Project: eems024

U.S. DEPARTMENT OF ENERGY

SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

Market Acceptance of Advanced Automotive Technologies (MA3T) - Mobility Choice: Analyzing the Competition, Synergy, and Adoption of Fuel and Mobility Technologies

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Vehicle Technologies Office – 2018 Annual Merit Review
June 19, 2018

Argonne NATIONAL LABORATORY | INL Idaho National Laboratory | BERKELEY LAB | OAK RIDGE National Laboratory | NREL NATIONAL RENEWABLE ENERGY LABORATORY

ENERGY EFFICIENT MOBILITY SYSTEMS PROGRAM
INVESTIGATES

MOBILITY ENERGY PRODUCTIVITY

THROUGH FIVE EEMS
ACTIVITY AREAS

Advanced R&D Projects

Living Labs

Smart Mobility Lab Consortium

Core Evaluation & Simulation Tools

HPC4Mobility &
Big Transportation Data Analytics

Advanced Fueling Infrastructure

Connected & Automated Vehicles

Urban Science

SMART MOBILITY LAB

CONSORTIUM

7 labs, 30+ projects, 65 researchers, $34M* over 3 years.

Mobility Decision Science

Multi-Modal Transport

*Based on anticipated funding

Overview

Timeline

Project start: 1 Oct 2017

Project end: 30 Sep 2019

Barriers

- Complex role of the human decision-making process in mobility systems
- Determining the value and productivity derived from new mobility technologies
- Computational difficulty of accurately modeling and simulating large- scale transportation systems

Budget

FY 2018: $200k

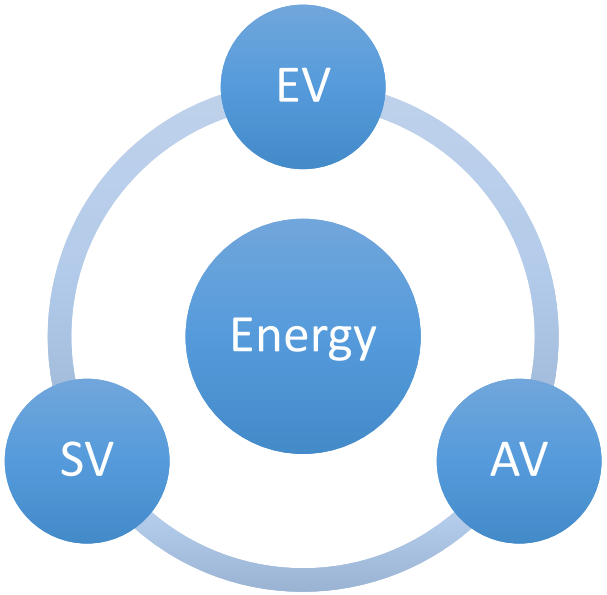
(100% DOE)

Partners

- Interactions / Collaborations
  - Oak Ridge National Laboratory
  - Argonne National Laboratory
  - National Renewable Energy Laboratory
  - Lowrance Berkeley Laboratory
- Project lead: Zhenhong Lin

Objective

- Understand behavioral factors and technological opportunities to accelerate transition to new mobility technologies such as automation and sharing.
- Model consumer mid-term and long-term consumer choices of vehicle and mobility technologies with a focus on energy implications.
  - Simulate long-term vehicle choices (buy new vehicles or not, buy human-driven or fully-automated vehicles, cooperative adaptive cruise control considered).
  - Simulate mid-term mobility choices (primarily using TNC (shared vehicles), public transit, or personal vehicles; TNC vehicles include human-driven and driverless vehicles).
  - Calibrate the behavioral parameters to SMART studies, historical and stated-preference data, including sales, TNC/mode choice demand, WholeTraveler observation and/or other surveys
  - Use MA3T-MC to generate scenario results to facilitate SMART research



Relevance

Research Questions

- Who are more likely to choose
  - CAV
  - Shared mobility
  - Shared CAV
  - PEV AV
  - PEV
  - Shared PEV
- Why, when and how many?
- What are the behavior and technological barriers?

…given relevant assumptions.

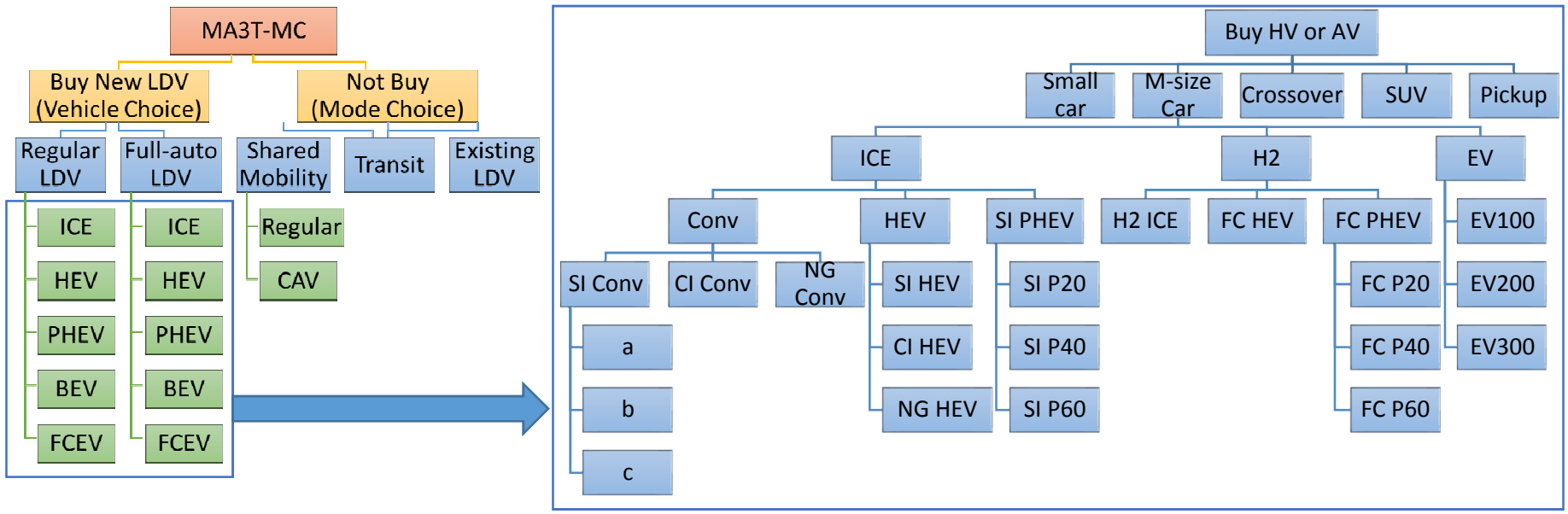
Therefore, it is for scenario analysis, not future prediction.

Milestones

Month/year	Description	Status
Mar 2018	progress update presentation on MA3T-MC development with a focus on disaggregate mobility choices	Complete
Jun 2018	scenario results of showing heterogeneous mobility decisions, the underlying reasons and demand magnitude	In progress

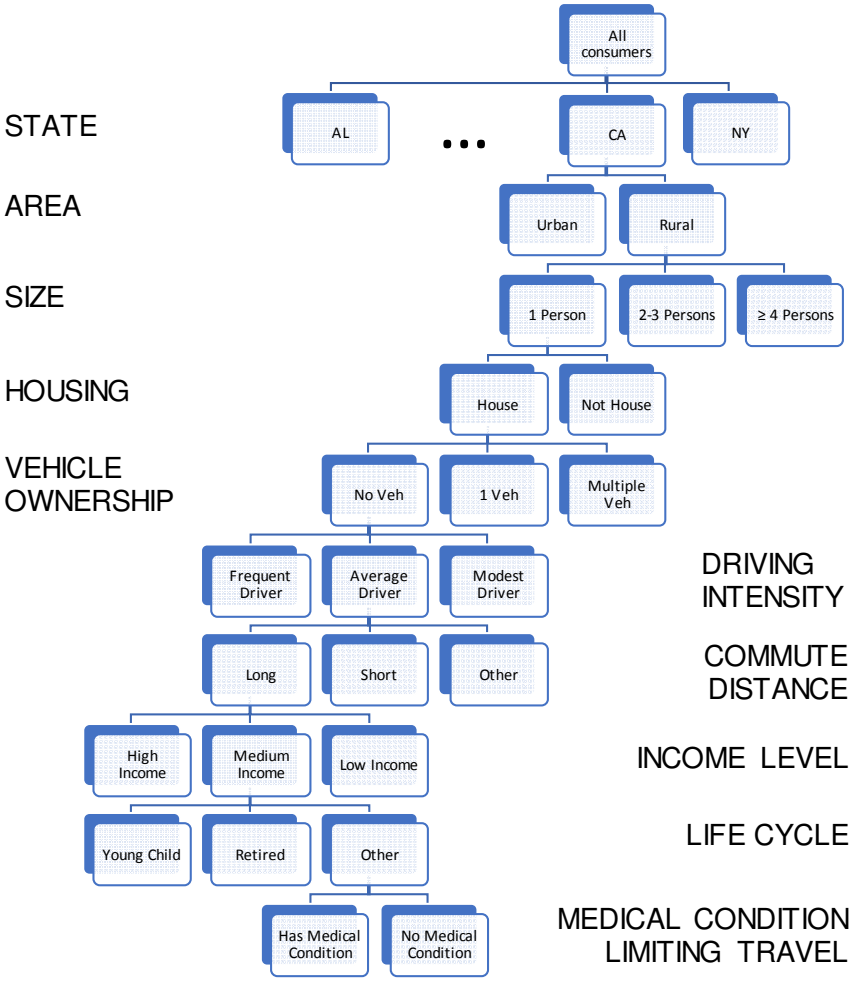
Nested multinomial logit theory with relevant vehicle and mobility technologies

- A natural expansion of powertrain-choice-only MA3T
- Cover VTO R&D technologies, automated vehicles (CACC and full automation), shared mobility
- Technology synergy and co-leaning



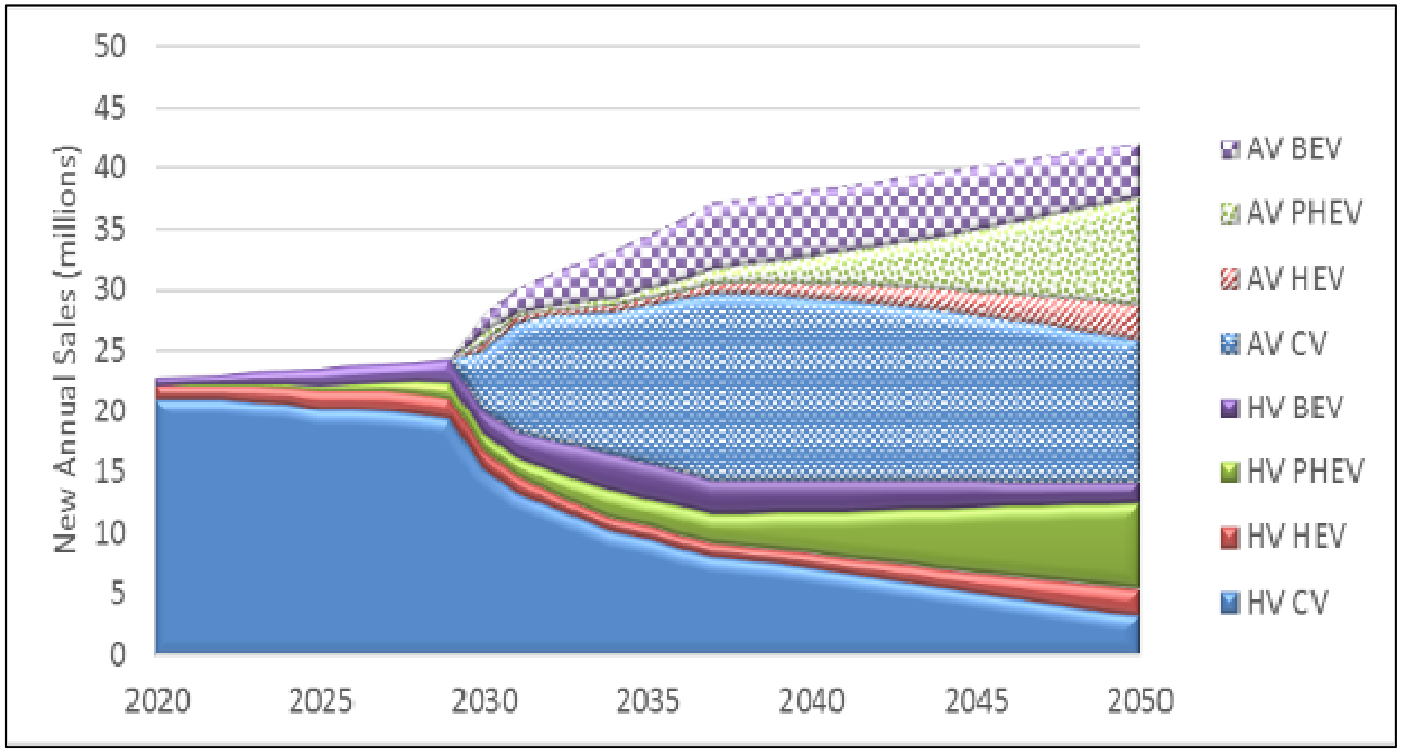
Consumer segmentation, because what some consumers choose affects how others choose

- Use NHTS 2017 data
- Household weighted K-Modes clustering based segmentation (implemented using Java)
- Automatically cluster >120,000 HHs into user defined segment groups (e.g., 5,000)
- More depth in segmentation dimension without worry of exponential growth in size
- Future opportunity in evaluating impacts of segmentation accuracy on estimation of vehicle market



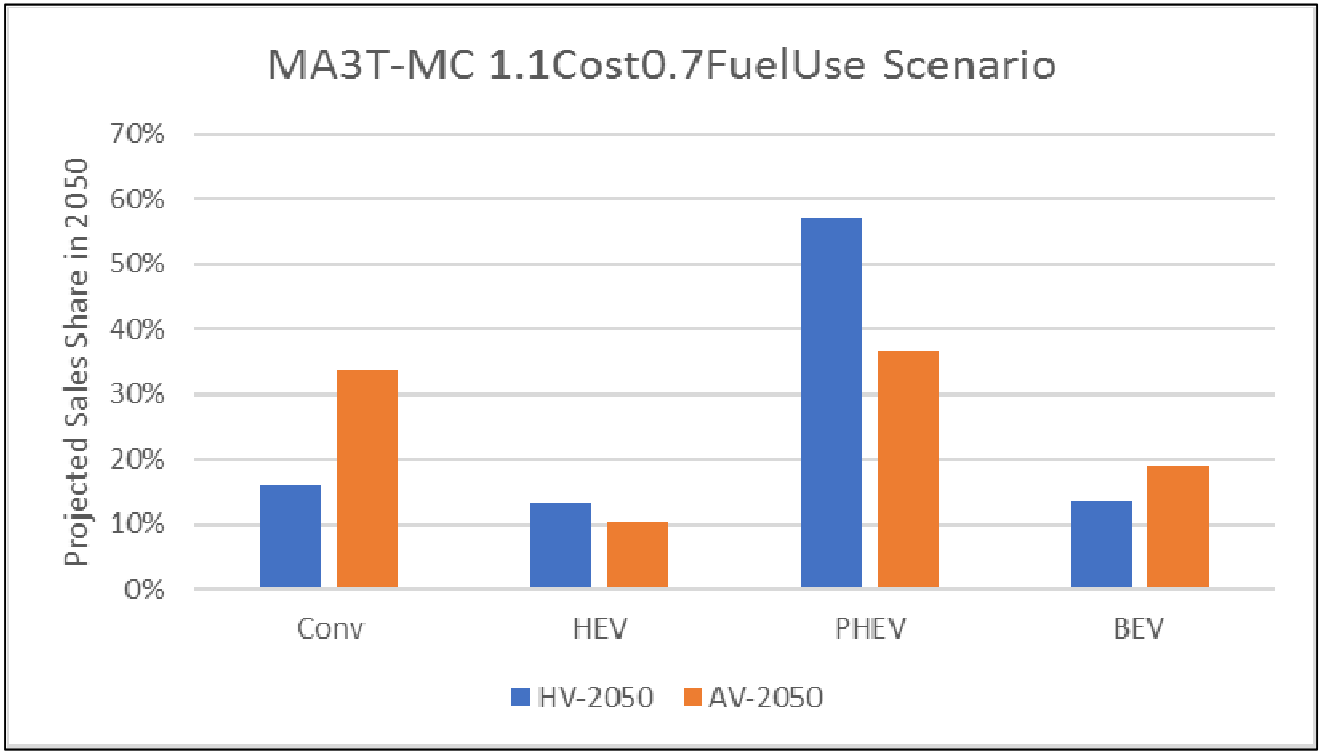
Market penetrations of automated vehicles by fuel types

- Why is this important?
  - Critical input for assessments of energy, environmental and mobility impacts.



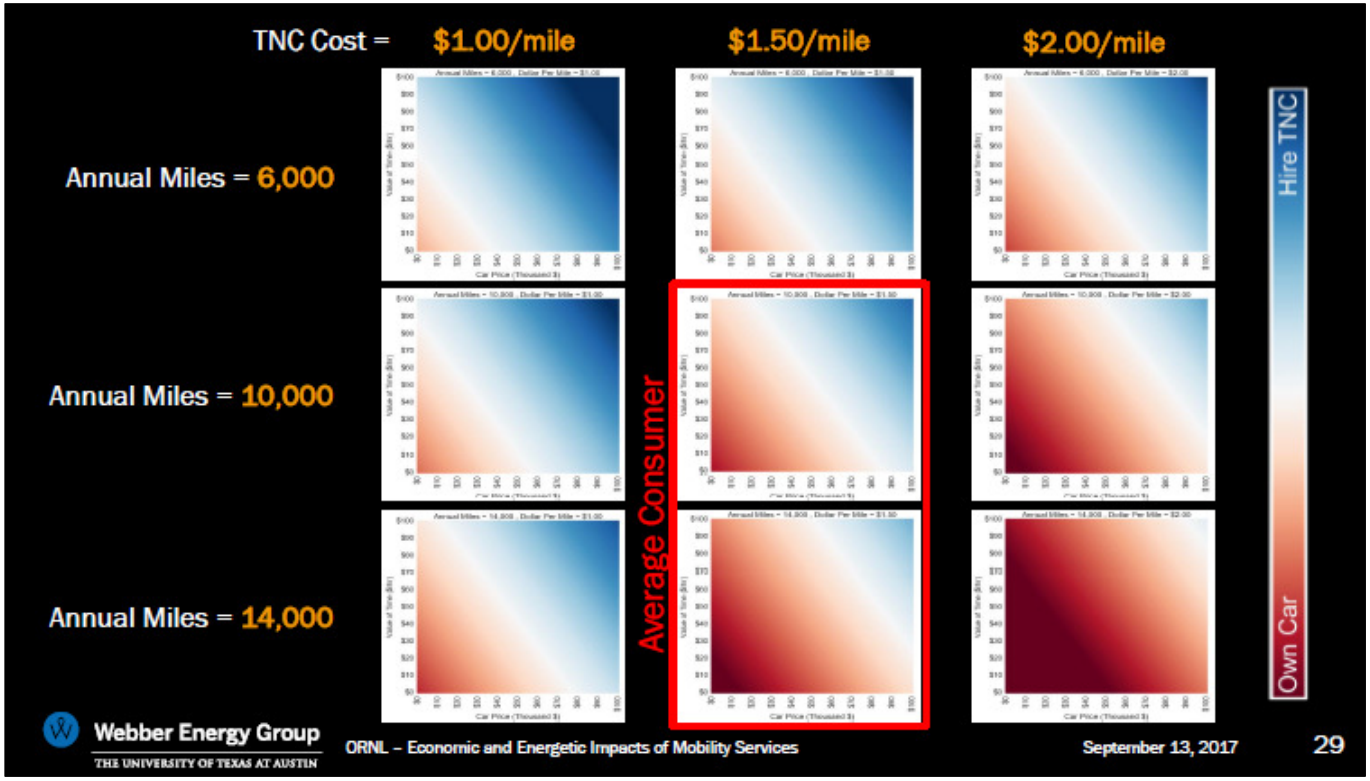
Market shares of PEV and HEV among automated vehicles and human-driven vehicles

- Why is this important?
  - Understand potential synergy between vehicle automation and electrification.



Acceptance of shared mobility affected by TNC cost, driving intensity, time value or income, etc.

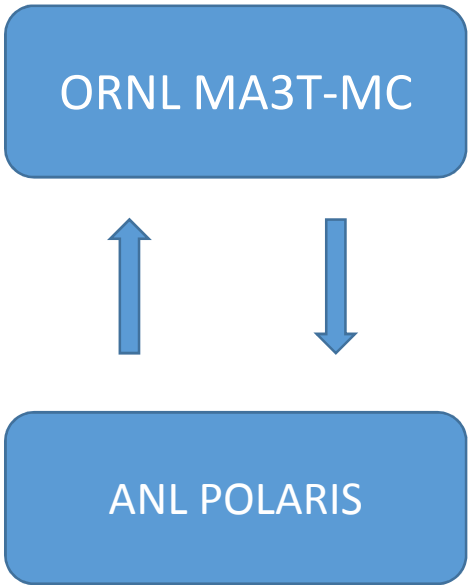
- Why is this important?
  - Shared mobility adoption has implications on energy, congestion and vehicle design.

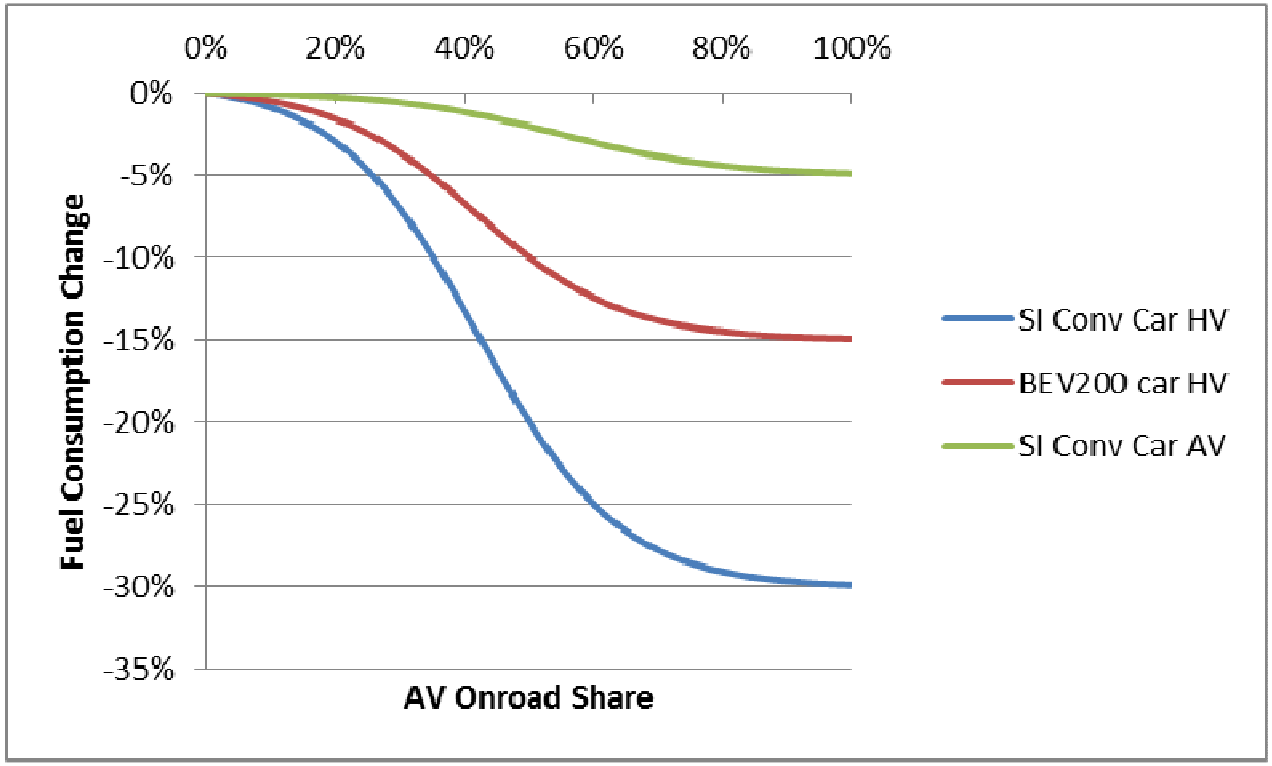


Todd Davidson, Michael E. Webber, 2017. **To Uber or not? Why car ownership may no longer be a good deal**. The Conversation.

Market adoption of AV depends on and affects evolving on-road vehicle efficiency

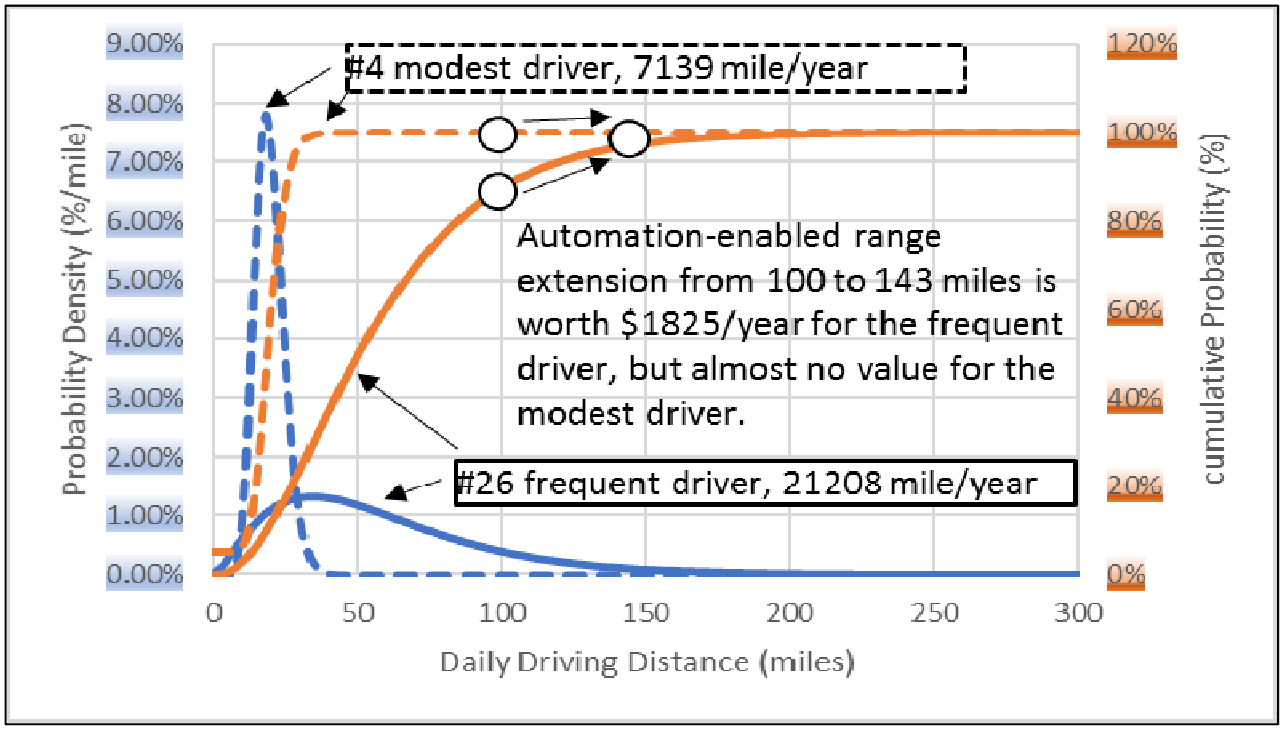
- Why is this important?
  - "Evolving vehicle efficiency" is important for accurate estimation of energy impact of AV.





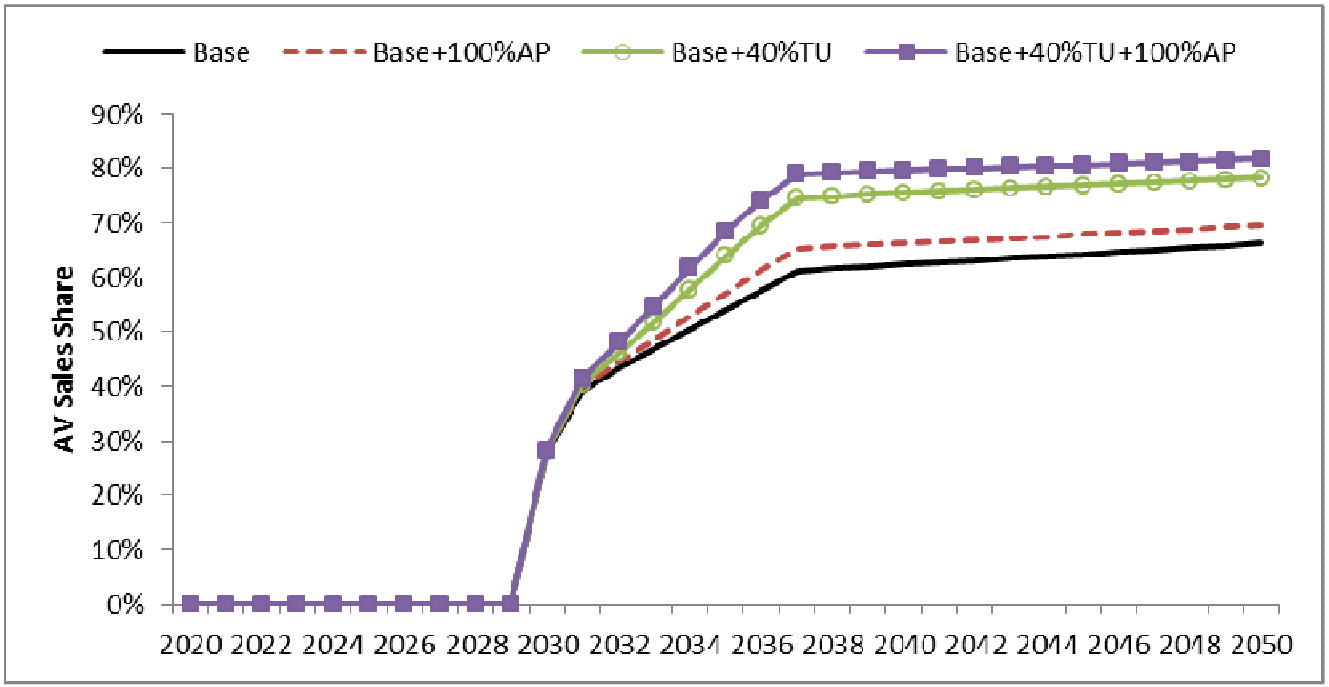
Heterogeneity in travel pattern, income, health, age, and location affects consumer adoption of 3R technologies

- Why is this important?
  - Accurate estimation of market size of each technology
  - help industry better serve consumers



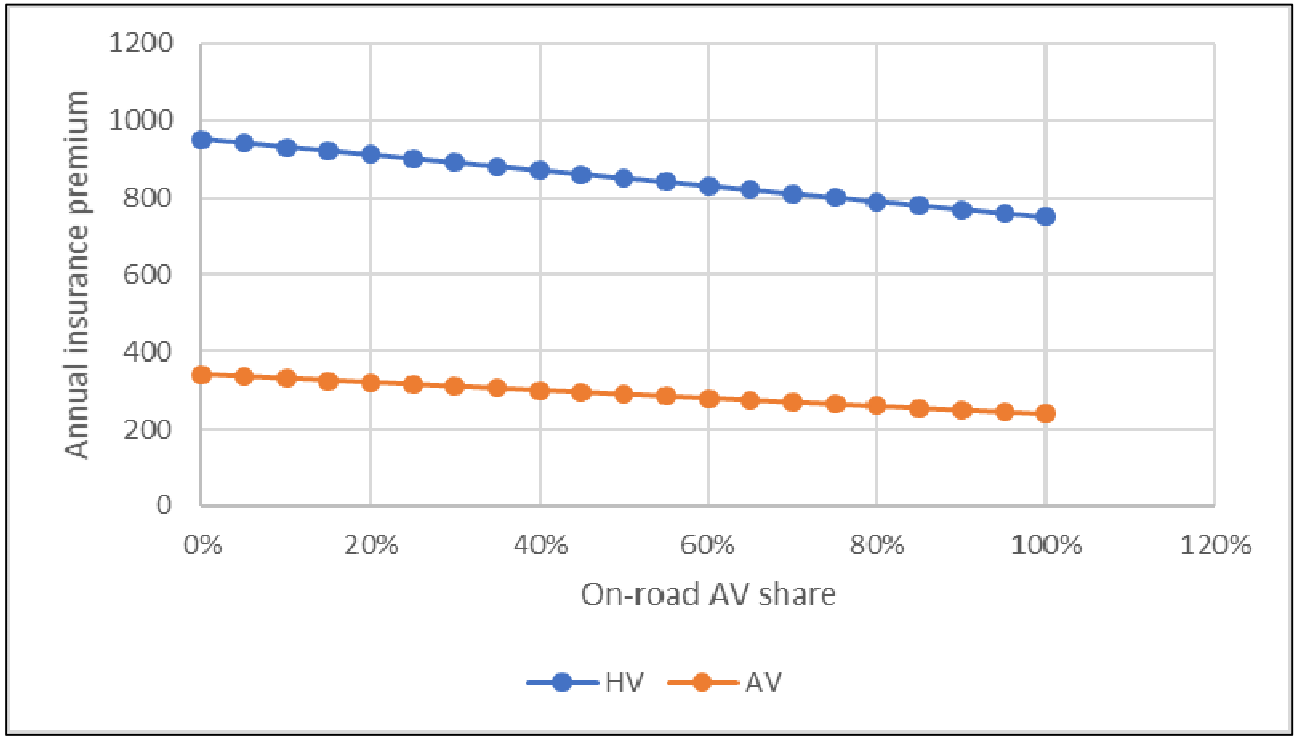
Time cost recovery --a key benefit of automation and shared mobility, but with uncertainty

- Why is this important?
  - Accurate estimation of market size of each technology
  - help industry better serve consumers



Network externality: increase of on-road AVs may benefit human-driven vehicles, on energy, safety, congestion, etc.

- Why is this important?
  - Just as “free riders”, HV drivers may become more reluctant to switch to AV
  - It calls for debate: should HVs be banned at some point or should market-driven AV-HV equilibrium be allowed?



Response to Previous Year's Reviewers' Comments

New project for FY18

Partnerships / Collaborations

MA3T-MC relies on inputs from diverse tasks of SMART Mobility among national labs

Consumer		Vehicle		Infrastructure		Operation

• Demographics
• Lifestyle
• Land use
• Interaction
• Attribute stability
• WTP for tech attributes
  • Automation
  • Range
  • Fuel economy
  • Safety
  • Less refueling
  • Charging availability
	X	• Fuel economy
		  • By fuel type, by automation, by onroad tech mix
		• Cost/price
		• Range/uncertainty
		• Space/design
		• Connectivity/automation
		• Component costs, learning by doing, co-learning
			X	• Fuel prices
				• Charging availability
				• Congestion/safety performance
					X	• Vehicle ownership/lease
						• Network flow coordination/optimization
						• Pricing
						• Mix of HV and AV
						• Shared mobility pricing
						• Charging infrastructure pricing

ANL, NREL, ORNL, LBL, INL, ISU, UTK, UT Austin, Vanderbilt, UC Davis

Remaining Challenges and Barriers

- Supply behavior of shared mobility
- Reliability of automated vehicles
- Network externality between AV and HV
- Contextual value of travel time

Any proposed future work is subject to change based on funding levels.

Proposed Future Work (FY19)

FY18

- Complete the development of MA3T-MC toward functional and logical
- Generate preliminary and sensible scenario results

FY19

- Improve assumptions of technology performances, costs, and demographics
- Proactively incorporate outputs of related SMART tasks into MA3T-MC
- Better representing partial automation such as CACC
- Achieve peer-reviewed publications on 3 Revolution technologies

Any proposed future work is subject to change based on funding levels.

Summary

- Market penetration and dynamics of the 3-Revolution technologies (electrification, automation and sharing) are relevant to the EEMS mission…
- … and are addressed with the development of the MA3T-MC model.
- MA3T-MC consider a wide range of the relevant technologies and consumer segmentation dimensions.
- Work in progress to achieve critical insights:
  - Market penetration of AV, synergy between AV and PEV, consumer heterogeneity, network externality, evolving vehicle efficiency
- MA3T-MC relies on close and extensive collaboration with national labs and academia.
- Team is on schedule to achieve important modeling insights.

ACKOWLEDGEMENTS

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