Modeling the Market Acceptance of Advanced Automotive Technologies

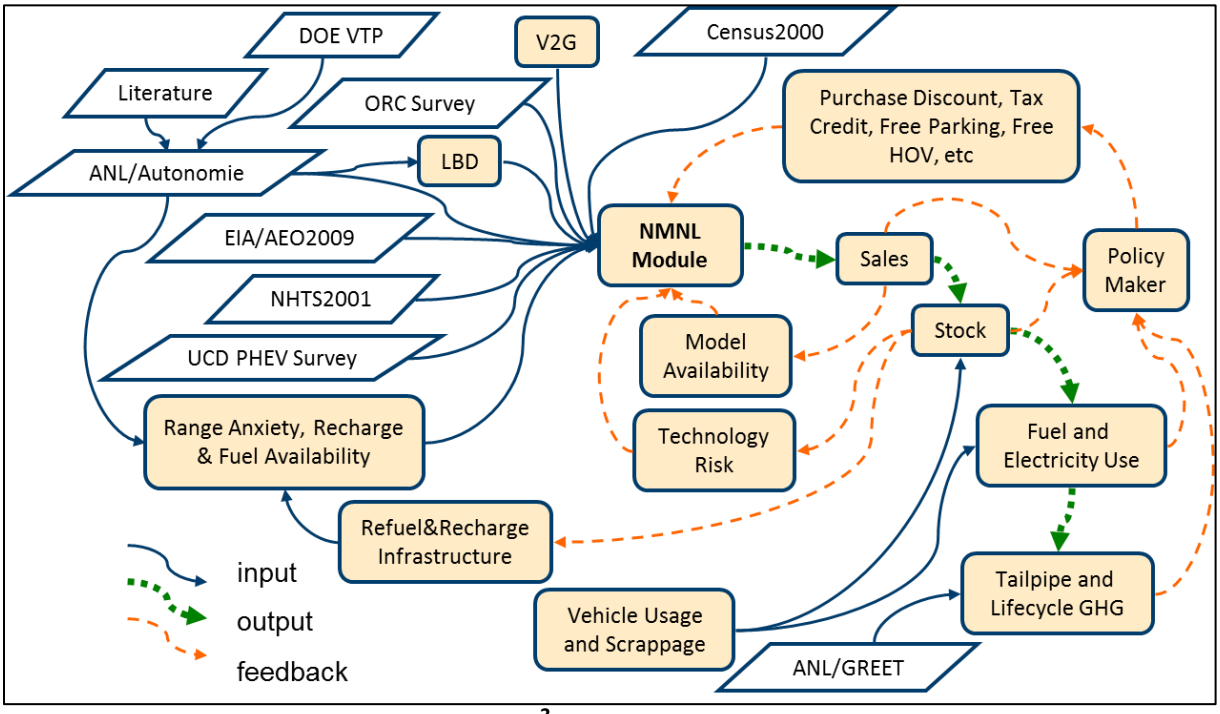
Understanding the diverse purchasing behaviors among individuals is key for designing efficient and effective policies for promoting advanced vehicle technologies. To address this need, ORNL developed the Market Acceptance of Advanced Automotive Technologies (MA^3T) model, a market simulation model for the DOE Vehicle Technologies Program. Implemented using Microsoft Excel for Windows, MA^3T simulates market demand for advanced vehicle technologies 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 and how these vehicles are likely to be operated. Because of this, the approach taken in developing the MA^3T model was 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 fully understood. As more is learned about the advanced vehicle technologies and consumer preferences toward them, the model will be continuously updated and improved.

What distinguishes MA^3T from other vehicle market models are technology richness, detailed consumer segmentation, market dynamics, daily distance distribution, and range-infrastructure characterization. MA^3T includes 40 choices consisting of 20 powertrain technologies for each of two vehicle size classes—passenger cars and light duty trucks. MA^3T considers U.S. household users of these vehicles as the consumer market, which is disaggregated into 1,458 segments based on 6 dimensions: census divisions, residential areas, attitudes toward novel technologies, driving patterns, home recharging situations, and work recharging situations. MA^3T projections currently cover the period from 2005 to 2050 and capture the temporal interaction between market penetrations and product diversity and risk. MA^3T characterizes daily driving distance variation with the Gamma distribution, validated with real-world high-resolution travel data. MA^3T explicitly quantifies range anxiety for electric vehicles and reflects the effect of charging and refueling infrastructure on the appeal of plug-in electric vehicles and alternative fuel vehicles.

The core of the model is a nested multinomial logit method that predicts purchase probabilities among 40 choices by each of the 1,458 consumer segments based on value components associated with vehicle attributes, user behavior, infrastructure, energy prices, and policies (figure). The segment purchase probabilities are translated into market penetrations, sales, populations, petroleum use, and greenhouse gas emissions. Some of the outputs serve as feedback signals and, together with other exogenous inputs from various sources, affect the purchase probabilities.

MA^3T can be used to analyze important issues of vehicle technologies and transportation energy, such as the required government support for promoting vehicle electrification in order to meet certain environmental and energy goals, and the role of infrastructure deployment in the clean energy vehicle market. The model has been applied in studies resulting in several peer-reviewed articles. Improvement

of the model is ongoing, in response to user feedback and new policy questions, but copies of the model and related publications can be provided upon request.



MA^{3}T model framework.

Related References:

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3. Z. Lin and D. Greene (2011). "Promoting the Market for Plug-in Hybrid and Battery Electric Vehicles: the Role of Recharge Availability," *Transportation Research Record,* No. 2252, pp. 49-56.
4. Z. Lin and D. Greene (2011). "Assessing Energy Impact of Plug-In Hybrid Electric Vehicles: Significance of Daily Distance Variation over Time and among Drivers," *Transportation Research Record,* No. 2252, pp. 99-106.
5. Z. Lin and D. Greene (2010). "Who Will More Likely Buy PHEV: A Detailed Market Segmentation Analysis," presented at the 25th World Battery, Hybrid and Fuel Cell Electric Vehicle Symposium & Exhibition, Shenzhen, China, November 5–9, 2010.
6. Z. Lin and D. Greene (2010). "A Plug-in Hybrid Consumer Choice Model with Detailed Market Segmentation," DVD-ROM of the 89th Annual Meeting of the Transportation Research Board, Washington, DC, January 10–14, 2010.