User Guide

Electric Vehicle Incentive Program Excel Tool

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Tool Overview

This tool is meant to help Community Choice Energy agencies predict costs and benefits associated with offering an incentive program to subsidize residents' purchases of battery electric vehicles (BEVs) or plug-in hybrid electric vehicles (PHEVs). Based on a variety of program and agency specifications, the model predicts the number of vehicle purchases that will be directly caused by an incentive program, and then calculates associated greenhouse gas (GHG) emission reductions and health impacts.

The tool uses an innovative modeling technique called a Technology Choice Model (TCM) to predict consumer response to a change in vehicle cost. TCM incorporates both real costs and subjective consumer preferences to make predictions about consumer behavior. Predictions of consumer behavior are then used to calculate the overall impacts of an incentive program.

The tool is organized into a Standard Model that predicts the results of an incentive program and an Expanded Model that predicts the results of offering a Smart Charger program in conjunction with an incentive program.

Using the Tool

Users will interact with the Interface worksheet, which contains all of the user inputs and resulting outputs. At a minimum, users will need to enter values into the Primary Inputs section of the Interface to run the Standard model. This section includes: CCE agency, year, source electricity mix, budget, and incentive amounts. By varying these inputs, users can predict and compare the results of running different BEV and PHEV incentive programs. There are a variety of additional inputs that allow users to users add further program specifications as appropriate. A detailed explanation of all available input options is included in the Interface section of this user guide.

Once the user has filled in the appropriate inputs and run the model, the Toolkit Results section of the Interface will display a summary of model predictions. These include: vehicle purchases caused by the incentive, magnitude and cost-effectiveness of GHG reductions, dollar estimates of total costs and benefits, and an overall benefit-cost ratio. More detailed results are presented below the Primary Outputs section of the worksheet, and a detailed breakdown of all outputs is included under the Outputs heading in the Interface section of this user guide.

The Expanded model produces the same outputs as the Standard model, but requires additional inputs from the user, including energy rate and energy mix broken down by time of day, and desired charging schedule. A full explanation of the Expanded Model inputs is included under the Expanded Model heading in the Interface section of this guide.

How it Works

The core of this tool is the Technology Choice Model (TCM), an economic input-output model that predicts consumer choices given a number of options with distinct costs[1]. In this case, a number of competing vehicle classes are used as purchase options. The model calculates the total costs of each option and adds uncertainty to each cost. This uncertainty represents qualitative factors that influence consumer choice, like personal preference and imperfect information flow. The tool runs thousands of simulations that vary the total costs of each option based on these set uncertainties. For each simulation, the model chooses the lowest cost option for purchase. Taken together, these simulations can be used to construct a predicted market share for the available vehicle classes.

This tool uses TCM and modifies the cost of BEV and PHEV options based on the offered incentive. Altering the overall vehicle costs creates a new market share that is compared to a predicted baseline. The difference between baseline market share and new vehicle market share is used to calculate the proportion of vehicle sales that were directly caused by the incentive, rather than used to subsidize customers that were planning to purchase a BEV or PHEV even without an incentive.

The predicted number of incentive-caused vehicle purchases is used to calculate the benefits associated with the incentive program. GHG and pollutant emissions from these vehicles are compared to the emissions from an average conventional light-duty-vehicle. This difference in emissions is then converted into GHG and health impacts and reported in the tool Outputs. A detailed explanation of calculations and assumptions is included in the Model Structure section of this user guide, under the heading matching the appropriate tool worksheet.

Worksheet Details

The worksheets can be grouped into interface, model and calculations, and data categories.

Interface: This is the worksheet with which users interact to use the tool.

Model and calculations: These worksheets contain the TCM portion of the tool, and the calculations for producing emission impacts. Worksheets in this category include:

- TCModel (Predict)
- TCModel (Base)
- Demand & Impacts
- Electricity Emissions

Data: These worksheets contain the background data that the model uses to make predictions. They include:

- Cost Matrix
- Top Vehicles
- Tailpipe Emissions

This user guide details the content and use of the Interface worksheet.

[1] Kätelhön, Arne, André Bardow, and Sangwon Suh. "Stochastic Technology Choice Model for Consequential Life Cycle Assessment." *Environmental science & technology* 50.23 (2016): 12575-12583.

Interface

This is the main worksheet with which a user will interact. All of the tool's inputs and outputs are included here. The tool is organized into Standard and Expanded modes. Standard inputs and outputs are gathered in columns B through I. Columns K through AI contain inputs to use the tool in its Expanded mode. These deal with time of day energy rates and mixes, and are only necessary if pairing EV incentives with a Smart Charger program.

To use the tool in its Standard mode, at a minimum users will need to enter the relevant information in the Primary Inputs section, detailed below. After entering the appropriate Primary Inputs, a user can run the model by clicking the Calculate button. This will produce predicted results based on the user's Primary Inputs and the model's default values for all remaining input categories.

Additional inputs are organized into Incentive Details, Program Details, Energy Consumption, and Benefit-Cost Valuation sections. These are populated with default values, but can be altered to suit user needs. The following Inputs section details all available inputs and their uses.

Tool outputs are organized into three categories: Vehicle Purchases, Emission Impacts, and Monetized Values. The Primary Outputs section includes a summary of these, and is followed by a more detailed breakdown of results in each category. Primary Outputs include the number of vehicle purchases caused by the incentive, resulting GHG reductions, cost per ton of CO_2e reduced by the program, and dollar estimates of overall costs and benefits. All tool outputs are further detailed in the Outputs section below.

Inputs (Standard Model)

Primary Inputs

These inputs represent the minimum amount of information necessary to run the model. They are:

- **Agency:** The CCE agency that will run the program. The model uses this information to set the correct population level and predict local emissions impacts. If a user selects the "Other" category for this input, they will need to fill in the two subsequent inputs:
    - **Population:** The population served by the agency.
    - **Air district:** The air district where the agency is located.
- **Incentives budget:** The total budget available for incentives, excluding spending on administrative and other costs.
- **Year:** The year that the incentive program will run.
- **BEV (Battery Electric Vehicle) Incentive:** The dollar amount that the agency will offer for each BEV purchase.

- **PHEV (Plug-in Hybrid Electric Vehicle) Incentive:** The dollar amount that the agency will offer for each PHEV purchase."
- **Energy mix:** The composition of the energy mix that is used to charge electric vehicles, used to calculate anthropogenic and biogenic GHG and criteria pollutant emissions. Unspecified power is treated as natural gas for emission calculations.

Incentive Details

These inputs allow agencies to add details about their incentive offerings, enabling more accurate predictions of consumer uptake. They are initially populated with default values that can be altered to match the agency's needs.

- **Include incentive for leased vehicles:** This is a Yes/No input set at Yes by default. Set at Yes the model will include leased vehicles as eligible for an incentive and exclude them if set to No.
- **Include incentive for luxury BEV and PHEV:** These are Yes/No inputs set at No by default. If switched to Yes, the model will include luxury vehicles,e.g. Tesla Model S (BEV) and Audi A3 e-tron (PHEV), among those that receive their respective incentives.
- **Federal tax credit availability/Clean Vehicle Rebate Project availability:** These are Yes/No inputs set at Yes by default. If switched to No, the model will remove that credit or rebate from its calculations of vehicle cost.
- **Additional Discount EV/Plug-in:** Additional discounts on the cost of BEVs or PHEVs, with a default value of $0. These are not included in the agency's overall program costs and may represent discounts offered by vehicle dealers or manufacturers.

Program Details

These allow the user to add details about their program, enabling more accurate predictions of consumer uptake and monetary costs and benefits. For the most part, defaults are provided based on the pilot incentive program that Sonoma Clean Power ran in 2016. Inputs include:

- **Program length:** The number of months that the incentive program will run, with the default set at 12.
- **Number of staff required:** The number of full-time employees needed to run the program, with the default value set at 5.15.
- **Administrative costs per person:** The salary and administrative costs per full time employee working on the program, with the default value set at $124,000 annually.
- **Additional implementation costs:** Any additional anticipated costs to run the program, with the default value is set at $98,000, based on the costs to run SCP's pilot EV incentive program.
- **Percent net revenue:** The percentage of electricity sales that goes to revenues, with a default set at 10%.
- **Marketing effectiveness:** A way to account for the role of marketing on influencing program effectiveness. Users may input the percentage of eligible customers they expect will be aware of the program being offered, with the default value set at 10%. This percentage directly modifies the predicted number of rebates redeemed in response to the inputs used.

Energy Consumption

This section of inputs allows the user to specify the costs of energy that the model will use, and details about how much energy is consumed per vehicle.

- **Average gasoline price:** The cost to fuel internal combustion vehicles, set at the 2016 California average by default.
- **Average electricity rate:** The cost to charge electric vehicles, set at the 2016 California average by default.
- **Rebound effect:** The increase in the amount that people drive once they switch to an electric vehicle from a conventional one. The default value is set at 3%, representing a 3% increase in annual miles driven for new BEV and PHEV drivers.
- **Transmission losses:** Percentage of electricity generated that is lost during transmission from the electricity source to the consumer. The default value is set at 4.23%, representing the California's average 2016 grid losses, according to the EPA.

Benefit-Cost Valuation

These inputs deal with calculating the costs and benefits of the incentive program over time.

- **Agency discount rate:** The annual rate at which future agency revenues are devalued in the CCE agency's financial calculations. The default value is set at 5%.
- **Societal goods discount rate:** The annual rate at which future costs and benefits to society are devalued in the CCE agency's financial calculations. The default value is set at 5%.
- **Carbon value:** The monetary value ascribed to an avoided ton of CO_2e emissions. The default value is set at $13/ton, based on the 2016 California market trading rate for CO_2e.
- **Health impact level:** The level (low, mid, or high) at which health impacts should be valued monetarily. Impacts will more likely be valued at a low level in sparsely populated areas, at a high level in densely populated areas, and so on.

Outputs

Primary Outputs

These include a summary of the main results of the model's calculations and are further examined in subsequent sections. These outputs include:

- **New sales caused by incentives:** This is the model's prediction for new BEVs or PHEVs bought as a result of the incentive program. These represent a fraction of the total number of incentives used by customers.
- **GHG emission reductions:** Predicted GHG emissions avoided because of the incentive program, in tons of CO_2e.
- **Cost of GHG emission reduction:** The cost to the agency per ton of CO_2e emissions avoided through the incentive program. This number is calculated by dividing total costs by tons of CO_2e reduced.
- **Total program costs:** The total costs of the program, minus revenues from added electricity consumption of new vehicle purchases. Revenues are discounted at the agency discount rate for a vehicle lifetime of 15 years.

- **Health benefits:** Monetized benefits to human health resulting from the incentive program. This value is discounted at the societal goods discount rate for a vehicle lifetime of 15 years.
- **GHG reduction benefits:** Monetized benefits of GHG reduction resulting from the incentive program. This value is discounted at the societal goods discount rate for a vehicle lifetime of 15 years.
- **Benefit-cost ratio:** Ratio of total calculated benefits (including program revenue and values of GHG emission reductions and health benefits) to total program costs. This is highly dependent on the amount set for the Carbon value in the Benefit-Cost Valuation section of the Inputs.

Vehicle Purchases

This section provides a breakdown of model predictions for vehicles sold through the incentive program.

- **Incentives used BEV/PHEV:** The model's prediction for number of incentives used for BEVs and PHEVs, limited either by budget or overall demand.
- **Purchases caused by incentives BEV/PHEV:** The model's prediction for number of vehicle purchases that would not have occurred without the incentive offering. This is the number of vehicles used to calculate program benefits.
- **Proportion of sales caused by incentive BEV/PHEV:** The proportion of incentivized BEV and PHEV purchases that were directly caused by the incentive offering.

Emissions Impact

This section provides further breakdown of model calculations for the emission reductions resulting from the incentive program.

- **GHG emission reductions:** Predicted GHG reductions in tons of CO_2e over the lifetime of the vehicles purchased because of the incentive program. This value is broken down further into the following components:
    - **Avoided emissions from conventional vehicles:** The CO_2e emissions that would have occurred in the absence of the incentive program from vehicles replaced by BEVs and PHEVs.
    - **Anthropogenic charging emissions:** Anthropogenic CO_2e emissions that result from charging BEVs and PHEVs that were purchased because of the incentive program. These include emissions from all electricity sources except for biomass.
    - **Biogenic charging emissions:** Biogenic CO_2e emissions that result from charging BEVs and PHEVs that were purchased because of the incentive program. Biogenic emissions include those released from the use of biomass as an energy source. These are not included in the overall calculation of emission impacts resulting from the incentive program.
- **Smart Charger reductions:** The tons of CO_2e reduced resulting from the Smart Charger program.
- **Smart Charger percent reductions:** Percent of total GHG emission reductions caused by the Smartcharger program.

- **Criteria Pollutant Reductions:** The emission reductions in kg of relevant criteria pollutants, including PM2.5, PM10, SOx, and NOx.

Monetized Values

This section presents model calculations for program costs and benefits converted to dollars, including:

- **Health effect.**
- **GHG emissions reduction.**
- **Revenue increase:** Revenues provided by electricity consumption from incentive-caused BEVs and PHEVs.
- **Customer saving due to Smart Charger program:** Electricity cost savings for customers using Smart Chargers.
- **Net Revenue:** Net revenues to the agency from electricity revenues.
- **Total costs for EV incentive program:** The total rebate, administrative, and implementation costs of an incentive program.
- **Total costs for Smart Charger program:** The total costs associated with offering a Smart Charger program.

Expanded Model (For Smart Charger program)

This set of inputs is necessary to fill out if the user wants to include a Smart Charger program in conjunction with the incentive program. Agencies can control when Smart Chargers charge an EV and use them to reduce peak electricity loads. To use this section of the model, the user must set the Smart Charger program option to "Yes" and fill in the remaining tables to specify energy rate and mix by time of day.

- **Smart Charger program:** Yes/No input with No set as the default. Inputting Yes will allow the Expanded model to run, and override the Energy Mix included in the Primary Inputs of the Standard model.
- **Smart Charger cost:** The cost to the agency for 1 Smart Charger.
- **Additional costs:** Additional costs of implementing a Smart Charger program.
- **Percent of customers receiving Smart Charger:** The percent of customers receiving an incentive that are expected to receive a Smart Charger.
- **Energy rate by time of day ($/kWh):** This table specifies the agency's hourly energy rate structure in $/kWh. Users can input distinct energy rates for weekend and weekdays in summer and winter.
- **Energy mix by time of day ($/kWh):** This table specifies the agency's hourly energy mix. Setting Smart charger Program to "Yes" and filling out this table will override the Energy Mix section of the Primary Inputs.