User Guide of the ORNL MA^{3}T Model (V20130729)

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Table of Contents

List of Abbreviations 2
1 Introduction 3
2 File structure 4
3 Running the model 5
4 Viewing and using the results 7
4.1 Result by choice 7
4.2 Result by consumer 8
5 Changing inputs 8
5.1 Scenario 9
5.2 Market segmentation 12
5.3 Energy prices 14
5.4 Policy 14
6 Saving and loading the input file 15
References 15

List of Abbreviations

AC	Alternating Current
AEO	Annual Energy Outlook
ARRA	American Recovery and Reinvestment Act of 2009
Autonomie	Vehicle simulation model developed by Argonne National Laboratory
Bbl	Barrel
Btu	British Thermal Unit
CAFE	Corporate Average Fuel Economy
CD	Charge-Depleting
CS	Charge-Sustaining
CI	Compression Ignition
CNG	Compressed Natural Gas
EIA	Energy Information Administration
BEV	Battery Electric Vehicle
EREV	Extended-Range Electric Vehicle
FC	Fuel Cell
GGEPM	Gasoline Gallon Equivalent Per Mile
GPM	Gallon Per Mile
H2	Hydrogen
HEV	Hybrid Electric Vehicle
HOV	High Occupancy Vehicle
HWFET	Highway Fuel Economy Test
ICE	Internal Combustion Engine
LDV	Light-Duty Vehicle
LTK	Light-Duty Truck
MA^3T	Market Acceptance of Advanced Automotive Technologies
MBOED	Million Barrels Oil Equivalent per Day
MSA	Metropolitan Statistical Area
MSRP	Manufacturer's Suggested Retail Price
NMNL	Nested Multinomial Logit
PHEV	Plug-In Hybrid Electric Vehicle
SI	Spark Ignition
TgCO2eq	Teragrams of CO2 Equivalent
UDDS	Urban Dynamometer Driving Schedule

1 Introduction

The Market Acceptance of Advanced Automotive Technologies (MA^3T) model has been developed by Oak Ridge National Laboratory (ORNL) as a tool for analyzing scenarios of demand for various automotive powertrain technologies in response to changes in technologies, infrastructure, energy prices, consumer preferences, and policies. Implemented using Microsoft® Excel for Windows, MA^3T simulates market demand by representing relevant attributes of technologies and consumer behavior, such as technological learning by doing, range anxiety, access to recharging points, daily driving patterns and willingness to accept technological innovation. Much remains to be learned about how consumers will evaluate novel vehicle technologies, such as plug-in hybrid electric vehicles (PHEV), extended-range electric vehicle (EREV), battery electric vehicles (BEV) and fuel cell vehicles (FCV), as well as how these vehicles are likely to be operated. Due to data limitation, the approach taken in developing the MA^3T model is to create a framework for integrating data and behavioral models at an appropriate level of detail, whether or not the data are fully available or the behaviors are fully understood at the present time. As more is learned about the advanced vehicle technologies and consumers' preferences towards them, the model will be continuously updated and improved.

Currently, MA^3T includes 40 choices, consisting of 20 powertrain technologies for each of the 2 vehicle size classes—passenger cars and light-duty trucks. MA^3T considers the U.S. household users of light-duty vehicles (LDV) as the consumer market, which is disaggregated into 1,458 segments by six dimensions: 9 census divisions, 3 residential areas, 3 attitudes towards novel technology, 3 driving patterns, 3 home recharging situations, and 2 work recharging situations. MA^3T currently has a study period from 2005 to 2050, which includes a calibration period of 2005-2011, a validation year of 2012, and the projection period of 2013-2050. All prices are expressed in 2005 US dollars.

In its core, MA^3T uses the nested multinomial logit (NMNL) method to predict purchase probabilities among 40 choices by each of the 1,458 consumer segments, based on value components associated with vehicle attributes, driver behavior, infrastructure, energy prices, and policies (Figure 1). The segment purchase probabilities are translated into market share, sales, vehicle populations, petroleum use, and greenhouse gas (GHG) emissions. Some of the outputs serve as feedback signals and, together with other exogenous inputs from various sources, affect the purchase probabilities.

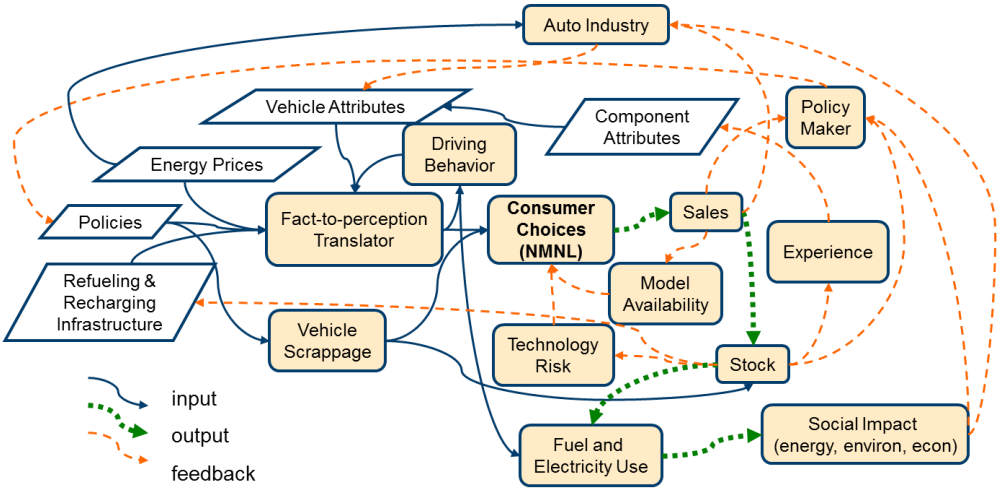

Figure 1. MA^{3}T Model Framework.

This report is intended to provide general instructions regarding how to use MA^{3}T. For a more detailed description of the methodology and applications, readers are encouraged to refer to Lin and Greene (2010, 2011).

The rest of the report is organized as follows. In Section 2, the file structure of MA^{3}T is introduced, followed by the description of the procedures to run the model in Section 3. After running the model, a result file will be generated, which is explained in Section 4. Finally, the last two sections describe how to change input assumptions and generate new scenarios.

2 File structure

The ORNL MA^{3}T model simulates competition of 40 vehicle technologies (see Table 2 for a complete list of these vehicle technologies). The model consists of two files, which are required to run MA^{3}T:

- ORNL_MA3T_v*yyyymmdd*.xlsm– the core model file,
- and MA3T_Result_Template.xlsx – the result template file.

The date number *yyyymmdd* in the core file name is the model release date and can be used for identifying the model version.

In addition, there are two other types of files that could be generated from using or executing MA^{3}T, namely result files and input files.

A result file is generated by running MA^{3}T and saved to the same folder where the core model file is located. Result files are named as "MA3T_Result_*ScenarioName*_R***x***.xlsx", where *ScenarioName* is the name of the scenario assigned in the core model file (Cell "B2" of Worksheet "Scenario") and ***x*** is the index of the run for the same scenario and will be assigned the value 1, 2, 3 and so on until there is no filename conflict with existing result files in the folder.

An input file is generated when the user clicks the SAVE button in the "Main" worksheet of the core model file to save all the inputs, data and assumptions that have been modified (see Section 4.3 for details). It is recommended, but not required, to name "Scenario- *ScenarioName*.xls", with the same definition for *ScenarioName* as previously mentioned.

It is recommended that these two core files are kept as read-only. Any changes of assumptions should be saved using the SAVE button in the 'Main' worksheet of the core model file into a separate input file.

3 Running the model

When the core model file (ORNL_MA3T_*yyyymmdd*.xlsm) is opened, Excel will automatically open the workbook to the "Main" worksheet. There are five buttons on this worksheet, namely SAVE, LOAD, SINGLE RUN, MULTI RUN, and CALIBRATE.

The core model file by default is loaded with the Base scenario which was calibrated to historical data between 2005 and 2011 and to AEO 2012 Reference case (EIA, 2012) with respect to the total LDV sales from 2012 to 2050.

Before running the model, users need to make sure that:

- Both the core model file and the result template file are located in the same folder;
- The result template file is closed. Error message (as shown in Figure 2) will pop up if the result template file is open while running the model due to a file access conflict.

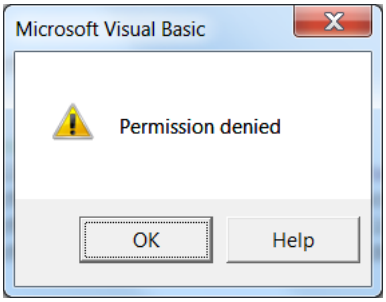

Figure 2. Error message when result template file is open.

To execute the MA^{3}T model for a single scenario, the following steps are suggested:
Step 1 (optional): Create a new scenario.

- Modify as needed the input tables in each of the "Scenario", "Segmentation", "EnergyPrices" and "Policy" worksheets, and click the SAVE button to create a new input file that consists of these 4 worksheets (see Section 4.3).
- If needed, click the LOAD button to load an input file (see Section 6).

Step 2: Run the model.

- Click the RUN button on the "Main" worksheet. A progress indicator window (see Figure 3) will pop up.

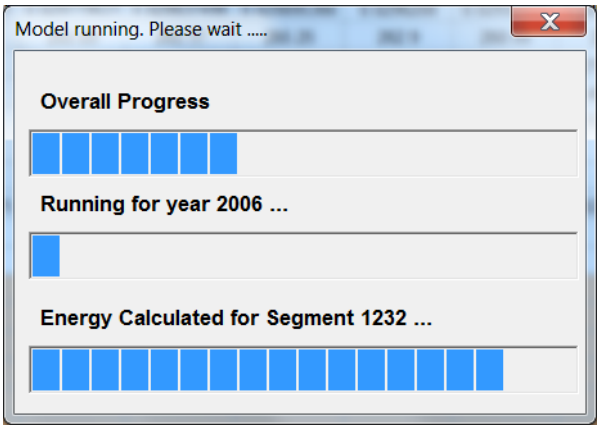

Figure 3. Progress indicator window

- Wait until the progress indicator window closes and the completion message pops up (see Figure 4).

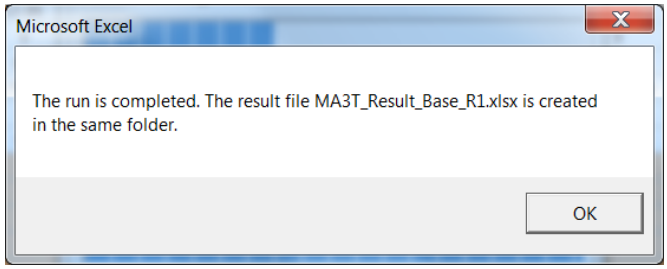

Figure 4. Completion indicator window

- If needed, press Esc to show the interruption window (Figure 5) and click the 'End' button to abort the simulation. If the interruption window does not show, press and hold 'Esc' for a few seconds.

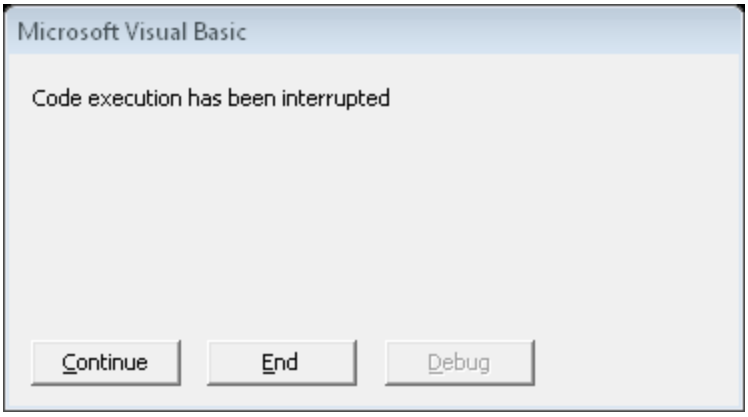

Figure 5. Program interruption window

Step 3: A result file will be automatically generated and stored in the same folder as the core model files.

To execute the MA^{3}T model for multiple scenarios, prepare multiple input files that represent the scenarios of interest. Then click on the MULTI RUN button, a dialogue window will appear to allow selecting those input files. Then MA3T will run those selected input files one by one and save all the result files in the same folders. It is useful to make sure those input files have unique scenario name in their B2 cell of the Scenario sheet. The completion indicator window as in Figure 4 will not appear after each run, so that the user does not need to interact during the whole process of running multiple scenarios.

The CALIBRATE button is disabled for users. It is currently only used by model developers to calibrate model coefficients with new historical data.

4 Viewing and using the results

There are three worksheets in the result file, namely "ResultByChoice", "ResultByConsumer" and "ResultForFleet".

4.1 Result by choice

The "ResultByChoice" worksheet contains the following outputs for each vehicle technology and for each year.

Table 1. Results for each vehicle choice and for each year

Output	Description
Average Fuel Efficiency (GPM)	Average fuel efficiency in gallon per mile
Fuel Availability (100%)	Fuel availability in percentage, which is the ratio of the number of alternative fuel refueling stations to the number of gasoline stations
Recharge Availability (100%)	Recharge facility availability in percentage of vehicles
Purchase Subsidy (USD)	Subsidy in US dollars
Stock (Thousands)[1]	Stock in thousands of vehicles
Vehicle MSRP (USD)	Manufacturer's suggested retail price in US dollars
Annual Sales (Thousands)	Annual sales in thousands of vehicles
Fuel Demand (MBOED)[2]	Fuel demand in million barrels oil equivalent per day
Electricity Demand (Million kWh/Year)	Electricity demand in million kilowatt-hours per year
Experience (Thousands)	The equivalent cumulative production of vehicles in thousands
Carbon Dioxide from Fuel (Tg CO2eq/Year)[2]	Carbon Dioxide generated from fuel use in teragrams of CO2 equivalents per year
Feebate (USD)	Feebate in US dollars

1. *MA^{3}T has a vehicle scrappage component that simulates the evolvement of vehicle stocks by technology and by vehicle age. Alternatively, MA^{3}T users can use the VISION model* (Ward et al., 2008) *developed by the Argonne National Laboratory to simulate the evolvement of vehicle stocks.*

2. *Fuel demand and CO2 emissions are currently based on tank-to-wheel, not well-to-wheel.*

4.2 Result by consumer

The estimated purchase probabilities and sales by vehicle type and by market segmentation are listed in the "ResultByConsumer" worksheet.

The household market is disaggregated into 1,458 segments by six dimensions: 9 census divisions (i.e. New England, Mid-Atlantic, East North Central, West North Central, South Atlantic, East South Central, West South Central, Mountain and Pacific), 3 residential areas (i.e. central city, suburban and rural), 3 attitudes towards novel technology (i.e. early-adopter, early-majority and late-majority), 3 driving patterns (i.e. modest-driver (driving 8,656 miles annually), average-driver (16,068 miles), frequent-driver (28,288 miles)), 3 home recharging situations (i.e. Level I, Level II, and None), and 2 work recharging situations (i.e. with and without work recharging facility). For each consumer segment, the probability of purchasing a specific type of vehicle is estimated separately using the NMNL method.

4.3 Result for Fleet

The "ResultForFleet" worksheet contains outputs that are related to the whole LDV fleet.

Output	**Description**
Consumer Surplus ($/HH)	The consumer surplus for a U.S. household.

5 Changing inputs

The core model file by default is loaded with the Base case assumptions. However, users can change these assumptions. There are four sets of assumptions defined in the core model file:

- technology assumptions in the "Scenario" worksheet;
- market segmentation assumptions in the "Segmentation" worksheet;
- energy price projections in the "EnergyPrices" worksheet;
- and policies in the "Policy" worksheet.

Though changing the numbers is allowed, the structure of the workbook and each worksheet need to be maintained. Otherwise, the core model file could be damaged. A backup of the model is recommended.

Model updates can result in changes in the structure of the input file. If this happens, any input files saved by the old versions of MA^{3}T will not be compatible with the newer versions of MA^{3}T. To use the old input files, the following practices are recommended:

- When making permanent input changes, always make changes in the input files, not in the core model file;
- After making changes in the input files, highlight the modified inputs by changing the text or cell format (e.g. filling the cells with your choice of color);

- When a newer version of MA^{3}T becomes available, save the default base scenario into an input file;
- Copy the modified inputs from the old input file into the corresponding cells in the new input file generated by the new MA^{3}T version;
- Again, change the modified inputs in the new input file to your choice of format.

5.1 Scenario

In the "Scenario" worksheet, the following tables are included.

Table "Scenario Name": By default, it is listed as "Base". When changes are made in the core model file or the input file, it is recommended to rename the scenario and save it as a new input file.

Table "TOTAL U.S. LIGHT-DUTY VEHICLE SALES": This table lists national LDV sales in the U.S. from 2005 to 2050. The national LDV sales are exogenous input. In the Base scenario, the national LDV sales are based on the AEO 2011 Reference case (EIA, 2011).

Tables "*Vehicle Technology* -- CHOICE ATTRIBUTES": 40 vehicle technologies (as listed in Table 2) and their attributes (Table 3) are defined in the subsequent tables. The vehicle attributes in the Base scenario are based on outputs of the Autonomie model as provided by Argonne National Laboratory (http://www.autonomie.net/).

Note that in the Base scenario, all EREV choices have the same attribute values with the SI PHEV of the same electric range, except the MSRP. For example, EREV40 has the same attribute values as SI P40. This is done to allow users to have the option of treating a PHEV as an EREV. On the other hand, the MSRPs of all EREV choices are multiplied by 10, which basically price out EREVs in the Base scenario. Users can choose to restore the competitiveness of EREVs by dividing the enlarged MSRPs by 10.

Table 2. Vehicle Technologies

Index	Abbreviation	Description
1	SI Conv Car	Spark Ignition Conventional Car
2	CI Conv Car	Compression Ignition Conventional Car
3	NG Conv Car	Natural Gas Internal Combustion Engine Car
4	SI HEV Car	Spark Ignition Hybrid Electric Car
5	CI HEV Car	Compression Ignition Hybrid Electric Car
6	NG HEV Car	Natural Gas Hybrid Car
7	SI P10 Car	Spark Ignition Plug-in Hybrid Electric Car with 10 miles of Charge-Depleting Range
8	SI P20 Car	Spark Ignition Plug-in Hybrid Electric Car with 20 miles of Charge-Depleting Range
9	SI P40 Car	Spark Ignition Plug-in Hybrid Electric Car with 40 miles of Charge-Depleting Range

10	H2 ICE Car	Hydrogen Internal Combustion Engine Car
11	FC HEV Car	Fuel Cell Hybrid Electric Car
12	FC P10 Car	Fuel Cell Plug-in Hybrid Electric Car with 10 miles of Charge-Depleting Range
13	FC P20 Car	Fuel Cell Plug-in Hybrid Electric Car with 20 miles of Charge-Depleting Range
14	FC P40 Car	Fuel Cell Plug-in Hybrid Electric Car with 40 miles of Charge-Depleting Range
15	BEV100 Car	Battery Electric Car with 100-mile Range
16	BEV150 Car	Battery Electric Car with 150-mile Range
17	BEV 250 Car	Battery Electric Car with 250-mile Range
18	EREV10 Car	Extended-Range Electric Car with 10 miles of Charge-Depleting Range
19	EREV20 Car	Extended-Range Electric Car with 20 miles of Charge-Depleting Range
20	EREV40 Car	Extended-Range Electric Car with 40 miles of Charge-Depleting Range
21	SI Conv LTK	Spark Ignition Conventional Light-duty Truck
22	CI Conv LTK	Compression Ignition Conventional Light-duty Truck
23	NG Conv LTK	Natural Gas Internal Combustion Engine Light-duty Truck
24	SI HEV LTK	Spark Ignition Hybrid Electric Light-duty Truck
25	CI HEV LTK	Compression Ignition Hybrid Electric Light-duty Truck
26	NG HEV LTK	Natural Gas Hybrid Light-duty Truck
27	SI P10 LTK	Spark Ignition Plug-in Hybrid Electric Light-duty Truck with 10 miles of Charge-Depleting Range
28	SI P20 LTK	Spark Ignition Plug-in Hybrid Electric Light-duty Truck with 20 miles of Charge-Depleting Range
29	SI P40 LTK	Spark Ignition Plug-in Hybrid Electric Light-duty Truck with 40 miles of Charge-Depleting Range
30	H2 ICE LTK	Hydrogen Internal Combustion Engine Light-duty Truck
31	FC HEV LTK	Fuel Cell Hybrid Electric Light-duty Truck
32	FC P10 LTK	Fuel Cell Plug-in Hybrid Electric Light-duty Truck with 10 miles of Charge-Depleting Range
33	FC P20 LTK	Fuel Cell Plug-in Hybrid Electric Light-duty Truck with 20 miles of Charge-Depleting Range
34	FC P40 LTK	Fuel Cell Plug-in Hybrid Electric Light-duty Truck with 40 miles of Charge-Depleting Range
35	BEV100 LTK	Battery Electric Light-duty Truck with 100-mile Range
36	BEV150 LTK	Battery Electric Light-duty Truck with 150-mile Range
37	BEV250 LTK	Battery Electric Light-duty Truck with 250-mile Range
38	EREV10 LTK	Extended-Range Electric Light-duty Truck with 10 miles of Charge-Depleting Range
39	EREV20 LTK	Extended-Range Electric Light-duty Truck with 20 miles of Charge-Depleting Range
40	EREV40 LTK	Extended-Range Electric Light-duty Truck with 40 miles of Charge-Depleting Range

Table 3. Vehicle Attributes

Attribute	Description
Vehicle MSRP ($)	Manufacturer's suggested retail price
Fuel Consumption, UDDS, CD, Fuel (GGEPM)	Fuel consumption in gasoline gallon equivalent per mile during charge-depleting mode, based on Urban Dynamometer Driving Schedule
Fuel Consumption, HWFET, CD, Fuel (GGEPM)	Fuel consumption in gasoline gallon equivalent per mile during charge-depleting mode, based on Highway Fuel Economy Driving Schedule
Fuel Consumption, UDDS, CS, Fuel (GGEPM)	Fuel consumption in gasoline gallon equivalent per mile during charge-sustaining mode, based on Urban Dynamometer Driving Schedule
Fuel Consumption, HWFET, CS, Fuel (GGEPM)	Fuel consumption in gasoline gallon equivalent per mile during charge-sustaining mode, based on Highway Fuel Economy Driving Schedule
Electricity Consumption, UDDS, CD (Wh/mi)	Electricity consumption in watt hour per mile during charge-depleting mode, based on Highway Fuel Economy Driving Schedule
Electricity Consumption, HWFET, CD (Wh/mi)	Electricity consumption in watt hour per mile during charge-depleting mode, based on Highway Fuel Economy Driving Schedule
Range, blended CD, UDDS (mile)	Blended charge-depleting range in miles, based on Highway Fuel Economy Driving Schedule
Range, blended CD, HWFET (mile)	Blended charge-depleting range in miles, based on Highway Fuel Economy Driving Schedule
Acceleration 0-60 mph (s)	Acceleration time in seconds from 0 to 60 mile per hour
Cargo/Luggage Space (cu.f)	Cargo/luggage space in cubic feet
Towing Capability (kg)	Towing capability in kilograms
H2 Storage (kg)	Hydrogen storage capacity in kilograms
Liquid Fuel Storage Capacity (GGE)	Liquid fuel storage capacity in gasoline gallon equivalent
Refueling Time (min)	
Fast Recharging Time (min)	
Fuel Availability	
Recharge Availability	
Electricity Generation Capability	
Discharge Availability	
Battery Electricity Storage Capacity (kWh)	Battery electricity storage capacity in kilowatt hour
Free Parking (year)	1: Free parking is granted for the year; 0: otherwise
HOV access (year)	1: HOV access is granted for the year; 0: otherwise
Subsidy ($)	Subsidy in US dollars

Battery cost ($)	Battery cost in US dollars
Battery service cost ($)	Battery service cost in US dollars
Battery life, time (year)	Battery life in years
Battery life, distance (mile)	Battery life in miles
Sales	
Stock	

Note: In the current version, the shaded attributes are unchangeable, not available, treated endogenously, or assigned elsewhere in the model.

The last three tables contain parameters regarding recharging availability, acceleration for battery cost projection and learning-by-doing, respectively.

Table "Endogenous Recharging Infrastructure Deployment": This table is used when the "Charging/Refueling Infrastructure Deployment" table in the "Policy" worksheet is selected as "Endogenous". By default, the refueling facility availability is determined exogenously using the "Charging/Refueling Infrastructure Deployment" table. The parameters of the response function in the Base scenario is preliminarily calibrated based on limited data on gasoline, diesel, hydrogen, natural gas, and charging infrastructure.

Table "Years of Acceleration for Battery Cost Projection": The years of acceleration for battery cost projection, defaulted to 0, can be specified as a non-negative integer (n). The row of battery cost (one of the vehicle attributes listed in Table 3) will be shifted by n years to the left to reflect the accelerated reduction in battery cost. This will also result in an accelerated reduction in MSRPs. The Base scenario assumes no acceleration.

Table "Learning-by-Doing Parameters": The learning-by-doing function is defined by two parameters, which are specified in this table. With the assumption of an asymptotic learning-by-doing function (Yeh et al., 2007), the retail price is formed by amplifying the fully-learned price difference between the vehicle technology of concern and the reference technology. The reference vehicle technology is defined as the one with the lowest retail price, which is typically the gasoline conventional vehicle. However, in some future years, an advanced vehicle technology might have a lower price compared to the conventional vehicle. Specifically, the actual MSRP (P_n) is an exponential function of the cumulative production n, governed by the mature MSRP of the vehicle technology (P_∞), the MSRP of the reference technology in the corresponding year (P_{ref}), and two parameters (a_1 and a_2). The parameters of the asymptotic learning-by-dong function in the Base scenario is calibrated by ensuring that the equivalent varying progress ratio falls close to the mean of the empirical range 0.7-0.9 (Wene, 2000).

$$P_n = (1 + a_1 \cdot e^{a_2 \cdot n}) \cdot (P_\infty - P_{ref}) + P_{ref} \quad (1)$$

Table "Annual Discounting Rate": By default, a 7% annual discount rate is assumed to compute the present value.

$$NPV = \frac{R_t}{(1+i)^t} \quad (2)$$

where

NPV = net present value
R_t = the cost at year t
t = year
i = discount rate

Table "Installed Home Charger Cost": The installation cost of level 1 and level 2 chargers is $878 and $2146, respectively (Morrow, 2008).

5.2 Market segmentation

In the "Segmentation" worksheet, six tables are defined to describe the segmentation of the market.

Table "Regional Share of Sales" describes the shares of sales by region from 2005 to 2050. For each year, the sum of all the regional shares needs to be 100%. The regional shares of LDV sales in the Base scenario are based on the AEO 2011 Reference case (EIA, 2011).

Table "Area Type" further segments the LDV sales within each region into three residential areas, namely central city inside MSA (or central city), suburb inside MSA (or suburban) and outside MSA (or rural). The residential area percentages in the Base scenario are based on the census population data 2000 from the U.S. Census Bureau (Census Bureau, 2000).

Table "Attitude" lists the percentage of attitude toward technology risk. An Early-Adopter perceives some benefit of owning a vehicle with a novel technology (novelty is measured by the accumulated stock of the technology). Members of the Early-Majority perceive a cost and those categorized as Late-Majority perceive an even higher cost. The percentages in the Base scenario are obtained based on the innovation diffusion theory (Rogers, 1962; Santini and Vyas, 2005).

Table "Driver" describes the shares of three levels of vehicle usage intensity. Driver Type 1 (Modest) drives on average 8,656 miles annually; Driver Type 2 (Average) drives 16,068 miles per year; and Driver Type 3 (Frequent) are those who drive 28,288 miles per year. The shares of each driver type by region and area in the Base scenario are estimated from the National Household Travel Survey (NHTS) 2001 (FHWA, 2002).

Table "Charge Level" describes the home charging amenity shares by area type and by charging facility type. The share estimates are based on the number of households in each census division and each residential area, according to the 2005 American Housing Survey (Census Bureau, 2005). Level 1 charging typically uses a standard electrical outlet with 120 Volt AC. Level 2 charging facility provides 240 Volt AC.

Table "Work Recharge Availability" lists the availability of work recharging facility as of year 2005. The percentages in the Base scenario are drawn from an early survey (Axsen and Kurani, 2009).

5.3 Energy prices

In the "EnergyPrice" worksheet, regional prices of gasoline, diesel, electricity, natural gas and hydrogen are defined.

Table "Implicit Price Deflator" lists the implicit price deflator, which is obtained from Annual Energy Review 2010 (EIA, 2010), Table D1, p. 383.

Table "Heat Content" lists the heat content of gasoline, diesel and electricity, which is used for energy unit conversion in the subsequent tables. Note that the corresponding values in tables "2005$/million Btu" and "2005$/gge" can be converted from one to another using the energy unit conversion. Though it is suggested to modify both tables to maintain consistency, only the values in "2005$/gge" will be used as input in the model.

Tables "Gasoline", "Diesel", "Electricity" and "Nature Gas" list the corresponding prices of gasoline, diesel, electricity and nature gas by census division. In particular, 2004-2007 prices of gasoline, diesel, and electricity come from Supplemental Tables to the Annual Energy Outlook 2007 and 2009 (EIA, 2007 and 2009), Tables 11-19. Natural gas prices are copied from the year 2008. However, this has no modeling impact as natural gas vehicles are not considered prior to 2008 in the choice model. The 2008-2035 prices come from Supplemental Tables to the Annual Energy Outlook 2011 (EIA, 2011), Tables 3. The 2036-2050 prices are extrapolated from the EIA projections.

Tables "Hydrogen" list prices of hydrogen, which are projected based on Greene et al. (2007), Fig. 41, p. 42. In addition, $0.50 is added to hydrogen prices to account for potential fuel taxes.

5.4 Policy

The "Policy" worksheet contains ten policies that affect consumer's choices.

Table "Purchase Subsidy" lists subsidy in 2005 US dollars for purchasing each type of vehicles from 2005 to 2050. The value of purchase subside in the Base scenario is 0.

Table "Tax Credit" lists tax credit in 2005 US dollars for purchasing each type of vehicles from 2005 to 2050. The ARRA Tax Credit for BEV/PHEV (EIA, 2011) is reflected in the model and thus is not included in this table. The value of additional tax credit in the Base scenario is 0.

Table "Battery Warranty Extension Multiplier" lists the multiplier of battery warranty extension (α). Federally-backed advanced battery warranty would allow manufacturers and the federal government to share financial risk from batteries that fail prematurely after the BEV/PHEV purchase. The warranty of the battery is extended to α times of the original value. The value of the warranty extension ratio in the Base scenario is 1.

Tables "Free Parking" and "Free HOV Access" describe whether free parking or HOV access is granted for a vehicle type in a particular year, respectively. In the Base scenario neither "free parking" nor "free HOV access" is granted for all years.

Table “CAFE Fuel Economy Target” provides the Corporate Average Fuel Economy (CAFE) fuel economy target for passenger cars and light-duty trucks in miles per gallon. The CAFE standard is used as a reference point for the Feebate policy.

Table “Feebate Coefficients for Formula” lists the Feebate coefficients. A positive value of Feebate means subsidy and a negative value means penalty. In the Base scenario, the Feebate coefficients are 0 and thus no Feebate is applied.

Table “Charging/Refueling Infrastructure Deployment” describes the deployment of charging/refueling infrastructure. It consists of two scenarios, namely charging infrastructure scenario for electricity charging and refueling infrastructure scenario for gasoline, diesel, natural gas and hydrogen fueling. This table is used in the choice model when recharging availability is exogenously (by default) defined; otherwise, the “Endogenous Recharging Infrastructure Deployment” formula in “Scenario” worksheet is used (see Section 5.1).

Table “Value of Range Anxiety” specifies the value of range anxiety for consumers with different attitudes toward technology risk. The anxiety ranges are applied across all years. The default values in the Base scenario are assumed to be 10, 20 and 50 dollars per day for early adopter, early majority and late majority, respectively.

Table “ARRA PEV Incentive Parameters” specifies the number of OEMs to produce eligible PEVs and the relevant parameters for ARRA incentives. These values are applied across all years before the ARRA incentives expire.

6 Saving and loading the input file

After changing the assumptions and specifying a unique name for the scenario, the user should click the SAVE button to save the four input worksheets as a new input file.

By clicking the LOAD button, the saved input file can be loaded for running a new scenario.

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