The Market Acceptance of Advanced Automotive Technologies (MA^3T) Model

MODEL PURPOSE

The Market Acceptance of Advanced Automotive Technologies (MA^3T) model endogenously estimates the demand for vehicle powertrain technologies as a function of technology, infrastructure, consumer and policy (TICP) factors.

Examples of questions addressed by MA3T:

- To what extent the reduction of battery cost to $150/kWh by 2030 can increase the sales of plug-in electric vehicles, reduce petroleum use and greenhouse gas emissions?
- What is the cost-effective deployment strategy for home, workplace, public, wired and wireless charging infrastructure for accelerating vehicle electrification?
- What are the economics, convenience and psychology barriers to better consumer acceptance of alternative fuel vehicles?
- What are the optimal public policy and the conditional optimal industry decision in the transition of vehicle technologies?

MODEL FRAMEWORK

MA3T includes a nested multinomial logit model at its core linked through several ORNL-developed algorithms to public TICP data. System dynamics are reflected through several feedback mechanisms such as consumer segmentation, technology learning by doing, make and model diversity and endogenous infrastructure deployment. The direct output, purchase probability by consumer segment and powertrain choice, is subsequently translated into sales, population, petroleum use and greenhouse gas emissions.

MODEL FEATURES

Low-cost software environment: Microsoft Excel without proprietary data

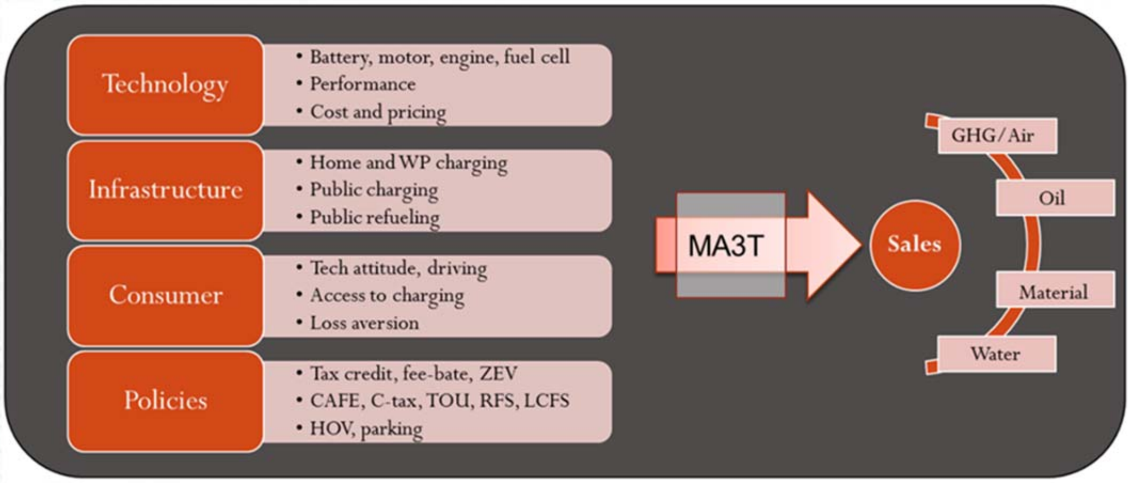
Temporal: Annual; 2005-13 for calibration, 2014 for validation, 2015-2050 for projection

Spatial: U.S. LDV market; by residential area by state; international interactions considered.

Choice theory/structure: Nested multinomial logit; buy/No-buy, 5 layers; 5 size classes, 3 variants, 300 choices; SI, CI, HEV, PHEV, EREV, BEV, FCEV, CNG

Consumer segmentation: 9180 consumer segments; 51 states, 3 areas, 3 adopters, 3 drivers, 2 HC situations, 2 WPC situations

Vehicle attributes: price, fuel economies, refueling hassle, range limitation,



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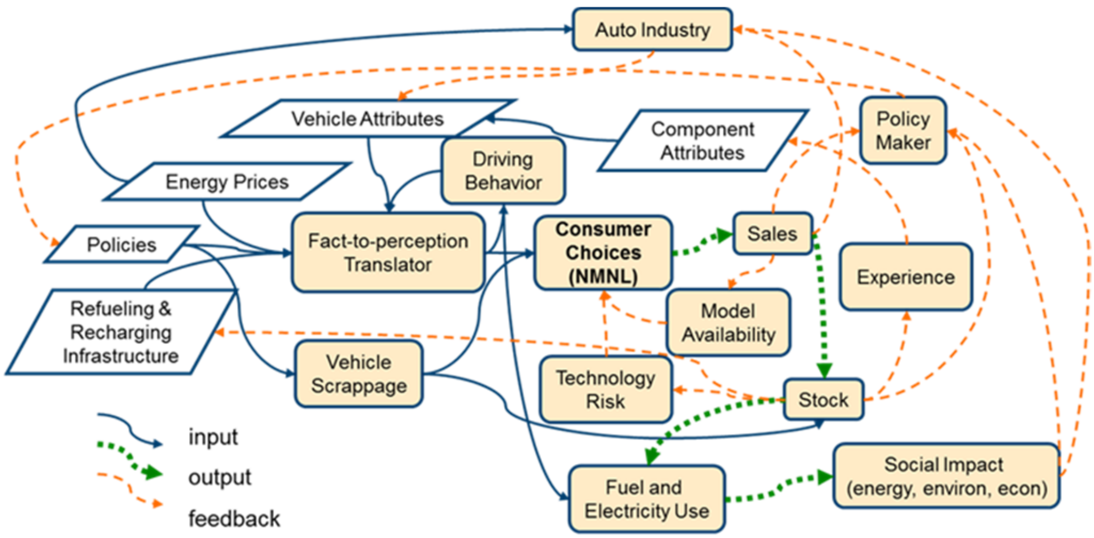

acceleration, interior space, towing capability, maintenance cost, and resale value

Infrastructure: hydrogen, natural gas, electricity, diesel; home, work, public charging, wireless charging

Policy: ARRA PEV tax credit, general tax credit, instant rebate, HOV access, free parking, fee-bate, energy pricing

Collaboration and linked efforts: AEO 2014, Autonomie, GREET, TEDB, NHTS 2009, VISION, AHS, HPMS, Polk, etc.

Output: sales/population by choice/state /year; energy use by fuel/state/year; tailpipe and WTW GHG emissions

Integrated logics or theories

Gamma/composite distribution

Fuel-travel-back station location, path-dependent charging benefits

Innovation diffusion, learning by doing, R&D delay/acceleration, technology co-leaning, international interactions, Supply constraints, infrastructure utilization, tax credit design, fee-bate design, endogenous infrastructure roll-out, automatic calibration

PROJECT PUBLICATION

1. Xing Wu, Md. Aviquzzaman, and Zhenhong Lin (2015). Analysis of plug-in hybrid electric vehicles' utility factors using GPS-based longitudinal travel data. Transportation Research Part C. Accepted.
2. Lin, Z., Li, J., & Dong, J. (2014). Dynamic Wireless Charging: Potential Impact on Plug-in Electric Vehicle Adoption. *Society of Automotive Engineers Technical Papers 2014-01-1965.*
3. Dong, Jing, Lin, Zhenhong, Liu, Changzheng, and Liu, Yanghe. (2014). "Assessing Grid Impact of Plug-in Electric Vehicle Charging Demand Using GPS-Based Longitudinal Travel Survey Data." *SAE Technical Papers* 2014-01-0343.
4. Dong, J., & Lin, Z. (2014). Stochastic Modeling of Battery Electric Vehicle Driver Behavior: The Impact of Charging Infrastructure Deployment on BEV Feasibility. *Transportation Research Record (accepted)*.
5. Lin, Z. (2014). Optimizing and Diversifying Electric Vehicle Driving Range for U.S. Drivers. *Transportation Science 48(4):635-650. http://dx.doi.org/10.1287/trsc.2013.0516*.
6. Wu, X., Dong, J., and Lin Z. (2014). "Cost Analysis of Plug-in Hybrid Electric Vehicles Using GPS-Based Longitudinal Travel Data." *Energy Policy* 68: 206–17
7. Dong, J., Liu, C., & Lin, Z. (2014). Charging infrastructure planning for promoting battery electric vehicles: An activity-based approach using multiday travel data. *Transportation Research Part C: Emerging Technologies*, *38*(0), 44 – 55.
8. Greene, D. L., Lin, Z., & Dong, J. (2013). Analyzing the sensitivity of hydrogen vehicle sales to consumers' preferences. *International Journal of Hydrogen Energy*, *38*(36), 15857 – 15867.
9. Lin, Z., Dong, J., and Greene, D.L., 2013. Hydrogen Vehicles: Impacts of DOE Technical Targets on Market Acceptance and Societal Benefits. International Journal of Hydrogen Energy, Vol 38, Issue 19, Pages 7973-7985
10. Lin, Z., Dong, J., Liu, C., & Greene, D. (2012). Estimation of Energy Use by PHEVs: Validating Gamma Distribution for Random Daily Driving Distance. Transportation Research Record, 2287(1), 37-43.
11. Lin, Z. (2012). Optimizing and Diversifying the Electric Range of Plug-in Hybrid Electric Vehicles for U.S. Drivers. International Journal of Alternative Powertrains, 1(1), 108-194.
12. Dong, J., & Lin, Z. (2012). Within-day recharge of plug-in hybrid electric vehicles: Energy impact of public charging infrastructure. Transportation Research Part D: Transport and Environment, 17(5), 405-412.
13. Lin, Z., & Greene, D. L. (2011). Promoting the Market for Plug-In Hybrid and Battery Electric Vehicles: Role of Recharge Availability. Transportation Research Record, 2252(1), 49-56.
14. Lin, Z., & Greene, D. L. (2011). Assessing Energy Impact of PHEVs: Significance of Daily Distance Variation over Time and Among Drivers. Transportation Research Record, 2252(1), 99-106.