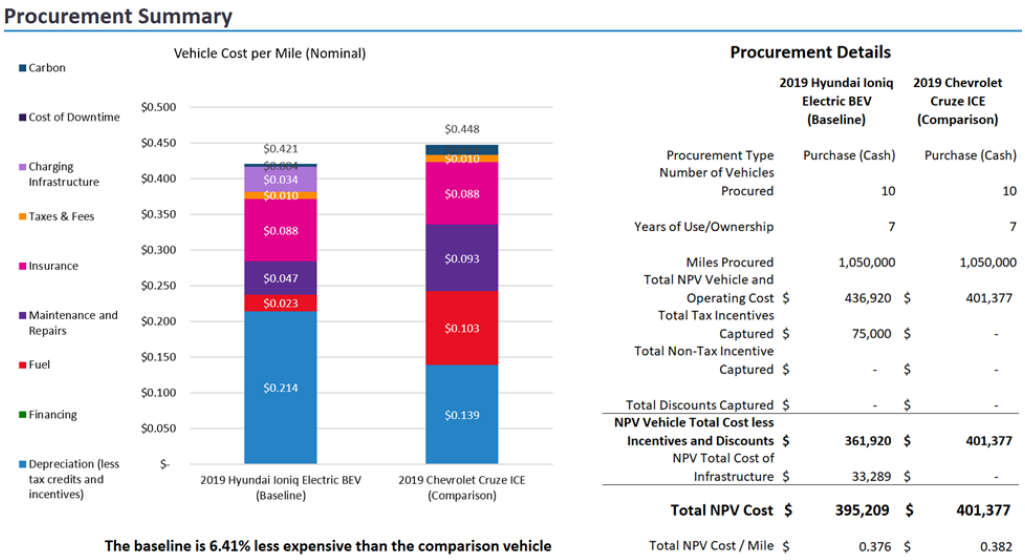
Step 4: Results Tab

This section presents a dashboard report that includes a procurement summary, societal benefit summary, and sensitivity analysis.

Procurement Summary

This section summarizes the financial performance calculations from the *Financial Model* tab. The figure below displays a dashboard with key financial metrics for you to easily assess the difference between the baseline and comparison procurements. The financial metrics include:

- **Vehicle Cost per Distance Traveled (Nominal)**: Shows the cost per mile or kilometer for each vehicle procured, which is the sum costs from charging infrastructure, social cost of carbon, taxes and fees, insurance, repairs, maintenance, fuel, financing, and depreciation (see Box 1).
- **Procurement Details**: Displays a breakdown of the major cost categories for both procurements and the total net present value (NPV) cost, which incorporates the time value of money.



	2019 Hyundai Ioniq Electric BEV (Baseline)	2019 Chevrolet Cruze ICE (Comparison)
Procurement Type	Purchase (Cash)	Purchase (Cash)
Number of Vehicles Procured	10	10
Years of Use/Ownership	7	7
Miles Procured	1,050,000	1,050,000
Total NPV Vehicle and Operating Cost	$ 436,920	$ 401,377
Total Tax Incentives Captured	$ 75,000	$ -
Total Non-Tax Incentive Captured	$ -	$ -
Total Discounts Captured	$ -	$ -
NPV Vehicle Total Cost less Incentives and Discounts	**$ 361,920**	**$ 401,377**
NPV Total Cost of Infrastructure	$ 33,289	$ -
Total NPV Cost	**$ 395,209**	**$ 401,377**
Total NPV Cost / Mile	$ 0.376	$ 0.382

Box 1. Depreciation and Residual Value

The tool uses a simple linear regression based forecast model to predict the residual (or resale) value of light duty electric vehicles based on their age, mileage and all-electric range. We selected this method because it is transparent, interpretable, and simple to implement in an Excel-based tool.

The model predicts the ratio of residual value to MSRP with the following polynomial form:

$$rvRatio = \beta_1 age + \beta_2 age^2 + \beta_3 mileage + \beta_4 electricRange$$

The model was calibrated using the statsmodel Python library based on training data from more than 1,000 used vehicle listings from cars.com. Listing data was enriched with range and MSRP data from fueleconomy.gov.

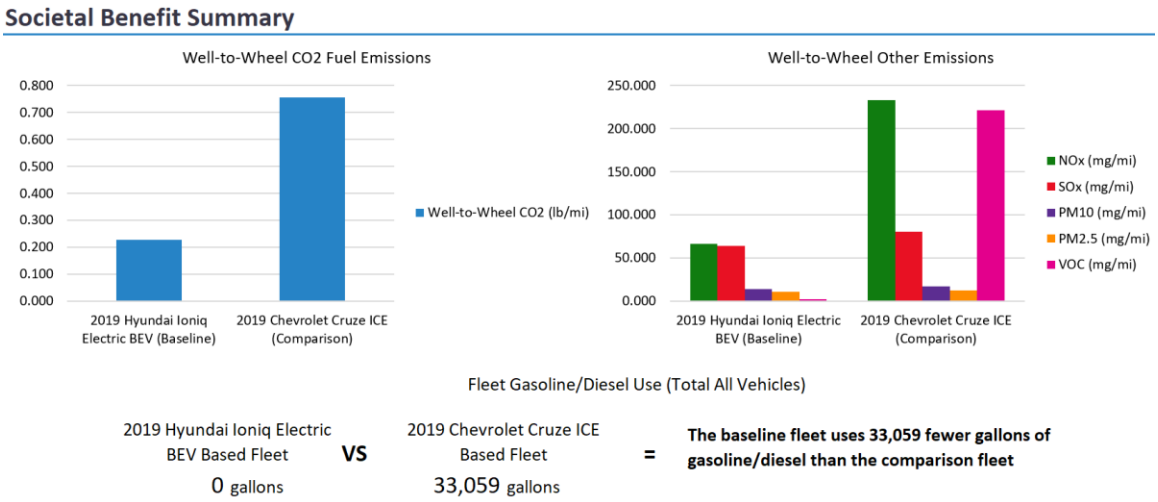
In the tool, the model-estimated parameters for age, age^2, mileage, and all-electric range, are applied to accumulated age and mileage to estimate vehicle residual value ratios for years 1-5. Beginning in year six, the model uses a standard annual percent reduction in value based on the final year reduction, as calculated by the regression analysis. This carries through the remaining years until a vehicle hits "scrap value," which is $300.

For medium- and heavy-duty vehicles, a simple two-step percent reduction was used which follows the calculation from Argonne National Lab's AFLEET Tool. The value is reduced by 23 percent for year zero and by 15 for each subsequent year until year six and beyond when the calculation is the same as light-duty vehicles.

The residual value and whether the vehicles reaches the "scrap value" depends on the Expected Years of Use/Ownership input field.

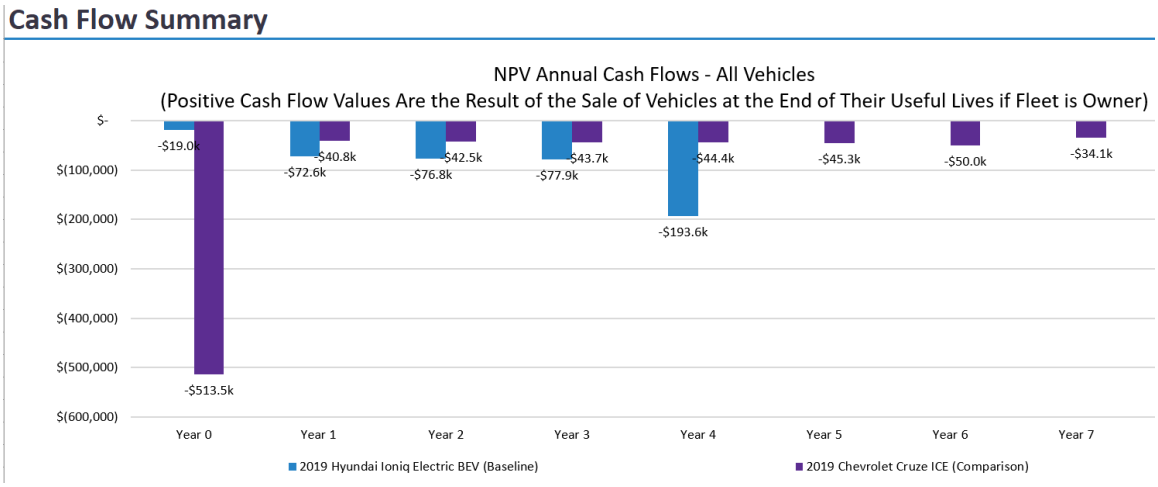
Societal Benefit Summary

This section summarizes the environmental impact calculations in the *Environmental Model* tab. These include a comparison of lifecycle emissions for each of the procurements on a per-vehicle basis, with carbon dioxide emissions highlighted. Also, included in this section is a comparison of total fleet gasoline consumption for each of the procurements.



Cash Flow Summary

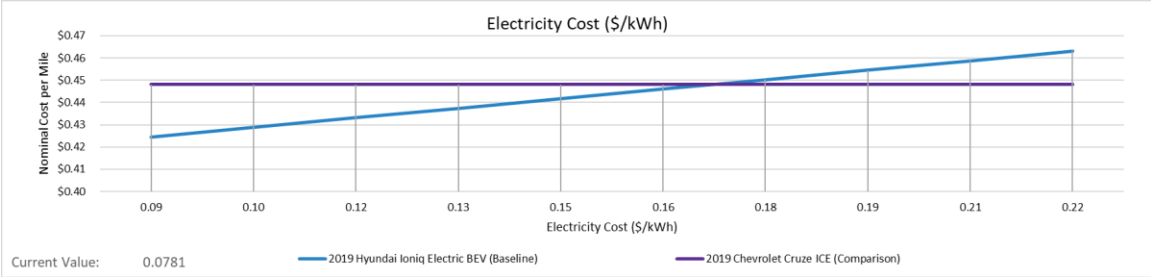
The summary tab also shows the cost comparison of the two procurements by summing incoming and outgoing cash flows over the life of the vehicles and adjusting for the time value of money. A positive cash flow value at the end of the timeframe is from the sale of vehicles at the end of their useful lives, if the fleet owns the vehicles.



Sensitivity Analysis

The figure below shows an example sensitivity analysis demonstrating how changes in the electricity cost ($/kilowatt-hour) affect the procurement's nominal cost-per-distance-traveled on per-vehicle basis. The 'Current Value' for each selected variable in the procurement (e.g., the input value for electricity cost) is shown in the Initial Settings tab.

You can adjust the assumptions for up to four sensitivity analyses at a time in the *Initial Settings* tab. Both the input variables and the minimum and maximum for the sensitivity analysis range can be adjusted.



Step 5: Financial, Environmental, and Billing Models

The modelling tabs show the detailed financial and environmental analyses that is condensed and presented in the *Results* tab. These tabs do not include any user inputs.

Financial Model: The data in this tab gives users detailed year by year evaluations of procurement costs. The tab details discounted costs, vehicle depreciation calculations, capital and financing costs, fuel and operating costs, and infrastructure-related costs from the time of vehicle acquisition through a maximum of 25 years of use. Results for both the baseline and comparison procurement is provided, and is distilled and presented in the *Results* tab.

Environmental Model: The data in this tab gives users detailed per-mile or per-kilometer procurement emissions. The tab compares fuel economy and energy consumption metrics between the baseline and comparison procurement based on annual vehicle distance travelled and local cost assumptions. From this information, carbon dioxide emissions and other lifecycle emissions are assessed on a weight and mass per-mile or per-kilometer basis, respectively. Data for both the baseline and comparison procurement is provided, and is distilled and presented in the *Results* tab.

Billing Model: This tab calculates the cost of electricity using specified electricity rates and a model of vehicle charging energy use and power demand. The model is only active when *Use Rate-Informed Electricity Cost?* Is 'Yes' in the input tab. The model takes inputs on number of vehicles procured, distance traveled annually, number of days in operation, and start and end of charging window, along with model data on vehicle efficiency to estimate daily energy need and simulate charging curves for managed, unmanaged, and time delayed charging curves. Then the tool, using user provided or included utility rate information, passes those rates through a bill calculation to return the total annual bill and cost per kilowatt-hour.

Data Management

The *Data* tabs contain the source data for all fields automatically populated in the tool. None of this data is updated automatically. The tool directly references cells in this tab and you should use caution when editing these data. Editing default data fields, which are shaded in light green, is best done directly on the *Inputs* tab. Data will be updated in the tool whenever possible.

Appendix A: Input Fields Descriptions

This appendix describes each user input field. The Fleet Procurement Analysis Tool has four categories of inputs: Market Inputs, Vehicle Inputs, Vehicle Procurement Inputs, and EV Infrastructure Inputs. Inputs can be either directly entered by the user or automatically filled out by the tool, as denoted in the tables below by User and Default, respectively. For inputs automatically filled out by the tool, users can customize the value for more accurate results.

Market Inputs

Input Field	Type	Market	Description
Market	Default	All	Select U.S. or Canada to set the tool for the appropriate region. This setting will determine if the tool will use imperial or metric measurements along with other geographic-specific factors.
ZIP Code	Default	U.S.	Any U.S. ZIP code. Default values for electricity and gasoline prices, emissions factors, and EV state incentives depend on the ZIP code. Enter 00000 for the national average.
Canadian Province	Default	Canada	Select a Canadian Province.
Gasoline and Diesel Price ($/Gallon)	Default	U.S.	Default gasoline and diesel price is the average price for last year available from U.S. Energy Information Administration and set based on ZIP code. Some prices are available at state level, while others are available at regional level (PADD).
Gasoline Price ($/Liter)	Default	Canada	Default gasoline cost is average price for the last year available from Natural Resources Canada and set based on a representative city from each province or territory.

Input Field	Type	Market	Description
Electricity Cost ($/kWh)	Default	U.S.	Default electricity cost is aggregated by state and the price is calculated based on revenue and energy delivered for commercial customers for last year available from U.S. Energy Information Administration's survey of electric utilities (EIA-861M).
Electricity Cost ($/kWh)	Default	Canada	Default electricity cost is the price for a representative city from each province or territory, as defined by an annual report from Hydro Quebec.
Public Charging Price ($/kWh)	Default	U.S.	Default public charging price is used for analyses where vehicles are charged in public some share of the time.
En Route Charging Price ($/kWh)	Default	U.S.	Default charging price for vehicles that are charged en route at other company-owned facilities. This price is relevant for analyses where vehicles are charged en route some share of the time.
Inflation Rate (Excluding Fuel) (%/Year)	Default	U.S.	Inflation rate is used for maintenance and other operating costs, excluding fuel. Default inflation rate is based on Federal Reserve's medium term target (2015). Inflation for fuel is based on data from U.S. Energy Information Administration.
Inflation Rate (Excluding Fuel) (%/Year)	Default	Canada	Inflation rate is used for maintenance and other operating costs, excluding fuel. Default inflation rate is average from 2017-2027 from Canada's Energy Future Report.
Cost of Downtime from Public Charging ($/Hour)	Default	U.S.	The cost of downtime from public charging is used to consider the time of value of money associated with vehicle charging while in public while drivers are "on the clock."

Input Field	Type	Market	Description
Include Cost of Carbon?	User	All	Optionally include a cost of carbon in the financial analysis.
Cost of Carbon ($/Metric Ton)	Default	U.S.	The default cost of carbon is the social cost of carbon in 2020 using a 3% discount rate, as defined by the U.S. federal government in 2016.
Cost of Carbon ($/Tonne)	Default	Canada	The default cost of carbon is the social cost of carbon using a 3% discount rate as defined by the Environment and Climate Change Canada.

Vehicle Inputs

Input Field	Type	Market	Description
Type of Vehicle	User	All	Database of vehicles includes battery size; electric range; fuel economy; MSRP; and insurance, maintenance, and repair costs. The tool also allows users to specify a "custom" vehicle. Users can enter custom values for more precise results.
Fuel Economy Gas City (MPG)	Default	U.S.	The default value is the city fuel economy when powered by gasoline for the selected vehicle from www.fueleconomy.gov. This field is not relevant for battery electric vehicles.
Fuel Consumption Gas City (L/100 km)	Default	Canada	The default value is the city fuel consumption when powered by gasoline for the selected vehicle from the Fuel Consumption Report. This field is not relevant for battery electric vehicles.
Fuel Economy Gas Hwy (MPG)	Default	U.S.	The default value is the highway fuel economy when powered by gasoline for the selected vehicle from www.fueleconomy.gov. This field is not relevant for battery electric vehicles.

Input Field	Type	Market	Description
Fuel Consumption Gas Hwy (L/100 km)	Default	Canada	The default value is the highway fuel consumption when powered by gasoline for the selected vehicle from the Fuel Consumption Report. This field is not relevant for battery electric vehicles.
Fuel Economy Electric City (MPGe)	Default	U.S.	The default value is the city fuel economy when powered by batteries for the selected vehicle from www.fueleconomy.gov. This field is not relevant for gasoline vehicles.
Fuel Consumption Electric City (Le/100 km)	Default	Canada	The default value is the city fuel consumption when powered by batteries for the selected vehicle from the Fuel Consumption Report. This field is not relevant for gasoline vehicles.
Fuel Economy Electric Hwy (MPGe)	Default	U.S.	The default value is the highway fuel economy when powered by batteries for the selected vehicle from www.fueleconomy.gov. This field is not relevant for gasoline vehicles.
Fuel Consumption Electric Hwy (Le/100 km)	Default	Canada	The default value is the highway fuel consumption when powered by batteries for the selected vehicle from the Fuel Consumption Report. This field is not relevant for gasoline vehicles.
Expected Years of Use/Ownership (Years)	Default	All	The default value is seven and users can customize this value to their expected years of vehicle use and ownership.
Annual Vehicle Mileage (VMT/Year)	Default	U.S.	The default value is 15,000 and users can customize this value to their expected number of miles traveled per year. The 15,000 value for annual vehicle mileage is the assumption used by Edmunds True Cost to Own calculator.

Input Field	Type	Market	Description
Annual Vehicle Mileage (VKT/Year)	Default	Canada	The default value is 24,135 km and users can customize this value to their expected number of kilometers traveled per year.
% of Annual Miles or Kilometers on Gasoline	Default	All	Default value is 100% for gasoline vehicles and 0% for battery electric vehicles. For plug-in hybrids, value is a function of electric range and expected daily vehicle miles or kilometers traveled. It is assumed the vehicle only charges once per day.
% of Annual Miles or Kilometers City Driving	Default	All	The default value is 55%, based on the U.S. Environmental Protection Agency's method for calculating fuel economy.
Cost to Insure ($/Year)	Default	U.S.	Average passenger car insurance costs from AAA 2017 Your Driving Cost Study. Users can set custom values that are more accurate.
Cost to Insure ($/Year)	Default	Canada	Average passenger car insurance costs from Table 3 of 2016 study on Auto Insurance System in Ontario.
Recurring Taxes and Fees ($/Year)	User	All	Annual taxes or other recurring fees for vehicle ownership, such as vehicle registration fees.
Use Drivetrain Default Maintenance and Repair Costs?	User	All	Whether to use the default maintenance costs for the selected drivetrain as defined in the database. Select "No" to use custom values.

Input Field	Type	Market	Description
Maintenance and Repair Cost - Years 1 - 5 ($ per Mile or Kilometer)	Default	All	Default costs for the first five years of use are based on vehicle drivetrain. Users can set custom values that are more accurate.
Maintenance and Repair Cost - Years 5+ ($ per Mile or Kilometer)	Default	All	Default costs after year five of use, based on vehicle drivetrain. Users can set custom values that are more accurate.

Vehicle Procurement Inputs

Input Field	Type	Description
Discount Rate for NPV Calculations (%)	User	The time value of money used for financial calculations.
Number of Vehicles to Procure (#)	User	The total number of vehicles to acquire.
Pricing Approach (select one)	User	Vehicle pricing could be from the “MSRP down” or the “dealer cost up.” MSRP pricing could include a discount and dealer cost (also known a triple net) could include a dealer markup.
MSRP ($/Vehicle)	Default	The price per vehicle. The default depends on the vehicle selection and users can set a custom value to reflect local pricing.

Input Field	Type	Description
Value of Negotiated Discounts off MSRP ($/Vehicle)	User	Per vehicle discount from automaker, auto dealer, or other party in the procurement. This field is only valid when using the "MSRP down" pricing approach.
Dealer Triple Net Price ($/Vehicle)	User	The price per vehicle. The triple-net price is the auto dealer invoice price minus any benefits that the dealer receives from the automaker when buying the vehicles.
Dealer Markup ($/Vehicle)	User	A markup above the triple-net price intended to be passed on to the auto dealer. This field is only valid when using the "dealer cost up" pricing approach.
Value of Federal Tax Incentives ($/Vehicle)	Default	Federal electric vehicle tax credit set based on the vehicle selection. The user can overwrite this value if only a portion of the benefit is being captured in the procurement.
Value of State Tax Incentives ($/Vehicle)	Default	State electric vehicle incentives for public fleets, set based on the vehicle selection and state. The user can overwrite this value if only a portion of the benefit is being captured in the procurement.
State Tax Incentive Cap ($)	User	The maximum funding amount of a state incentive that can be used by a fleet in a procurement.
Value of Non-tax Incentives ($/Vehicle)	User	Value of other per-vehicle incentives, such as state grants or incentives from an automaker or third-party.
Initial Tax, Title, and Registration Cost ($/Vehicle)	User	Upfront fixed fees for vehicle purchase, which can vary locally.
Initial Fee as Percent of	User	Upfront fee as a percentage of the vehicle Base Price, such as a sales tax.

Input Field	Type	Description
Vehicle Base Price (%)		
Include Utility Value Stream (Demand Response or Grid Service)?	User	Select “Yes” if you wish to enter precalculated value stream income (e.g., demand response) from the utility.
Estimated Net Income from Utility Program (Nominal)	User	Input estimated net income from a utility program, ensuring to subtract any additional costs that program might cause (such as additional battery wear, etc.). This net income must be estimated outside of the tool.
Income Period	User	Select whether the estimated net income is to be accumulated on an annual or monthly basis.
Include Fuel Carbon Credits?	User	The estimated annual change in net income from the utility program.
Include Fuel Carbon Credits?	User	Select "Yes" to include fuel carbon credits (e.g., LCFS) in the procurement. This is only valid in California or Oregon at present.
Electricity Carbon Intensity (grams CO2e/MJ)	User	Enter the carbon intensity (grams of CO2e/MJ) of the electricity used to charge EVs. Carbon intensity pathways for electricity are made available by the State of California and the State of Oregon.
Start Year	User	Enter the start year of the procurement, which is used to determine the carbon intensity regulatory target (aka benchmark).
Carbon Credit Value by Year (Nominal)	User	Enter in the estimated value you expect to be able to sell credits for by year from Year 0 to Year 10. Year 10 values are used for all subsequent dates. Any year after the maximum year is constant.
Ownership Structure	User	Ownership structure selection, including various leasing and purchasing options. Fields will be

Input Field	Type	Description
		enabled depending on the user's selection. Detailed descriptions of each ownership structure are found in the *Instructions* tab of the tool.
Tax Credits Can Be Monetized? (Y/N)	User	Setting this value to "Yes" will pass along the state and federal tax credits to the fleet as part of the procurement.
Down Payment ($/Vehicle)	User	Down payment in cash for each vehicle.
Lease Term (Years)	User	Lease and/or loan term cannot exceed the expected years of ownership. For tax-exempt lease-purchase or leases where the purchase option is not pursued, the lease term must equal the years of ownership.
Interest Rate (APR - %)	User	Interest for leases is often discussed in a format call "Money Factor," which is the annual percentage rate (APR) divided by 2,400. Users can input either APR or money factor and the tool will automatically calculate the other.
Money Factor (#)	User	
Acquisition Fee ($/Vehicle)	User	An acquisition fee is also known as an initiation fee or a bank fee if the lessor is a bank rather than a dealer.
Disposition Charge ($/Vehicle)	User	Fee to cover the expense of cleaning up and selling the car after it is returned at the end of the lease.
Negotiated Residual Value ($/Vehicle)	User	Value of the vehicle at the end of the lease term. For a Tax-Exempt Lease Purchase, the residual value must equal $1.
Mileage Included (Closed-End Only)	User	Annual mileage allowed for in the lease agreement.

Input Field	Type	Description
Excess Mileage Cost ($ per Mile or Kilometer)	User	Cost per mile or kilometer above the mileage included in the lease agreement.
Loan Term (Years)	User	Lease and/or loan term cannot exceed the expected years of ownership. For tax-exempt lease-purchase or leases where the purchase option is not pursued, the lease term must equal the years of ownership.
Interest Rate (APR - %)	User	Annual interest rate for the lease.

EV Infrastructure Use and Installation Inputs

Input Field	Type	Description
% Depot/Home Charging	Default	The share of charging done at the home base of the vehicle. The default is 100%.
% Public Charging	User	The share of charging done at publicly available charging stations.
Charging Level	User	The charging level (Level 2 or DC fast charging). This informs the maximum power and charging costs for projects with infrastructure.
Maximum Power for Public Charging Only (kW)	Default	The maximum power for a public charging station. Used to calculate the cost of charging due to downtime while drivers are “on the clock.”
Procurement Includes EV Charging?	User	Whether EV charging stations should be included in the financial calculations of the procurement.
Number of Level 2 EV Stations Needed (#)	Default	The total number of Level 2 charging stations. The default value is the number of vehicles in the procurement.

Input Field	Type	Description
Equipment and Installation Cost ($/Station)	Default	The equipment and installation cost per station. The default value is $5,000, which assumes $2,000 for equipment and $3,000 for installation. Costs are site-specific and it is recommended to investigate local costs and use more accurate cost figures here.
Maintenance Cost ($/Station/Year)	Default	The annual maintenance cost per year for station upkeep. The default value is $75 per year, or 3% of the equipment cost.
Ownership Structure	User	Setting to either pay for the charging stations through a cash purchase or loan.
Cash Upfront / Down Payment ($)	User	The down payment on the loan for the charging stations.
Loan Term (Years)	User	Length of loan in years.
Interest Rate (APR - %)	User	Annual interest rate for the loan.

Rate Informed Electricity Cost Inputs

Input Field	Type	Description
Use Rate-Informed Electricity Cost?	User	This tool supports commercial rate structures with TOU/TOD billing components only. If a non-default rate structure is needed, see “Loading Additional Rates” documentation for guidance on how to load additional rates into model.
Use User-Defined Custom Rate Structure?	User	Select "Yes" to use a custom rate structure. Custom rates must be entered in the 'Custom Utility Rate' tab.
Utility	User	Select a utility to use a specific rate structure provided by the utility.

Input Field	Type	Description
Rate Structure Name	User	Select a rate structure from the selected utility.
Peak Shave / Demand Charge Management?	User	Select “Yes” to enable a demand charge management simulation that will automatically schedule charging to reduce peak energy usage. This simulated management will usually result in a lower energy cost than unmanaged charging.
Operating Days per Year	User	Enter the number of days per year (100-365) that the vehicle(s) will operate.
Max Charging Power (kW)	User	The maximum power in kilowatts that a single charger can deliver at a set time window.
Charging Window Start Time	User	The charging window is the period of time when the vehicle is idle at its charging location and can be plugged in and charging. Start Time defines the first hour of that window.
Charging Window End Time	User	End time defines the last hour of the charging window.
Optimize Time of Use Delay	Button	Automatically determine the interval within the charging window where average electricity cost is cheapest. This process will delay the charging start and often result in lower energy costs.

Appendix B: Version History

Version	Date	Author	Organization	Revisions
1.00	5/30/2017	Philip Quebe	The Cadmus Group, Inc.	First launch
1.05	6/1/2017	Philip Quebe	The Cadmus Group, Inc.	Minor bug fixes: sensitivity analysis and EV infrastructure inputs
1.06	7/3/2017	Nick Nigro	Atlas Public Policy	Added support for U.S. average emissions and fuel prices. Use ZIP Code 00000 to set to U.S. average. Added support for more comprehensive vehicle selection and vehicle incentives. Improved robustness of some table lookup calculations. Added link to vehicle details on fueleconomy.gov.
1.07	9/5/2017	Nick Nigro	Atlas Public Policy	Fix to allow users to add custom vehicles to "DB_Vehicles" table.
1.08	10/2/2017	Nick Nigro	Atlas Public Policy	Added support for Canadian market (metric system, Canadian province-specific data, etc.). Moved remaining hardcoded defaults to Data tab to make it easier for users to customize them. Speed up user experience when editing inputs. Updated GREET figures for gasoline emissions. Updated U.S. insurance costs. Argument files created with previous version of the tool will not work correctly.
1.09	11/17/2017	Philip Quebe	The Cadmus Group, Inc.	Improvements to sensitivity analysis functionality. Added ability to model both baseline and

Version	Date	Author	Organization	Revisions
				comparison scenarios in a single sensitivity chart. Simplified and organized sensitivity selection options.
1.10	12/4/2017	Philip Quebe	The Cadmus Group, Inc.	Backend code improvements
1.11	1/17/2018	Nick Nigro	Atlas Public Policy	Add significantly more U.S.-based light-duty vehicles (over 2,000). Updated fuel price data for 2017.
1.12	4/12/2019	Nick Nigro	Atlas Public Policy	Update data through 2018 for U.S. and Canadian markets.
1.13	6/17/2019	Nick Nigro	Atlas Public Policy	Fixed bug with calculating costs for Purchased (loan) when lease year is set to a non-zero value.
1.14	9/17/2019	Nick Nigro	Atlas Public Policy	Upgrade to support medium- and heavy-duty vehicles. Fixed bug with calculating maintenance costs for Canadian market. Updated vehicle incentives for light-duty vehicles to remove federal incentive for Tesla and General Motors. Added vehicles for model years 2019 and 2020.
1.15	11/20/2019	Nick Nigro	Atlas Public Policy	Fixed bug with custom vehicle selection.
1.16	12/11/2019	Nick Nigro	Atlas Public Policy	Fixed bug with vehicle selection.
1.17	2/12/2020	Nick Nigro	Atlas Public Policy	Updated fuel prices for 2019, vehicle availability through February 2020, and eGrid for 2018. Fixed bugs with cash flow chart and Load/Save feature.

Version	Date	Author	Organization	Revisions
1.18	11/30/2020	Nick Nigro, Charles Satterfield	Atlas Public Policy	Improved descriptions in tool. Corrected emissions factor for NOx emissions for heavy-duty vehicles. Added many more vehicles to vehicle database from fueleconomy.gov and Atlas database of medium- and heavy-duty vehicles. Updated light-duty vehicle depreciation calculation for BEVs to reflect resale data from 2015-2019. Updated light-duty vehicle insurance costs and charging infrastructure costs. Updated medium- and heavy-duty vehicle maintenance costs using the 2019 version of AFLEET.
1.19	4/7/2021	Nick Nigro, Josh Rosenberg	Atlas Public Policy	Updated data for U.S. and Canadian market for fuel prices, vehicles available, incentives, and inflation.
1.20	4/9/2021	Nick Nigro, Josh Rosenberg	Atlas Public Policy	Resolved issue related to incorrect emissions modeled for Canadian provinces.
1.21	9/14/2021	Josh Rosenberg	Atlas Public Policy	Updated vehicle availability and state incentives. Resolved issue where users were unable to select a charging level. Added license.
1.22	11/10/2021	Nick Nigro	Atlas Public Policy	Corrected error in calculation of electricity prices from EIA.
1.23	11/16/2021	Nick Nigro	Atlas Public Policy	Resolved regression with Save/Load settings.

Version	Date	Author	Organization	Revisions
1.24	11/30/2021	Nick Nigro	Atlas Public Policy	Resolved another regression with Save/Load settings. Add Diesel Price to sensitivity variables.
1.25	10/7/2022	Nick Nigro	Atlas Public Policy	Fixed formula for loan calculation. Previous calculation was attempting to do monthly accrual of principle and interest payments. This was inaccurate since the model is annual. This change affected loan calculations for vehicles and infrastructure. Also, updated data for 2022.
1.26	2/28/2023	Nick Nigro	Atlas Public Policy	Resolve issue with emissions calculations.
1.30	3/16/2023	James Di Filippo, Josh Rosenberg, Nick Nigro	Atlas Public Policy	Added in Billing Model to calculate electricity price based on custom charging billing setup. Added in LCFS Model to include inputs for Utility Value income and carbon fuel credits. Updated data for multiple sources. Resolved error in calculation of Canadian maintenance prices.
1.31	5/2/2023	James Di Filippo, Nick Nigro	Atlas Public Policy	Resolved issues with custom rates in billing model module. Correct error with User-Defined Custom Rate Structure when the Workbook structure is protected.
1.32	3/5/2024	James Di Filippo, Nick Nigro	Atlas Public Policy	Updated maintenance costs with results from 2021 Argonne National Laboratory study. Updates to depreciation calculation for BEVs using new used vehicle data. Updates to fuel prices for 2023. Added more new vehicle

Version	Date	Author	Organization	Revisions
				models for model year 2023 and 2024.

Appendix C: License

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