ESTIMATING POTENTIAL ENERGY AND MOBILITY IMPACTS OF CAVS IN THE U.S.

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Passenger Travel Demand:

- Consumption due to deployment of connected and automated vehicles (CAVs)
- Non-fuel Veh. AV: Automated vehicle
  - Highly automated vehicles: privately-owned, and shared
  - Design domain (allowable operating conditions)
- Congestion, Speed, Time-value
- Different levels of traffic control
- VMT-related Congestion
- Fuel-related Emissions
- Value of travel time

MOTIVATION

- CAVs may disrupt travel patterns, vehicle use and ownership, and even vehicle design with large changes in energy consumption
- Economic theory and market models can provide credible estimates of possible future changes in travel demand and energy use
- Recent and ongoing analysis of CAVs under the U.S. Department of Energy Vehicle Technologies Office-funded SMART Mobility CAVs Pillar are providing estimated energy impacts at the local and regional levels (Auld et al., 2017)
- Methods are being developed to expand these results (and others as available) for the national level

GENERAL APPROACH

Estimate potential changes in travel behavior and energy consumption due to deployment of CAVs using top-down and bottom-up approaches
- Economic/Macroeconomic "Top Down" model
  - Alternatives of CAVs and shared vehicles by consumer segment
  - Develop methods to expand regional simulation results using transferability modeling and to aggregate results of detailed, regional case studies to the national level ("Bottom-Up")

PROJECT OVERVIEW

Objective: Estimate potential changes in travel demand and energy consumption due to deployment of connected and automated vehicles (CAVs) at a national level
- Develop CAV deployment scenarios
  - Highly automated vehicles: privately-owned, and shared
  - Connected, partially automated vehicles, with cooperative adaptive cruise control (CACC) and coordinated flow through intersections
- Use economic/market model to estimate changes in travel and energy use (given AV adoption levels) at a national scale
- Develop consumer adoption model for highly automated vehicles (national scale, with segmentation)
- Develop aggregation/transfer methods to extrapolate detailed, regional simulation results to the national level

REFERENCES

- Stephens, T., Frew, S. 2016 “Quantifying the energy and economic impacts of CAVs on vehicle efficiency and vehicle use” (CAV401), U.S. Department of Energy

SCENARIOS TO BE ANALYZED (OR UNDER CONSIDERATION)

- Base case: similar to Energy Information Administration Annual Energy Outlook Reference case
- Personal travel with different levels of adoption of cooperative adaptive cruise control (CACC) and interaction control
- Personal travel with highly automated, privately-owned or shared vehicles (basic) with different operational design domains (allowable operating conditions)

SUMMARY/CONCLUSIONS

- An analytical model developed to describe the influence of CAVs adoption on Mobility (VMT) and fuel use under a wide range of assumptions about how vehicle automation will change
  - Vehicle fuel economy and emissions
  - Crash frequency
  - Congestion
- The model accounts for travelers' budget and time constraints and effects of taxes
- Perceived costs and values of CAV technologies to consumers are used in the MA3T-MC model to assess potential adoption by different consumer segments
- Results of regional (metropolitan-area) transportation system simulations with CAVs are being transferred to the national level
- Results of activity-based model are combined with national-level data
- An analytical framework to assess energy and mobility impacts of CAV national level was demonstrated
- Considers technology progress in non-CAVs and CAVs fleet
- Cost-benefit analysis is applied

EXAMPLE RESULTS

- Projected sales shares by powertrain & automation
- Share of VMT by private vs. shared vehicles
- National-level VMT will be used to estimate fuel use

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