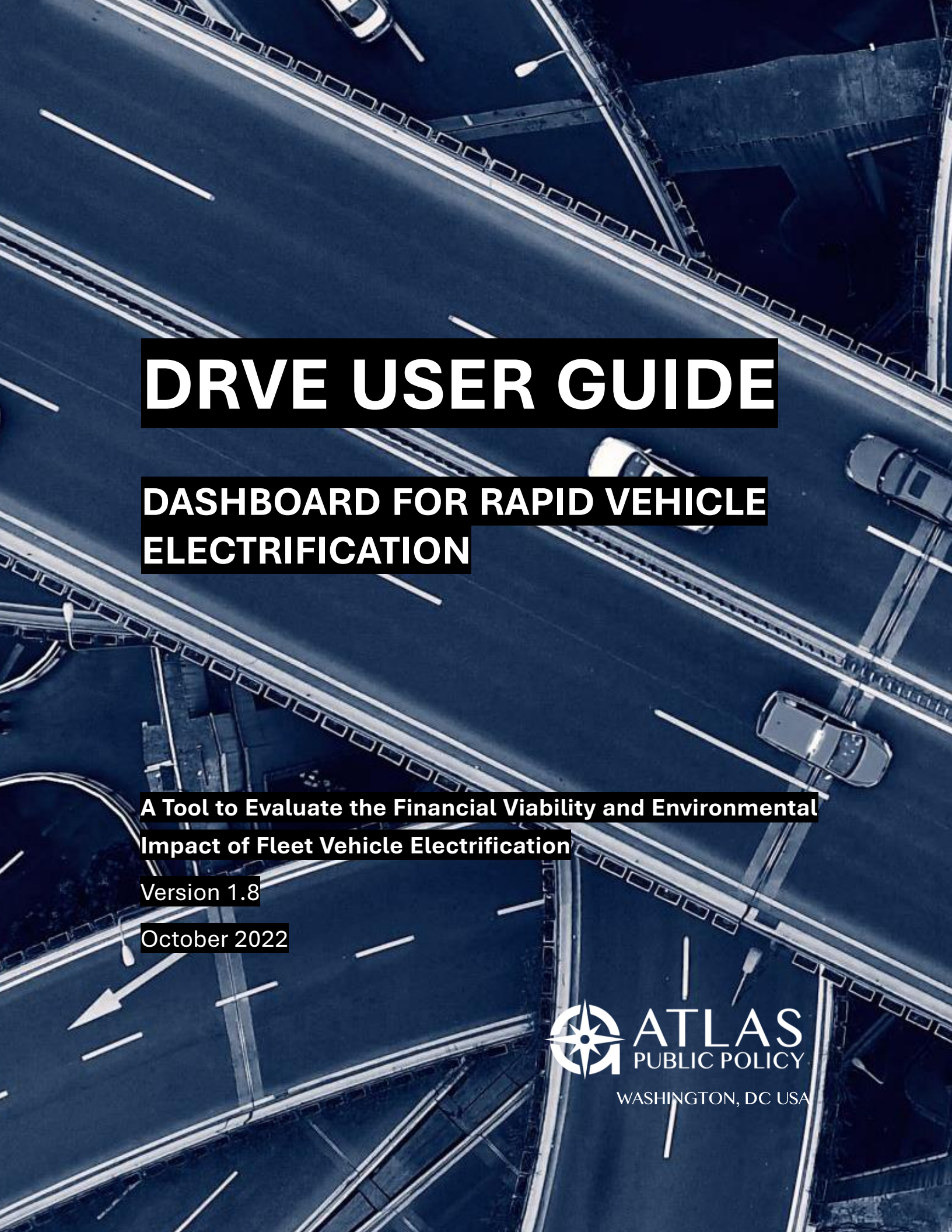


DRVE USER GUIDE

DASHBOARD FOR RAPID VEHICLE ELECTRIFICATION

A Tool to Evaluate the Financial Viability and Environmental Impact of Fleet Vehicle Electrification

Version 1.8

October 2022

ATLAS PUBLIC POLICY

WASHINGTON, DC USA

Contents

About DRVE

Dashboard for Rapid Vehicle Electrification, or DRVE, is a powerful tool that equips users with decision-relevant information on the financial viability and environmental impact of light-, medium-, and heavy-duty vehicle fleet procurements across an entire fleet. The Microsoft Excel-based tool can evaluate a variety of procurement ownership structures, vehicle types, electric vehicle charging configurations, and many more scenarios.[1]

In a nutshell, the tool allows users to import all fleet vehicles and compare a fleet's conventional vehicles with an electric vehicle (EV) alternative. The analysis compares vehicles on a total cost of ownership basis along with well-to-wheels emissions based on regional electrical grid characteristics.

The tool is highly flexible and supports customizable market, charging, and procurement settings. The results of the tool can be explored directly within DRVE or imported for use by dashboarding software like Microsoft Power BI.

DRVE was created with support from the Electrification Coalition. See below for contact information for any questions about using DRVE.

Contact at Atlas Public Policy

Spencer Burget
Policy Analyst
Spencer.burget@atlaspolicy.com

[1] DRVE is limited to 1 million scenarios for a single analysis, though it is recommended that you limit the number of scenarios to optimize runtime.

Operating System and Excel Compatibility

Supported Operating Systems

The following operating systems and versions are supported:

- Windows 10

Supported Excel Versions

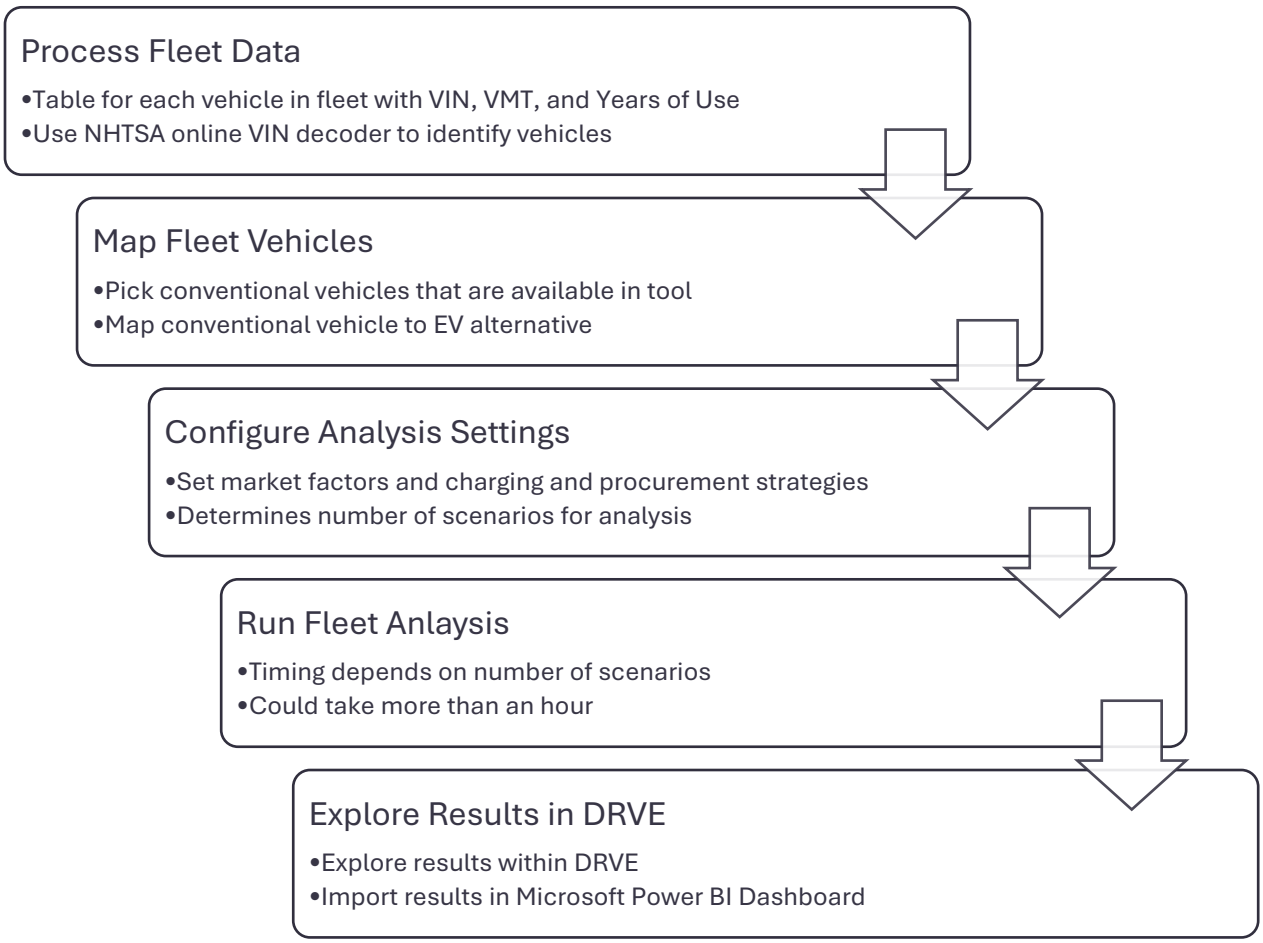
The following operating systems and versions are supported:

- Excel 2019
- Excel 2016

Overview of the Tool Structure

DRVE was built using Microsoft Excel and is presented as a stand-alone application. The user follows 5 steps to run their analysis:

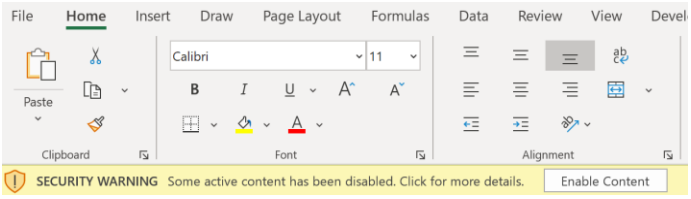
1. **Load Data:** The user will load their fleet's data by identifying required fields needed to load the data.
2. **Map Vehicles:** The user will create a mapping for each of their unique vehicles to the vehicle options that will be procured in place of them.
3. **Set Options:** The user will add various settings such as fuel costs, charging scenarios, and vehicle ownership structures.
4. **Run Analysis:** The tool will run the analysis with no actions required from the user.
5. **View Results:** The user will view their results in a sophisticated dashboard.



Getting Started

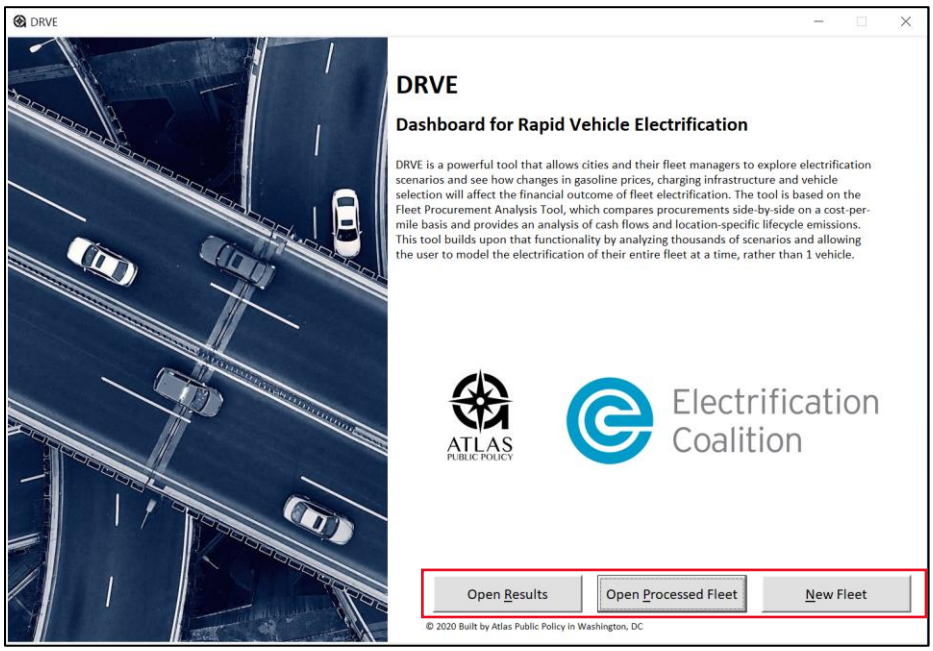
Step 1: Open the Tool

DRVE is a single Microsoft Excel file ("DRVE.xlsm"). In case it does not launch automatically, and a Microsoft Excel workbook is shown, you may need to select "Enable Content" and "Enable Editing" buttons that appear in the yellow bar below Excel's toolbar (see screenshot below).



You may also need to manually enable macros depending on your system configuration (see Box 1). Once you've cleared the warning(s), DRVE should open automatically; click the "Launch DRVE" button if not.

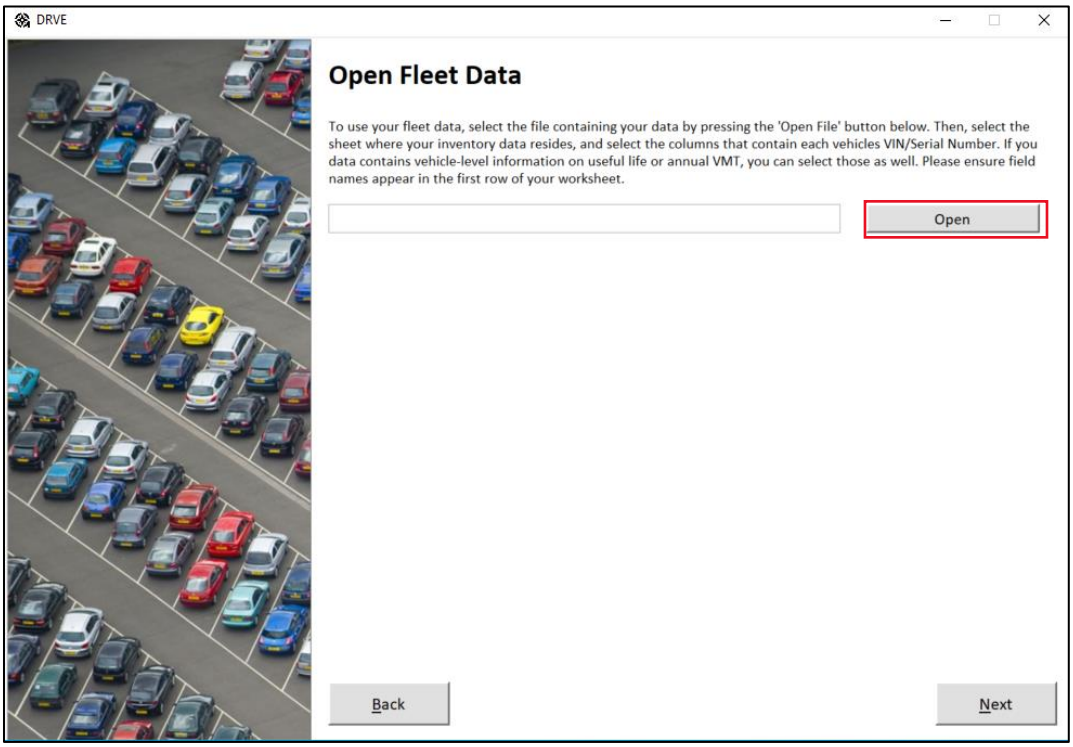
Below is the main launch screen of DRVE. Select "Open Results" to view the results of a previous analysis in an Excel dashboard. Select "Open Processed Fleet" to analyze a fleet already processed; selecting this option will allow the user to skip *Step 2: Process Fleet Data* and go to *Step 3: Map Fleet* Vehicle. Click "New Fleet" to open a file of individual vehicles for processing and vehicle mapping.



Box 1. Enabling Macros in Microsoft Excel

Macros must be enabled to use DRVE. You may need to manually enable them depending on your configuration of Microsoft Excel. To enable macros, go to File -> Options -> Trust Center -> Macros -> Enable Macros. This experience may vary depending on the version of Microsoft Excel you are using. For more information, visit Microsoft's support page here.

Step 2: Process Fleet Data



For new fleets, we must identify the vehicle makes and models for all vehicles. The data used must contain the vehicle identification number (VIN) for each vehicle to be analyzed. It can also include per-vehicle annual miles traveled and the expected years of use for the vehicle.

Currently, the tool supports Excel and CSV (comma-separated values) files. For Excel files, the user should ensure the following is true for the data being used:

- The data is contained in a single sheet, with valid column headers and rows for each vehicle.
- Column headers should be in the first row of the worksheet.

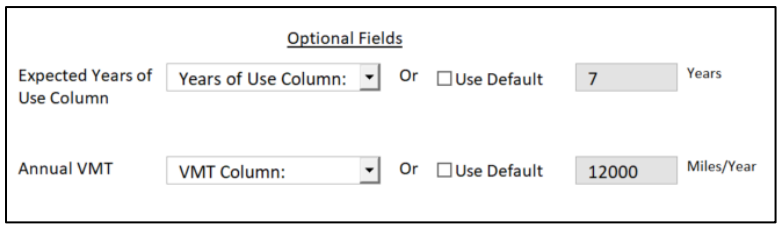
- There should be no additional data beneath the fleet inventory data.

First, press the "Open" button to open the fleet data file in CSV or Excel format. DRVE will then process your fleet file to determine if it can be used. Following processing, the "Required Fields" appears (see below). If an Excel file was selected, the "Inventory Worksheet" dropdown will populate with the names of the worksheets (tabs) in the workbook selected.

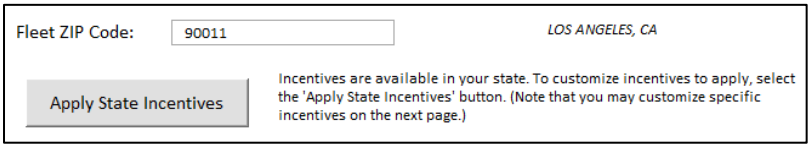
The "VIN/Serial Number Column" is a required column where the VIN for each vehicle in the fleet is located. DRVE decodes the vehicle make and models from the VINs to map those vehicles to ones available within DRVE along with their electric alternatives.

After selecting a valid VIN/Serial Number column, the "Optional Fields" section will become visible. The two optional fields are:

- **Expected Years of Use**: An integer representing the expected years of useful life for each vehicle in the fleet. This value is used to calculate the total cost of ownership across the vehicle's useful life. Select a column containing this value or set a default to be used across all vehicles.
- **Annual VMT**: The average annual vehicle miles traveled for each vehicle in the fleet. Select a column containing this value or set a default to be used across all vehicles.

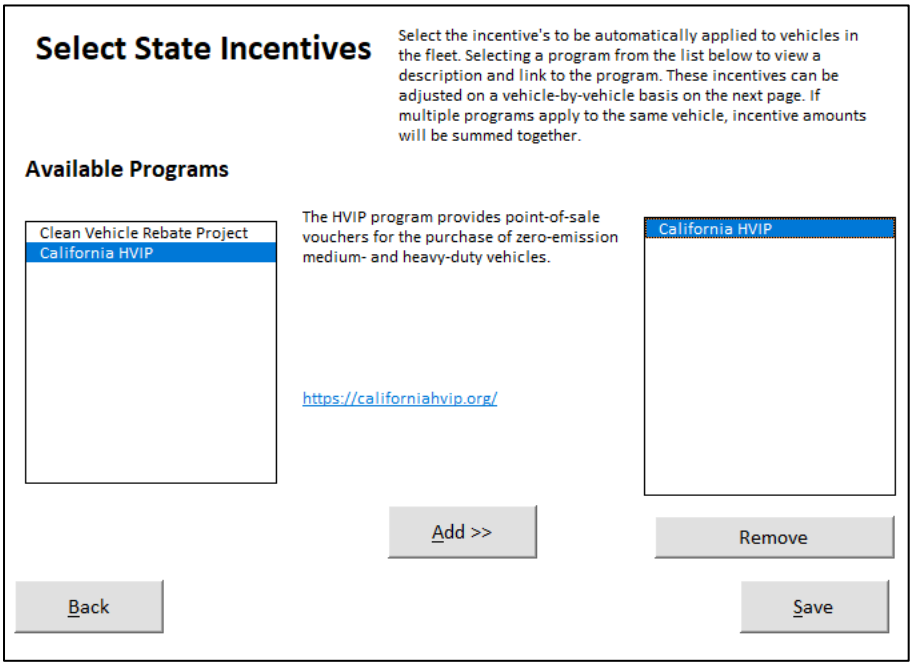


Lastly, there is an option to apply state incentives. Enter the fleet ZIP code, and the Apply State Incentives Button will light up if there are incentives available in the state.[2]



[2] Note that local/utility incentives and competitive grant programs are not included.

Click Apply State Incentives to view the incentives available in the state. Click on an available program to view a brief description and a link to the program website. If the fleet is eligible for the program, click Add >> to use the incentive to the analysis. The tool will automatically apply the appropriate incentive value to eligible vehicles based on the vehicle class. The incentive amount for each vehicle can be edited in the next step. When done adding incentives, click Save to return to the Fleet Data window.



Once completed, you can click “Next” to begin fleet processing.

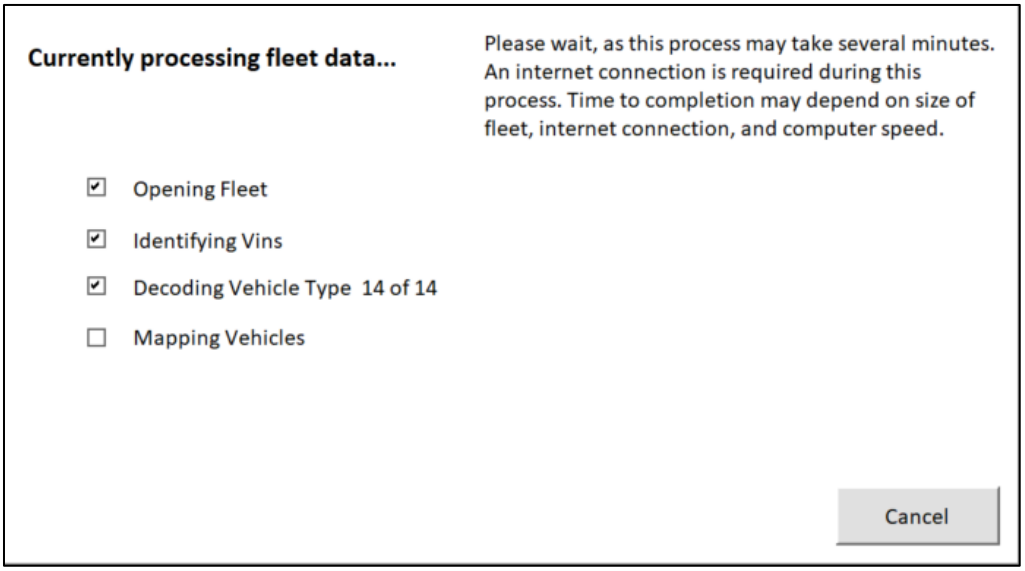
Processing the Fleet

Processing a fleet is completed in three steps. First, the data from the fleet is imported; second the VINs from the fleet are decoded; and finally, the fleet vehicles are mapped to conventional vehicles (Baseline Vehicle) found within DRVE along with their electric alternatives (EV Replacement Vehicle).

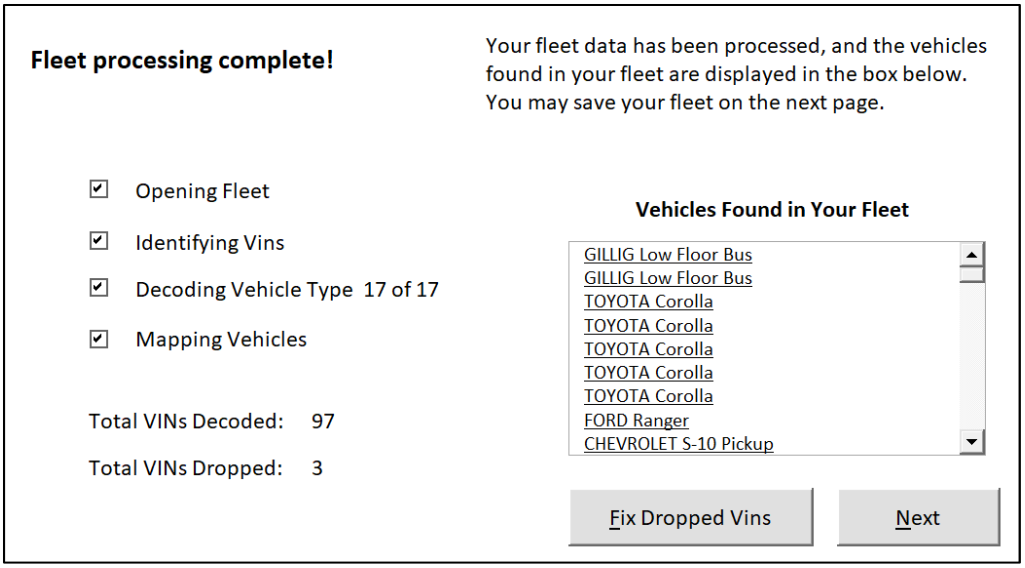
Note, DRVE uses the VIN decoding service provided by the National Highway Traffic Safety Administration (NHTSA) known as vPIC; see Box 2 below.

Box 2. VIN Decoding process using vPIC

VIN decoding is needed to identify vehicle makes and models from fleet data. A VIN is a unique set of characters that is issued by manufactures to identify vehicle model year, drivetrain, weight class, and more. Each unique VIN prefix (first 10 characters) represents a unique vehicle type and only needs to be decoded once, rather than decoded for each fleet vehicle. DRVE uses NHTSA's publicly available vPIC tool to decode VINs and generate a consistent naming process across all vehicles. The service has a 24/7 uptime, but occasionally will be down for maintenance. If the NHTSA service is unavailable or is down for maintenance, the fleet processing step will fail and DRVE will display an error message. More information on VPIC is here: https://vpic.nhtsa.dot.gov.

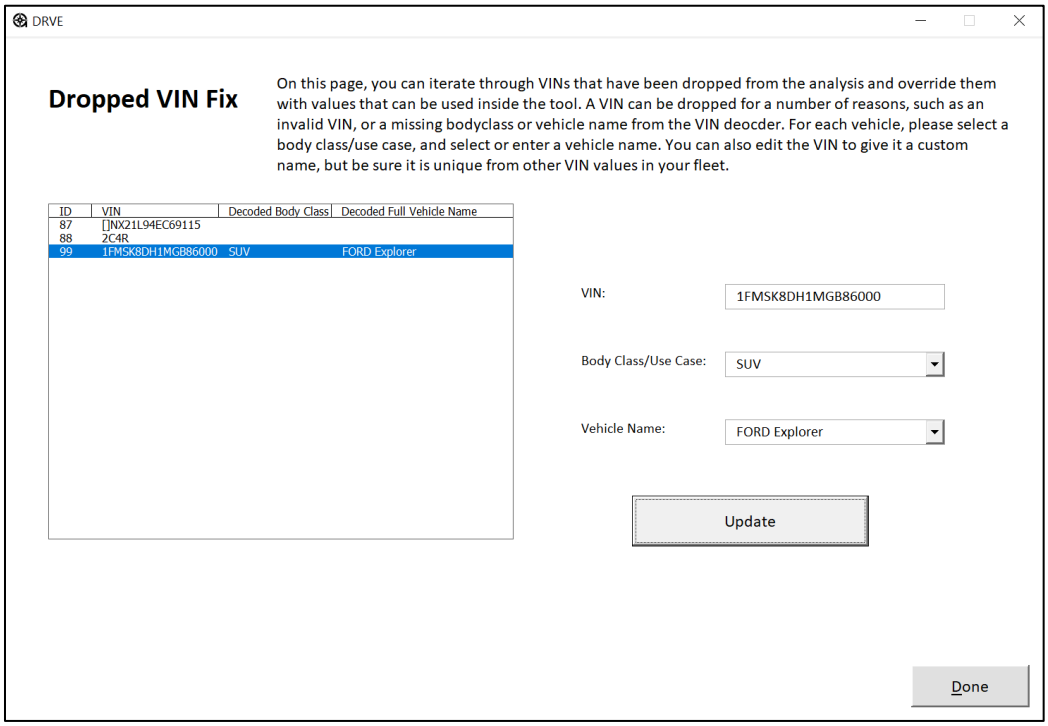


Below is a screenshot of the message will be shown when the fleet is being processed by the tool. The progress of this processing will be marked as each sub task is checked off. Once the fleet has been processed, identified vehicles will appear on the right-hand side of the window. The tool then notifies the user of how many VINs have been decoded, and how many have been dropped. A VIN will be dropped if it is in an invalid format or the decoding of it results in an error. If you do not want to fix any dropped VINs, the next step is to view and customize the vehicle mapping that DRVE created for your fleet.



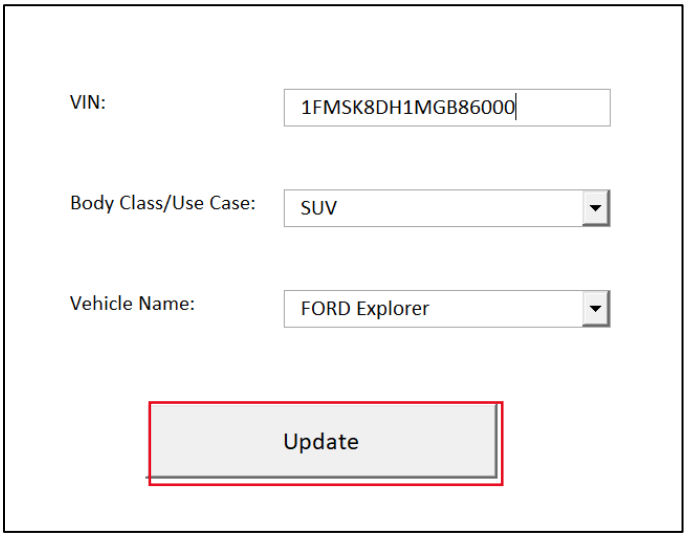
Fixing Dropped VINs

Users can overwrite any dropped VINs with the correct vehicle they would like modeled in the tool. To perform this, overwrite, they can select the “Fix Dropped VINs” button on the page above. They will then be brough to a page where they can select each dropped VIN and overwrite it with a correct value.

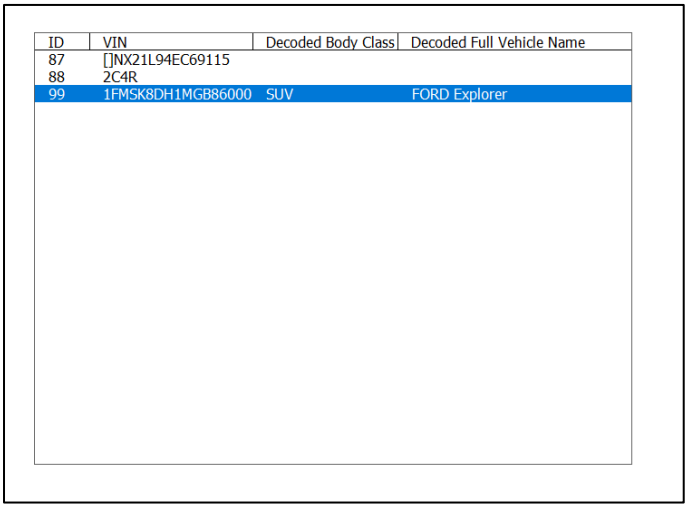


The user can either modify the VIN itself, or simply select a body class and vehicle to map to. A vehicle can either be selected from the dropdown list, or a new vehicle can be

entered. Users must select a body class/use case from the drop down. One valid entries have been enters, such as the example below, the user must hit **Update** for the changes to appear in the table.



Once updated, the changes will be reflected in the table as shown below:



After all the VINs that the user wishes to have modeled have been overwritten, the user can hit the “Done” button to return to the import page and continue with the analysis.

Step 3: Map Fleet Vehicles

You can now go through each unique vehicle that was found in the fleet and customize which conventional vehicles and EVs DRVE will use in the analysis.

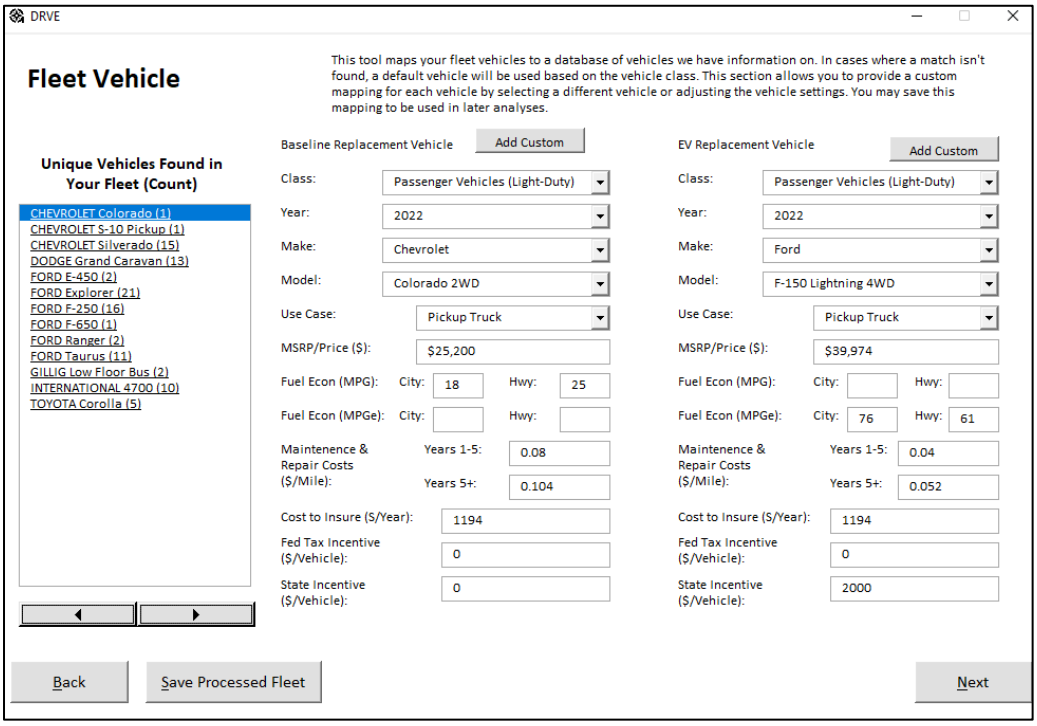
Nearly all passenger vehicles available in DRVE were imported directly from the FuelEconomy.gov, a joint effort by the U.S. Department of Energy and U.S. Environmental Protection Agency to catalog details on all passenger vehicles from 1984 to the present day; the website also includes the manufacturer's suggested retail price (MSRP) for many vehicles. DRVE uses FuelEconomy.gov for vehicle makes and models, fuel economy ratings, and MSRP where available. For medium- and heavy-duty vehicles along with some passenger vehicles, Atlas Public Policy maintains a database that is updated on a rolling basis, as no public source provides makes this information available. Atlas retrieves details on these vehicles directly from manufacturer's websites or other reputable sources. For vehicles not yet available for purchase, Atlas may rely on press reports or other third parties to determine vehicle characteristics.

DRVE currently supports customizing the following fields for each vehicle:

- **Category:** The vehicle category of the vehicle to be procured, including light-, medium-duty, and heavy-duty.
- **Year:** The model year of the vehicle to be procured.
- **Make:** The make of the vehicle to be procured.
- **Model:** The model of the vehicle to be procured. The user may select from different trim levels for any vehicle where multiple options are given (e.g., All-Wheel Drive, Sport configurations).
- **Use Case:** A custom use case which is based on the body-class of the vehicle. This can be customized for each vehicle to see specific vehicles grouped together. A use case is created automatically for each vehicle found in the fleet, but if the user changes the mapped vehicle, they will need to specify a use case.
- **MSRP ($):** The manufacturer suggested retail price per vehicle. The default will be the national default MSRP for the vehicle and will depend on the vehicle selection. Users can set a custom value to reflect local pricing.
- **Fuel Economy Gasoline/Diesel (MPG) [City/Highway]:** The default value is the city/highway fuel economy for vehicles powered by gasoline or diesel in mile per gallon for the selected vehicle from FuelEconomy.gov for passenger vehicles and from Atlas's internal database otherwise. This field is not relevant for battery electric vehicles.
- **Fuel Economy Electric (MPGe) [City/Highway]:** The default value is the city/highway fuel economy for vehicles powered by batteries in mile per gallon of gasoline equivalent for the selected vehicle from FuelEconomy.gov for passenger vehicles and from Atlas's internal database otherwise. This field is not relevant for gasoline or diesel vehicles.
- **Maintenance & Repair Costs ($/Mile):** Default costs for the first five years of use or all years after the fifth year of use are based on vehicle drivetrain. Users can set custom values that are more accurate.

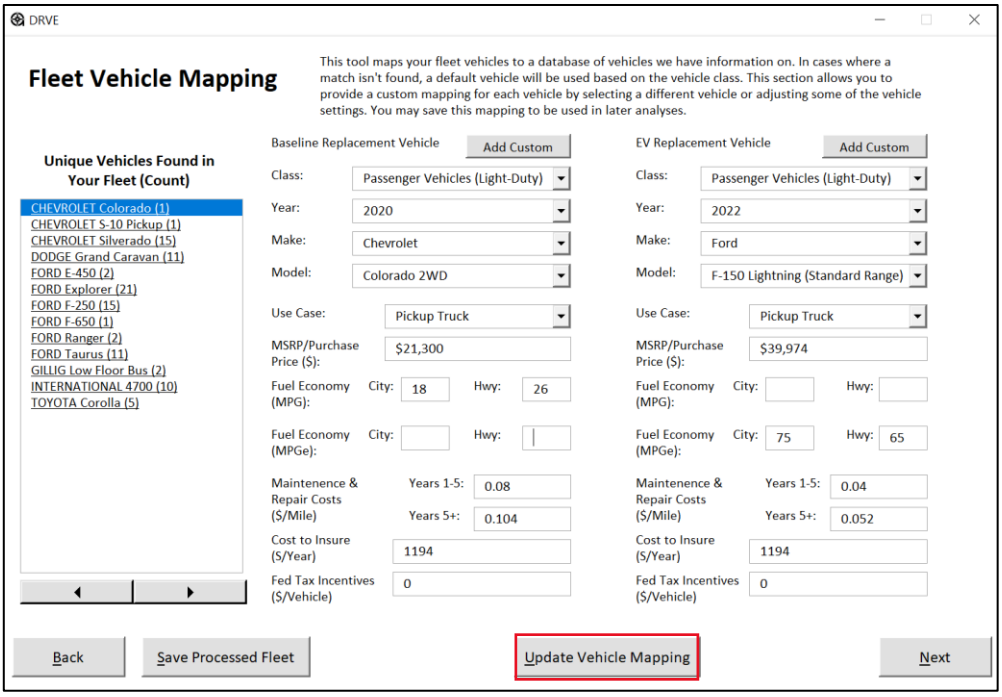
- **Cost to Insure ($/Year):** Average passenger car insurance costs from AAA 2017 Your Driving Cost Study. Users can set custom values that are more accurate. Users can also scale this value down across all scenarios in the procurement settings section.
- **Federal Tax Incentives ($/Vehicle):** Federal 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. Users can also scale this value down across all scenarios in the procurement settings section.
- **State Incentive ($/Vehicle):** Total state incentive value based on the incentive programs added in the previous step. The value for each vehicle is determined based on the vehicle class. Users may overwrite this value for each vehicle.

A screenshot of the fleet mapping screen is presented below.



Update Vehicle mapping

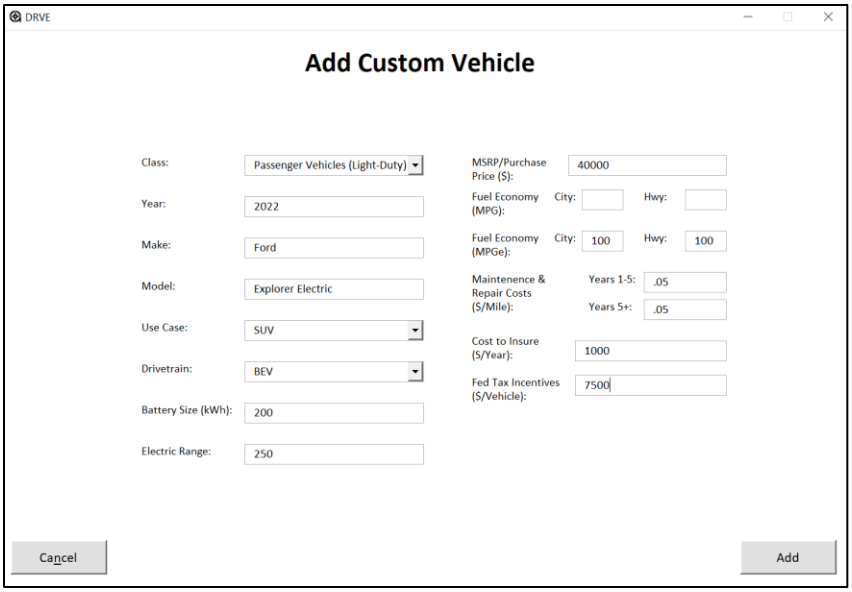
Each time you change any value fields for a vehicle, the “Update Vehicle Mapping” button appears under; you can click that button to save the customization. If the mapping is not updated, the customization will not be saved, and the default mapping will be used for the analysis.



Add Custom Vehicle

If the vehicle you wish to model is not included in the available options, you can add a custom vehicle by clicking the “Add Custom” button for either the baseline replacement vehicle or the EV replacement vehicle, as shown below.

Clicking this button will bring you to a page where you can add all of the relevant settings for the vehicle, as shown below. Once all of the relevant information is entered, the user can hit “Add” and the vehicle will be added to the model, and the user will be able to use this vehicle as an alternative for any other vehicles in the fleet. These custom vehicles will be saved and imported along with the rest of the custom fleeting by saving the processes fleet file.



Save Processed Fleet File

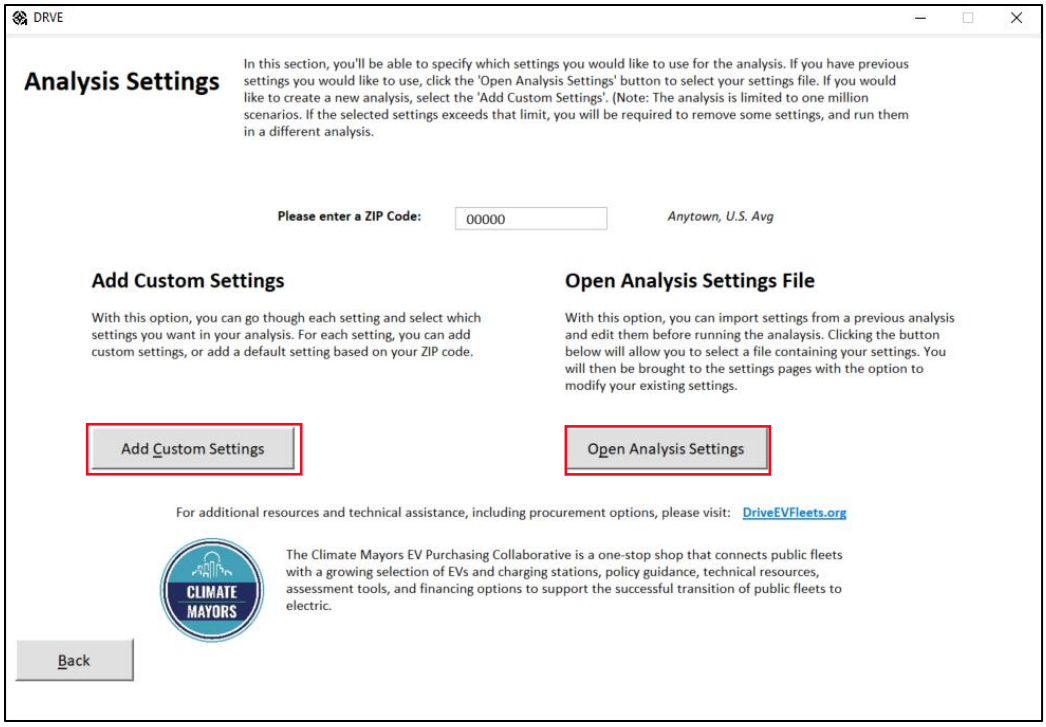
The fleet can be saved at any point while the user is on the mapping screen by clicking "Save Processed Fleet." It is recommended you save your processed fleet to save time in for future analyses. *This will save both the processed fleet and any custom vehicles the user has entered*.

Step 4: Configure Analysis Settings

Once your vehicles are mapped, you can configure the fleet analysis. First, enter your ZIP code, which DRVE uses to set default fuel and electricity prices along with electricity emissions. To use the U.S. average, enter "00000." There are two options for selecting the settings in the analysis:

- **Using Custom Settings**: You can go through each category of settings and select which to model in the analysis. Default settings will be loaded based on the entered ZIP Code. For each category, a custom setting can be added, or the user can select to keep the default settings. You can import settings from a previous session with the "Open Setting" button, or all new settings can be entered with the "Add Custom Settings" option.
- **Open Analysis Settings File: With this option, you can import settings from a previous analysis and edit them before running the analysis. Once you open your Analysis Settings file, you will then be brought to the settings pages with the option to modify your existing settings.**

For information on the settings used throughout the analysis, please refer to *Appendix A*.

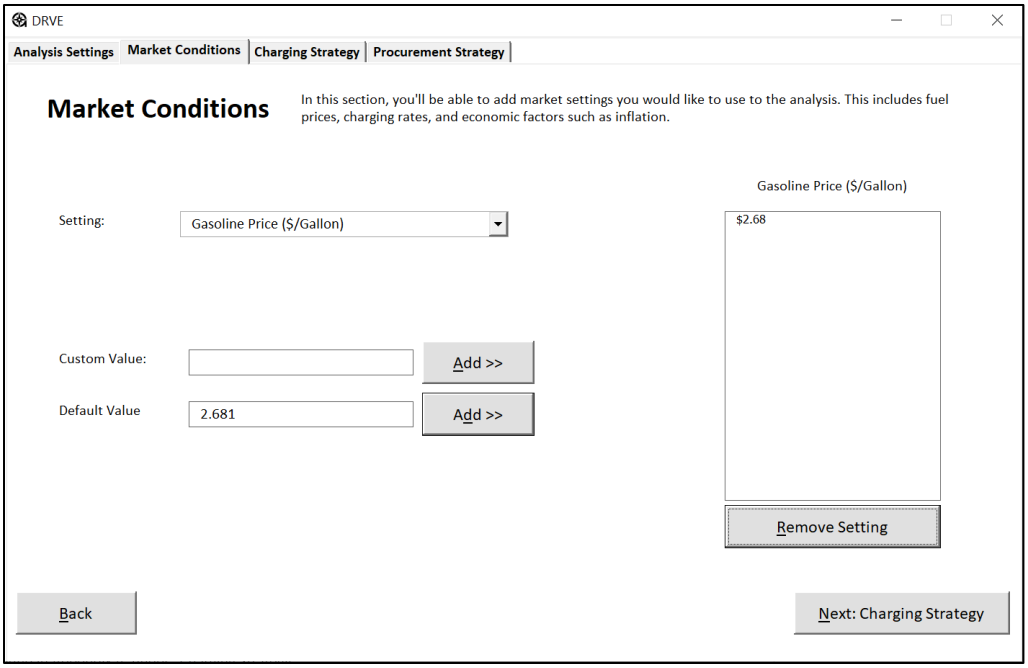


Market Conditions

The first section of the analysis settings is for market conditions, including electricity and gasoline/diesel prices, forecast scenarios, the cost of EV charging in the public and while a vehicle is "on route," an optional cost of carbon dioxide emissions, inflation, and the cost to the fleet manager of downtime while waiting for an EV to charge (see *Appendix A* for definitions of each field). A default value is provided for each value, in some cases based on the ZIP code entered. A custom value can be added by inserting a value into the "Custom Value" and clicking the "Add" button directly next to it. A setting can also be removed by clicking on the setting in the right-hand box and clicking the "Remove Setting" button.

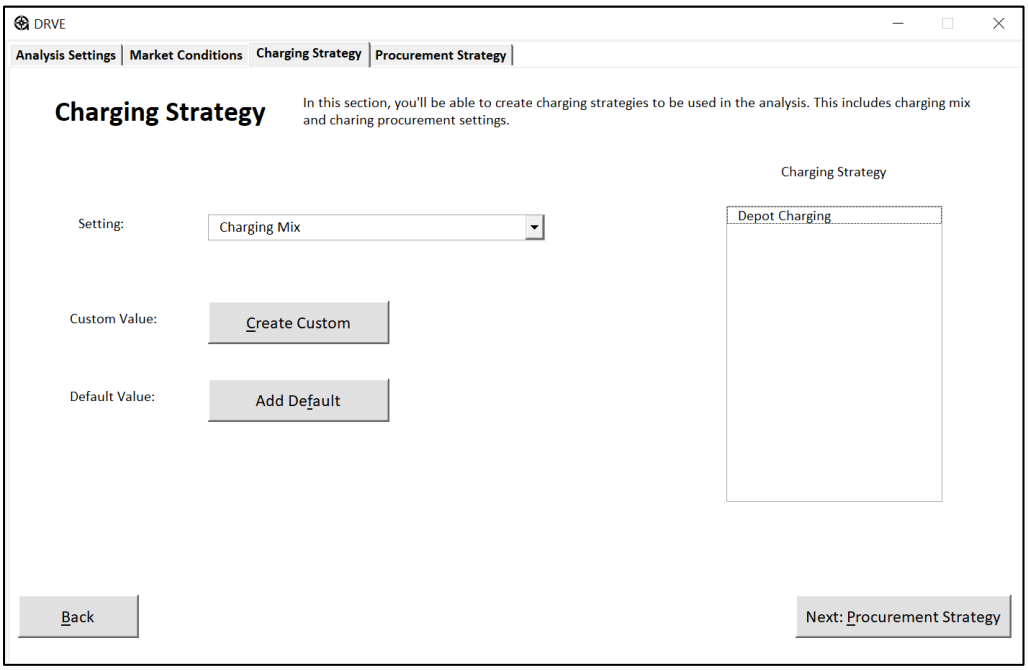
Note: Each setting adds a scenario for all relevant fleet vehicles. For example, adding an electricity price adds a scenario for each EV. Care should be taken in adding many scenarios as that can increase the time to complete an analysis. DRVE is limited to 1 million scenarios.

Once you have configured your market conditions, click "Next: Charging Strategy"



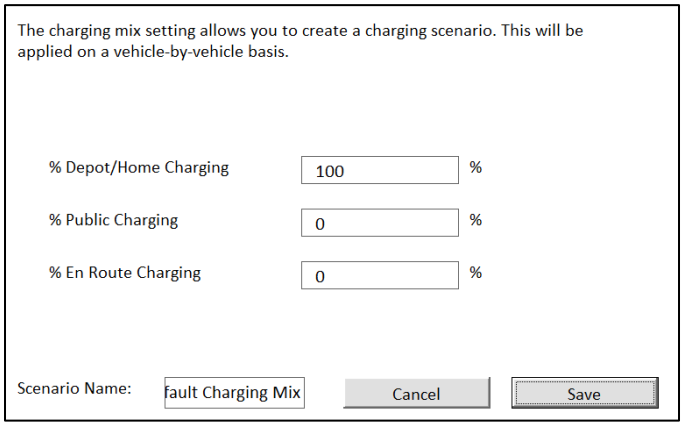
Charging Strategy

Next, you can configure the charging configurations used in the analysis, including the mix of charging at three location types and the procurement settings for charging equipment.



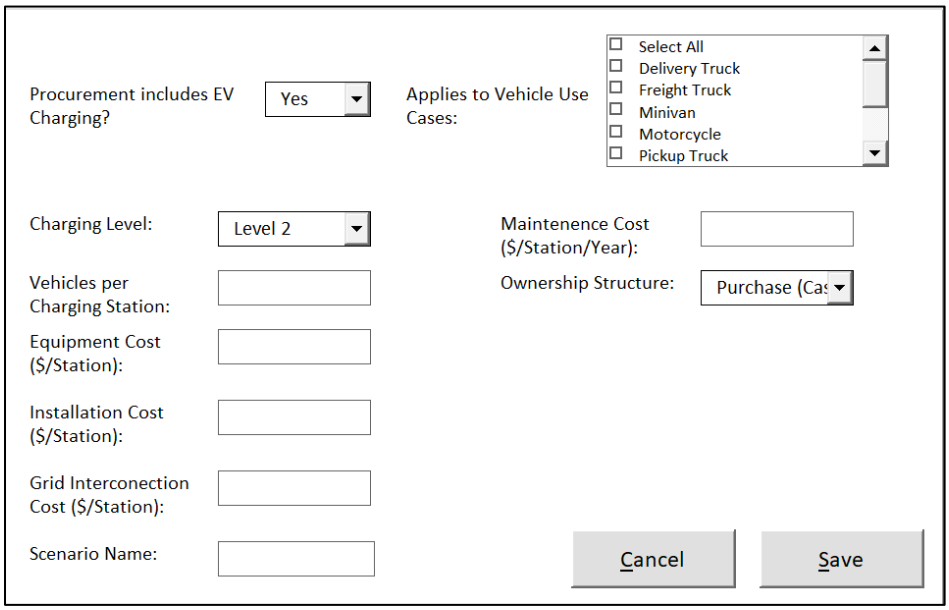
For the charging mix, enter the share of charging you expect to occur at a depot or a user's home, in the public and at charging sites while a vehicle is "on route." The cost for each charging location type is in the Market Conditions settings. The "Scenario Name" field

makes it possible to easily distinguish among the various charging mix configurations in the output data.



For charging in public and when the cost of downtime is set in the Market Conditions settings, DRVE uses the "Maximum Power for Public Charging Only (kW)" to calculate the cost of downtime while EV drivers wait for their vehicle to charge.

For charging procurement settings, the user can specify which vehicle use cases the charging procurement will be applied to. A ratio of vehicles to charging stations that best suits the needs of the fleet can be set, and the charging procurement settings include one-time costs for equipment, installation, and electrical grid interconnection and annual costs for maintenance. These costs are calculated on a per-vehicle basis based on the ratio of EVs per charging station. The "Scenario Name" field makes it possible to easily distinguish among the various charging procurement configurations in the output data.

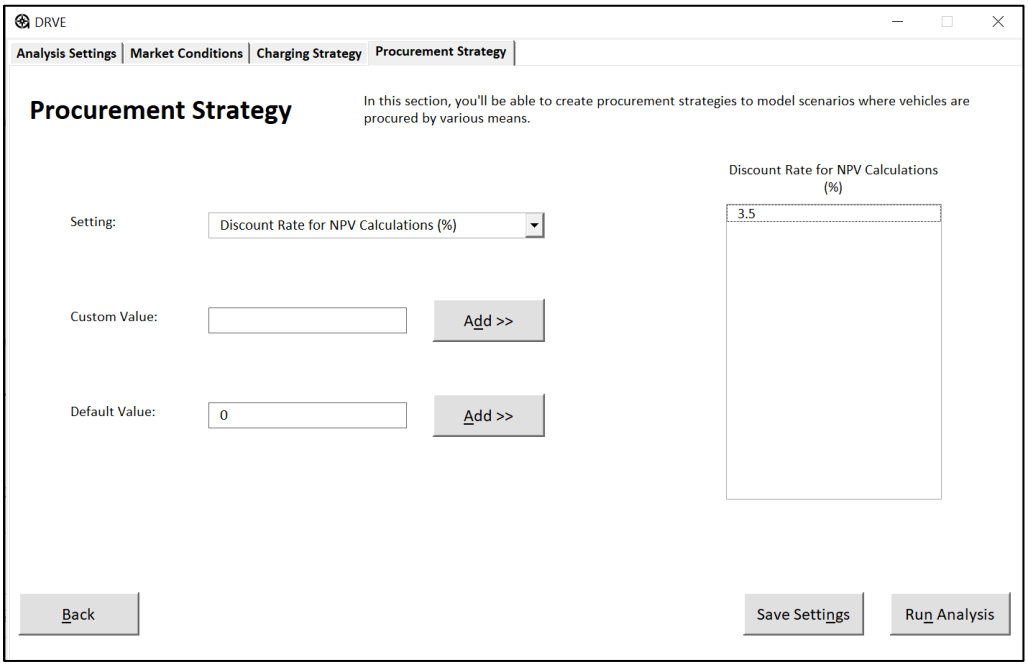


As settings are saved, they are queued up in a box on the right-hand size of the screen. You can edit any setting configuration by clicking “Edit.” Any changes made will be saved after the users clicks “Save.”

Once you have configured your charging strategy, you can click “Next: Procurement Strategy” to configure the last options before running the analysis.

Procurement Strategy

The procurement strategies allow you to model vehicle acquisitions by various means. They can also specify custom incentives they wish to see for both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). This step will also allow the modeling of additional fees that may be used in the procurement, such as initial purchasing fees. For settings that require multiple inputs, they can be edited by clicking the setting name in the box on the right-hand side and clicking “Edit”. Any changes made will be saved after the users clicks “Save”.

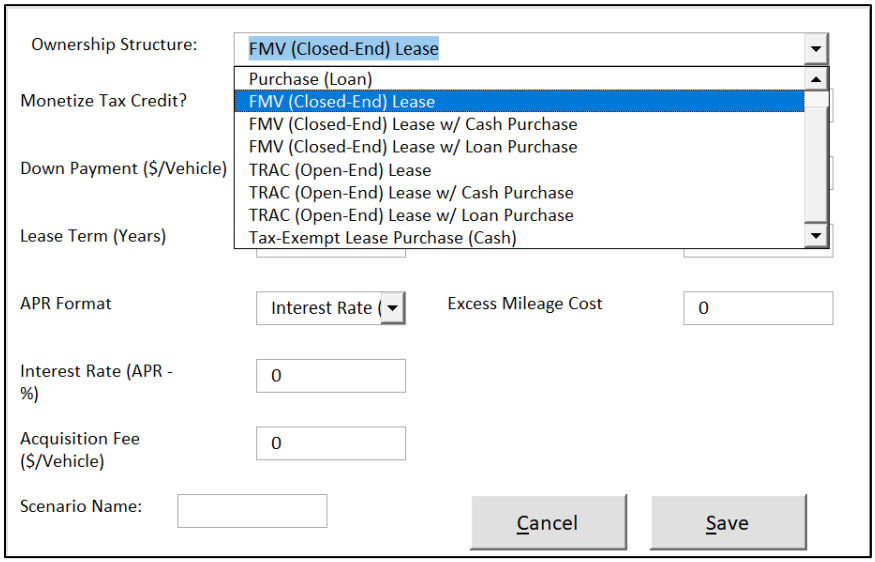


The first setting is the discount rate used in the financial analysis.

The next setting is the pricing approach, where users can select from an MSRP Less Discounts approach, or a dealer cost plus markup. In either case, the user can input the respective discount or markup they wish to see modeled.

DRVE 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.

Users can select from any of these ownership structures and apply settings relevant to that structure.



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

The tool supports state incentives for either BEV and PHEV vehicles, and users have the flexibility of setting a state incentive specific to BEV's or PHEV's. (Note: The tool does not currently support a custom federal tax incentive setting. Federal tax incentives are applied automatically based on the vehicle selection and will be applied if tax incentives are monetized.) A cap on the incentives can be set with the State Tax Incentive Cap ($/Vehicle) setting. Any other incentives the user wishes to see can be set with the Non-tax Incentives ($/Vehicle) setting.

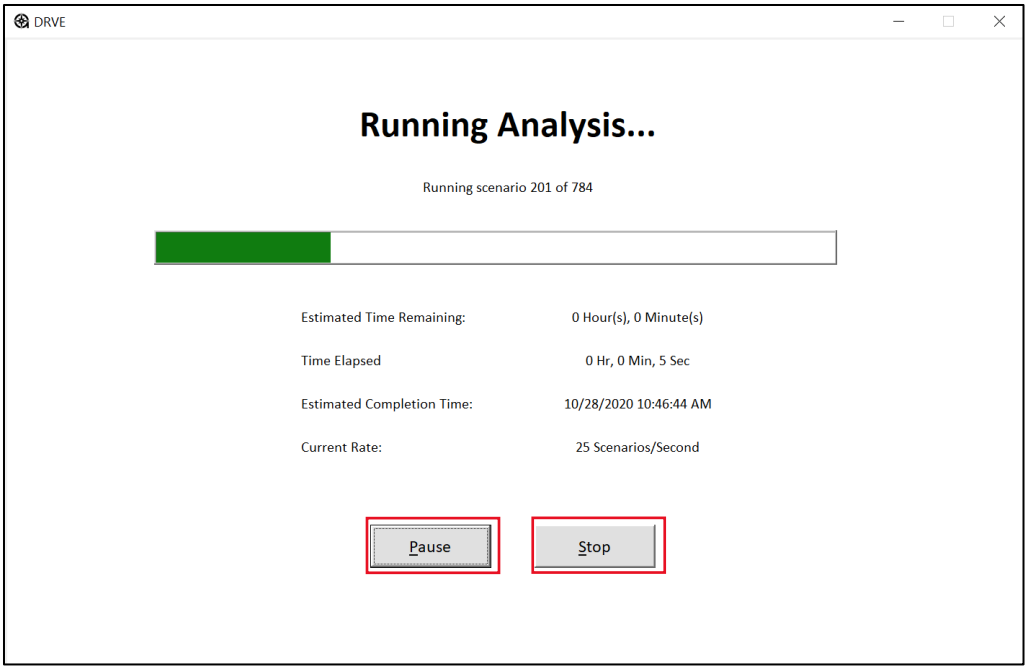
The tool supports scaling the fixed insurance costs and federal tax incentive settings. By setting values between 0 and 1 for the Insurance Adjustment of Fed Tax Credit Adjustment settings, you can specify how much of the set value to capture. This would be useful in cases where the user wants to model no insurance costs alongside the full insurance costs.

Save Analysis Settings File

Once all the desired settings have been entered, press the "Save Analysis Settings" button on the bottom-right of the "Procurement Strategy" screen. This will allow you to re-use the settings in a future run of DRVE.

Step 5: Run Fleet Analysis

After you've configured the vehicle mappings for your fleet along with all your analysis settings, you can begin the analysis by clicking the "Run Analysis" button on the bottom-right of the "Procurement Strategy" screen. The next screen will allow you to monitor the progress of the analysis.



The process for running the analysis is described below:

1. Scenarios are built based on the settings inputted by the user. The tool will apply each setting across the entire fleet where applicable. Additional information on how scenarios are built is provided in the box below.[3]
2. Each vehicle scenario is run through the financial and environmental model within DRVE, and the outputs are stored in a table.
3. After DRVE has finished the analysis, the user can save the results to an external Excel file or explore the results within DRVE.

Box 3. Scenarios in DRVE

The tool builds the scenario table by applying each setting input by the user to each of the relevant vehicles in the fleet. The number of total settings will grow considerably for each setting configuration. For example, adding a single gasoline price will not affect the number of scenarios, but adding a second price will double the number of scenarios for gasoline vehicles.

While running the analysis, the user will be provided with various progress metrics, including the following:

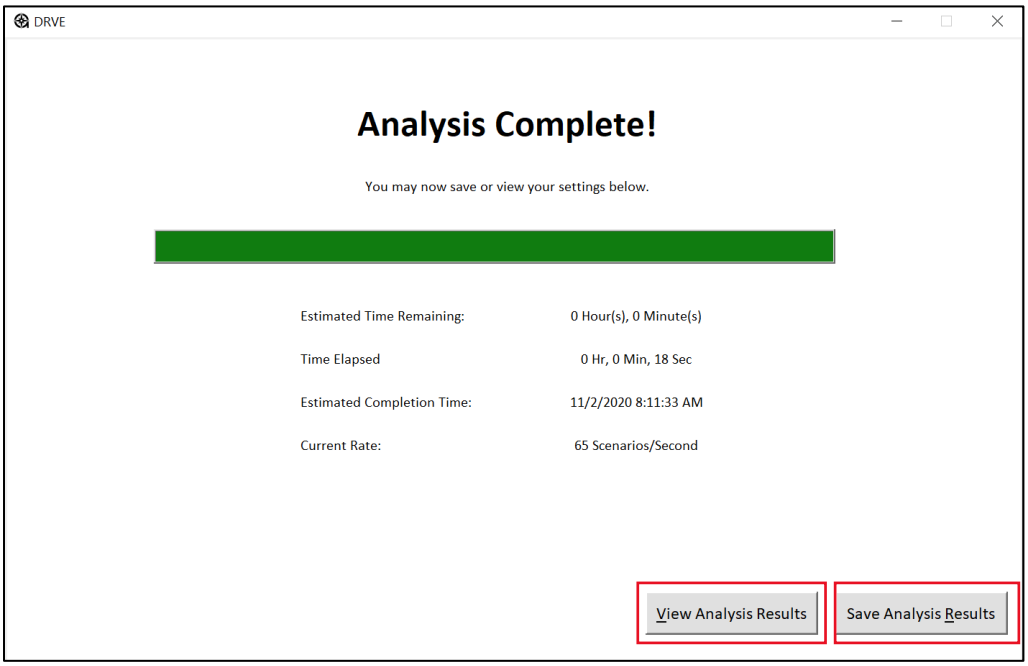
[3] DRVE only supports up to 1 million scenarios per analysis.

- **Estimated Time Remaining:** This estimate is based on the current rate of execution and could vary depending on the execution speed.
- **Time Elapsed:** This is the total time that has passed while running the analysis.
- **Estimated Completion Time:** This is an estimation of the exact time which the analysis will complete. This estimate is based on the current rate of execution and could vary depending on system resources.
- **Current Rate:** This will track the current rate of execution in scenarios per second, which can vary depending on the system resources. Tip: When running a large analysis, it is recommended to close as many applications as possible.

Pausing or Stopping the Analysis

The analysis can be paused at any point by double-clicking the "Pause" button. To continue the analysis, simply hit resume.

If the analysis needs to be cancelled for any reason, it can be halted by double-clicking the "Stop" button. This will terminate the analysis, and you will not be able to resume it. You will be able to save the scenarios that were run if the analysis is canceled.



Saving the Analysis Results

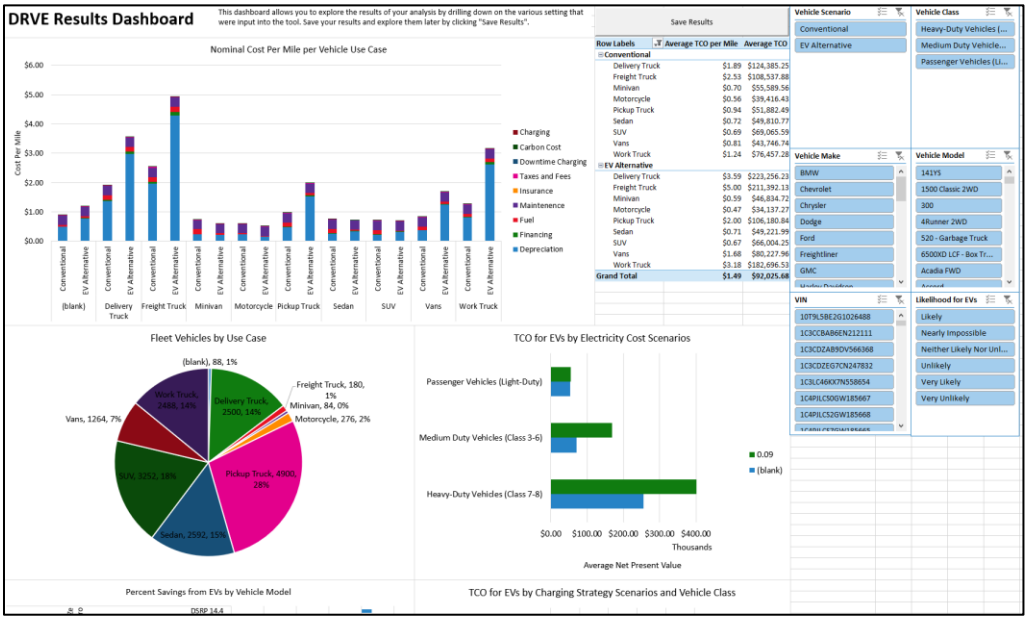
Once the analysis has completed, you can save the results by clicking the "Save Analysis Results" button on the bottom-right of the analysis window. Once these results have been saved, you can explore the results within DRVE or with the save file using dashboard software like Microsoft Power BI.

Viewing the Analysis Results

Once the analysis has completed, you can view the results by clicking the "View Analysis Results" button on the bottom-right of the analysis window. This will prepare the results and present them in the tool's dashboard. You can save the results before viewing them or save them while inside the dashboard.

Step 6: Explore Results in DRVE

You can view your results in an Excel Dashboard. The dashboard allows you to explore the results of the analysis through various filters, such as vehicle use case, vehicle make and model, all the way down to the VIN number of a single vehicle.



Using the filters on the right-hand side, you can drill down into the following scenarios:

- **Vehicle Scenario:** Specify whether you would like to view only the conventional or electric vehicles procured, or view both.
- **Vehicle Class:** Choose to view results for only a specific category of vehicles. This could be used if you only want to analyze the light-duty vehicles in your fleet.
- **Vehicle Make:** View only select vehicle makes that have been analyzed.
- **Vehicle Model:** View only select vehicle models that have been analyzed.
- **VIN:** Drill down to specific vehicles in the analysis based on its VIN.
- **Likelihood for EVs:** View scenarios where an EV alternative is likely or unlikely to be cheaper than its conventional vehicle as defined in the table below.

Likelihood Category	TCO Percentage Difference from Internal Combustion Equivalent
Very Likely	At least 10% lower
Likely	Between 10% lower and 5% higher
Neither Likely nor Unlikely	Between 5% and 20% higher
Unlikely	Between 20% and 35% higher
Very Unlikely	Between 35% and 100% higher
Nearly Impossible	More than 100% higher

You can save the results as a separate file at any point by pressing the "Save Results" button at the top of the page. This will create a file containing the full results of the analysis, which you can open in the tool at a later point.

Note: You will not be able to save the results once you close the workbook. You must you save the results before closing the dashboard in order to prevent the loss of your data.

APPENDIX A: INPUT FIELDS DESCRIPTIONS

This appendix describes each user input field. The DRVE 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. respectively. For inputs automatically filled out by the tool, users can customize the value for more accurate results.

Scenario Analysis Support: DRVE supports multi-variate scenario analysis meaning you can vary many input fields and run a single analysis at once. For example, you can analyze the total cost of ownership for all vehicles for an electricity price of $0.10 per kilowatt-hour and $0.12 per kilowatt-hour. The analysis result will include scenarios for all electric vehicles with both electricity prices. As you add more scenarios, the analysis becomes considerably more complex so this feature should be used with caution. For some input fields, scenario analyses are not applicable (e.g., VIN). For input fields that support scenario analyses, they can be varied individually (e.g., electricity price) or can be grouped with other, relevant fields. The grouped scenarios are **Charging Mix**, **Charging Procurement**, and **Ownership Strategy**.

Market Inputs

Input Field	Scenario Support	Description
Gasoline Price ($/Gallon)	Individual	The price of gasoline that is paid for by the fleet. Default gasoline price is the average price for the last year available from the U.S. Energy Information Administration and set based on ZIP code. Some prices are available at the state level, while others are available at the regional level (PADD).
Diesel Price ($/Gallon)	Individual	The price of diesel that is paid for by the fleet. Default diesel price is the average price for the last year available from the U.S. Energy Information Administration and set based on ZIP code. Some prices are available at the

Input Field	Scenario Support	Description
		state level, while others are available at the regional level (PADD).
Electricity Price ($/kWh)	Individual	The price of electricity used for charging that is paid for by the fleet Default electricity price is aggregated by state and the price is calculated based on revenue and energy delivered for commercial customers for the last year available from U.S. Energy Information Administration's survey of electric utilities (EIA-861M).
Public Charging Price ($/kWh)	Individual	Default public charging price is used for analyses where vehicles are charged in public some share of the time.
En-Route Charging Price ($/kWh)	Individual	Default charging price for vehicles that are charged en-route at other company-owned facilities. This price is relevant for analyses where vehicles are charged en-route some share of the time.
Inflation Rate (Excluding Fuel) (%/Year)	Individual	Inflation rate is used for maintenance and other operating costs, excluding fuel. The default inflation rate is based on the Federal Reserve's medium-term target (2015). Inflation for fuel is based on data from U.S. Energy Information Administration.
Cost of Downtime from Public Charging ($/Hour)	Individual	The cost of downtime from public charging is used to consider the time of value of money associated with vehicle charging in public while drivers are "on the clock."
Include Cost of Carbon?	Individual	Option to include the cost of carbon by ton in the financial analysis. The default used would be to not include the cost of carbon.
Cost of Carbon ($/Ton)	Individual	A cost paid for by the fleet for the amount of carbon produced by the fleet. The default cost

Input Field	Scenario Support	Description
		of carbon is the social cost of carbon using a 3% discount rate, as defined by the U.S. federal government in 2016.
Forecast Year	Individual	The year in which to forecast the market and infrastructure conditions. More information on forecasting is available in Appendix B.
Forecast Scenario	Individual	The scenario in which to forecast the market and infrastructure conditions. More information on forecasting is available in Appendix B.

Charging Strategy

Input Field	Scenario Support	Description
% Depot/Home Charging	Charging Mix	The share of charging done at the home base of the vehicle. The default is 100%.
% Public Charging	Charging Mix	The share of charging done at publicly available charging stations. The default is 0%.
% En-Route Charging	Charging Mix	The share of charging done at company-owned charging stations away from the vehicles home base. The default is 0%.
Maximum Power for Public Charging Only (kW)	Individual	The maximum power for a public charging station. Used to calculate the cost of charging due to downtime while drivers are "on the clock."
Charging Level	Charging Procurement	The charging level (Level 2 or DC fast charging). This informs the maximum power and charging costs for projects with infrastructure.
Charging Procurement	Charging Procurement	Option to include or not include EV charging stations in the financial calculations of the procurement.

Input Field	Scenario Support	Description
Charging Ratio	Charging Procurement	The number of vehicles that will be used on each charger. The default value is 1, for a 1:1 vehicle/charger ratio.
Equipment and Installation Cost ($/Station)	Charging Procurement	The equipment and installation cost per station. The default value is $5,000, which assumes $2,000 for equipment and $3,000 for installation.
Maintenance Cost ($/Station/Year)	Charging Procurement	The annual maintenance cost per year for station upkeep. The default value is $75 per year, or 3% of the equipment cost.
Ownership Structure	Charging Procurement	Setting to either pay for the charging stations through a cash purchase or loan.
Cash Upfront / Down Payment ($)	Charging Procurement	The down payment on the loan for the charging stations if ownership structure is loan.
Loan Term (Years)	Charging Procurement	Length of loan in years if ownership structure is loan.
Interest Rate (APR - %)	Charging Procurement	Annual interest rate for the loan if ownership structure is loan.

Vehicle Inputs

Input Field	Scenario Support	Description
Class	N/A	The class of the vehicle based on the GVWR. Choose from Passenger/Light Duty Vehicles (Class 1-2), Medium-Duty Vehicles (Class 3-6), and Heavy-Duty Vehicles (Class 7-8).
Year	N/A	The model-year of the vehicle to use in the analysis.
Make	N/A	The make of the vehicle to use in the analysis.
Model	N/A	The model of the vehicle to use in the analysis. There may be multiple options for each

Input Field	Scenario Support	Description
		vehicle with different drive types (AWD/FWD). The tool does not distinguish between trim, and defaults to the model with the lowest MSRP.
MSRP ($/Vehicle)	N/A	The price per vehicle. The default depends on the vehicle selection and users can set a custom value to reflect local pricing.
Use Case	N/A	A custom use case is used to group vehicles when visualizing the analysis. This option does not have an effect on the analysis, but lets users filter down on vehicles with specific use cases.
Fuel Economy Gas City (MPG)	N/A	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 Economy Gas Hwy (MPG)	N/A	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.
Fuel Economy Electric City (MPGe)	N/A	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 Economy Electric Hwy (MPGe)	N/A	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.
Expected Years of Use/Ownership (Years)	N/A	The default value is seven and users can use the value from their fleet data to set specific years of use for each vehicle.
Annual Vehicle Mileage (VMT/Year)	N/A	The default value is 12,000 and users can customize this value to their expected number of miles traveled per year.

Vehicle Procurement Inputs

Input Field	Scenario Support	Description
Discount Rate for NPV Calculations (%)	Individual	The time value of money used for financial calculations. Default value is zero.
Pricing Approach (select one)	Individual	Vehicle pricing could be from the "MSRP down" or the "dealer cost up." MSRP pricing could include a discount and dealer cost (also known as Triple Net Price) could include a dealer markup.
Value of Negotiated Discounts off MSRP ($/Vehicle)	Individual	Per vehicle discount from automaker, auto dealer, or other party in the procurement. This field is only valid when using the "MSRP down" pricing approach.
Dealer Triple Net Price ($/Vehicle)	Individual	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. This field is only valid when using the "dealer cost up" pricing approach.
Dealer Markup ($/Vehicle)	Individual	A markup above the triple-net price intended to be passed on to the auto dealer. This field is only valid when using the "dealer cost up" pricing approach.
Value of Federal Tax Incentives ($/Vehicle)	Individual	Federal electric vehicle tax credit set based on the vehicle selection. Users can overwrite this value if only a portion of the benefit is being captured in the procurement.
Ownership Structure	Ownership Strategy	Ownership structure selection, including various leasing and purchasing options. DRVE supports the following ownership structures: Purchase (Cash), Purchase (Loan), FMV (Closed-End) Lease, FMV (Closed-End) Lease w/ Cash Purchase, FMV (Closed-End) Lease

Input Field	Scenario Support	Description
		w/ Loan Purchase, TRAC (Open-End) Lease, TRAC (Open-End) Lease w/ Cash Purchase, and TRAC (Open-End) Lease w/ Loan Purchase. Tax-Exempt Lease Purchase (Cash): Vehicles leased with tax-exempt lease-purchase structure. Vehicles are purchased at end of lease term with cash, typically a nominal amount ($1).
Tax Credits Can Be Monetized? (Y/N)	Ownership Strategy	Setting this value to "Yes" will pass along the state and federal tax credits to the fleet as part of the procurement.
Lease Down Payment ($/Vehicle)	Ownership Strategy	Down payment in cash for each vehicle for lease procurements.
Lease Term (Years)	Ownership Strategy	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.
Lease Interest Rate (APR - %)	Ownership Strategy	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 DRVE will automatically calculate the other.
Money Factor (#)		
Lease Acquisition Fee ($/Vehicle)	Ownership Strategy	An acquisition fee is also known as an initiation fee or a bank fee if the lessor is a bank rather than a dealer. This is only applicable to lease procurements.
Lease Disposition Charge ($/Vehicle)	Ownership Strategy	Fee to cover the expense of cleaning up and selling the car after it is returned at the end of the lease. This is only applicable to lease procurements.

Input Field	Scenario Support	Description
Lease Negotiated Residual Value ($/Vehicle)	Ownership Strategy	Value of the vehicle at the end of the lease term. For a Tax-Exempt Lease Purchase, the residual value must equal $1. This is only applicable to lease procurements.
Lease Mileage Included (Closed-End Only)	Ownership Strategy	Annual mileage allowed in the lease agreement. This is only applicable to lease procurements.
Lease Excess Mileage Cost ($ per Mile)	Ownership Strategy	Cost per mile above the mileage included in the lease agreement. This is only applicable to lease procurements.
Loan Term (Years)	Ownership Strategy	Term of loan for loan procurements. Loan term cannot exceed the expected years of ownership.
Loan Interest Rate (APR - %)	Ownership Strategy	Interest rate used for loan purchasing for loan procurements.
Value of State Tax Incentives ($/Vehicle)	Individual	State electric vehicle incentives for public fleets, set based on the vehicle selection and state. Users can overwrite this value if only a portion of the benefit is being captured in the procurement.
State Tax Incentive Cap ($)	Individual	The maximum funding amount of a state incentive that can be used by a fleet in a procurement.
Value of Non-tax Incentives ($/Vehicle)	Individual	Value of other per-vehicle incentives, such as state grants or incentives from an automaker or third-party.
Initial Tax, Title, and Registration Cost ($/Vehicle)	Individual	Upfront fixed fees for vehicle purchase, which can vary locally. Default is $0.
Maintenance and Repair Cost - Years 1 - 5 ($ per Mile)	N/A	Maintenance and repair costs per vehicle per mile for the first five years of ownership. Default costs for the first five years of use are

Input Field	Scenario Support	Description
		based on vehicle class and drivetrain and can be customized for each vehicle.
Maintenance and Repair Cost - Years 5+ ($ per Mile)	N/A	Maintenance and repair costs per vehicle per mile for sixth and subsequent years of ownership. Default costs after year five of use are based on vehicle class and drivetrain and can be customized for each vehicle.
Cost to Insure ($/Year)	N/A	Annual insurance costs per vehicle. The default passenger car insurance costs are from the AAA 2019 Your Driving Cost Study, while the default value for medium-duty vehicles is from an article by boxtruckinsruancehq.com. DRVE provides the option of using specific insurance cost data from the fleet to set insurance costs for each vehicle.

APPENDIX B: FORECASTING IN DRVE

DRVE allows users to model replacing vehicles in the future to project the effect of price changes on electrification viability based on when a vehicle is procured. Projections on vehicle prices were derived from a 2020 study completed by Atlas Public Policy, Washington State University, and the National Renewable Energy Laboratory. The study, available online here, projected vehicle prices by vehicle class, use case, and drivetrain for 2025, 2030, and 2035. The following is an explanation of the methodology for estimating vehicle price directly from the report:

> For these projections, the Manufacturer Suggested Retail Prices (MSRP) of currently available vehicles—electric and conventional—are projected in the future. MSRP is estimated by leveraging projections for vehicle technology costs from the U.S. Department of Energy (DOE) for Light-Duty Vehicles [1] and Medium- and Heavy-Duty Trucks [2]**.** As per these reports, there are two different cost projections, a business-as-usual (BAU) projection, referred as the BAU Tech scenario, and an R&D Success scenario.
>
> As the name suggests, the BAU Tech projections forecast vehicle costs assuming the current trends in technology continue in the future. While the R&D Success scenario assume the DOE targets are achieved and implemented in the automotive market. These scenarios are used to reflect the uncertainty associated with projecting automotive technology costs, including for engines, motors, power electronics, and batteries.
>
> As these reports put forth the projected costs and not the MSRPs, a methodology was developed to forecast the MSRP from vehicle technology costs. First, for each technology a percentage change in projected costs for each vehicle class and year ($\alpha_{c,y}$) was estimated with respect to 2020 technology costs (Equation 1). Further, a 'cost ratio' was estimated for each technology (t) for each vehicle class (c) and each year (y). A 'cost ratio' can be defined as a ratio of projected cost of an EV to the projected cost of a conventional vehicle (Equation 2). The percentage changes (α) along with the cost factors, were used as multiplying factors to estimate the MSRP projections for each vehicle class and each powertrain variant (conventional and electric), as shown in the Equation 3.

$$\alpha_{c,y}\ (in\ \%) = \frac{Cost_{c,y} - Cost_{c,2020}}{Cost_{c,2020}};$$ Equation 1

$$c = vehicle\ class, y = 2020\ to\ 2035$$

$$Cost\ Ratio_{t,c,y} = \frac{Cost_{\ t,c,y}}{Cost_{t=conventional,c,y}};$$ Equation 2

$$t = technology,$$

$$MSRP_{t,c,y} = MSRP_{t,c,2020} \times Cost\ Ratio_{t,c,y} \times \alpha_{c,y}$$ Equation 3

In these projections, the costs for conventional vehicles increase over time as a result of integrating advanced fuel economy technologies. The costs of BEVs and PHEVs decrease because of cost reductions primarily associated with high voltage batteries. Therefore, for conventional vehicles the MSRPs are generally expected to increase in the BAU Tech as well as the R&D Success projections. On the contrary, the MSRPs of BEVs and PHEVs are expected to decrease. However, the R&D Success scenario projects a more optimistic case for BEVs and PHEVs than that of the BAU Tech scenario.

Source [1]: Energy Consumption and Cost Reduction of Future Light-Duty Vehicles through Advanced Vehicle Technologies: A Modeling Simulation Study Through 2050 (anl.gov)

Source [2]: ANL-MDHD Vehicle Simulation Report.pdf (autonomie.net)

APPENDIX C: VERSION HISTORY

Version	Date	Author	Organization	Revisions
0.3	10/20/2020	Josh Rosenberg	Atlas Public Policy	Beta Launch
0.4	11/3/2020	Josh Rosenberg	Atlas Public Policy	Addressed cosmetic issues around procurement settings page.
0.5	11/3/2020	Josh Rosenberg	Atlas Public Policy	Fixed refresh issue causing unexpected error when viewing results. Fixed memory allocation issue which caused program to run out of memory too early.
0.6	11/4/2020	Josh Rosenberg	Atlas Public Policy	Fixed bug which didn't allow users to save the results from the dashboard.
0.7	12/7/2020	Josh Rosenberg	Atlas Public Policy	Introduced performance improvement which fixed issue causing high memory usage. Introduces feature allowing using to specify maintenance, insurance, and fed incentive costs on a vehicle-by-vehicle basis. Minor bug fixes.
1.0	2/17/2021	Josh Rosenberg	Atlas Public Policy	Official Launch. Minor bug fixes: resolved fields that allowed for bad input. Added report feature which summarizes analysis and provides ability to export report as a PDF.
1.1	3/1/2021	Josh Rosenberg	Atlas Public Policy	Bug fixes: Resolved issue causing users to be unable to import a fleet file. Added support for transit, school, and coach buses. Next release will include

Version	Date	Author	Organization	Revisions
				optimization to VIN decoding process.
1.2	3/5/2021	Josh Rosenberg	Atlas Public Policy	Bug fixes: Resolved other issue causing users to be unable to import a fleet file. Fixed bug causing application to crash upon inventory sheet selection. Optimization to VIN decoding process where processing time will be a function of unique models. Add user license.
1.3	3/31/2021	Josh Rosenberg	Atlas Public Policy	Increased error reporting when fleet has no valid VINs. Updated data on vehicle availability, fuel prices, energy inflation, emissions, and insurance.
1.4	7/1/2021	Josh Rosenberg	Atlas Public Policy	Bug fixes: Resolved issue causing buses to not be mapped. Feature updates: Added ability to set custom defaults for VMT and Years of Use. Added forecasting feature in the market settings. Added additional guidance on procurement settings. Added values for default charging procurements. Allowed users to start with all defaults preloaded into the tool.
1.5	10/7/2021	Josh Rosenberg	Atlas Public Policy	Added functionality to overwrite dropped VINs. Added ability to add custom vehicles to use in analysis that are not present in default vehicles. Updated vehicles and incentives. Minor bug

Version	Date	Author	Organization	Revisions
				fixes and performance improvements.
1.6	11/5/2021	Josh Rosenberg	Atlas Public Policy	Fixed bug which caused visuals on dashboard to not refresh. Updating Dashboard and Report page visuals. Included Sandbox page to allow users to create their own tables and visuals.
1.7	9/30/2022	Spencer Burget, Josh Rosenberg	Atlas Public Policy	Updated fuel prices and available vehicles. Added ability to apply specific state incentives and rebates for a number of programs. Fixed minor bugs.
1.8	10/21/2022	Spencer Burget	Atlas Public Policy	Updated available vehicles and default vehicle mappings. Fixed formula for loan calculation. Previous calculation was attempting to do monthly accrual of principal and interest payments. This was inaccurate since the model is annual. This change affected loan calculations for vehicles and infrastructure.

APPENDIX D: LICENSE

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