Analysis of Tipping Points in Connected and Automated Vehicle (CAV) Adoption Scenarios

Brian Bush, Laura Vimmerstedt, and Jeff Gonder (NREL)

Objectives: Explore transitions to large-scale CAV adoption
- Identify tipping points to large-scale adoption
- Understand sensitivity of adoption to key factors
- Examine technological, economic, demographic, and regulatory issues
- Highlight relevant data and data needs
- Explore effects of policy through scenario analysis
- Understand sensitivity of adoption to key factors
- Examine technological, economic, demographic, and capabilities to explore different end states. (Source: NREL)

Analytical Methods: The CAV tipping point model includes a broad range of stakeholders

The results show different outcomes for CAV adoption and system-wide fuel use, given behavioral parameters such as consumer preferences (e.g., value of time) and financial parameters (e.g., operating cost).

Conclusions: The dynamic interplay of factors (e.g., stakeholder environment, costs, vehicle preferences, and freed time) contributes to large-scale CAV adoption scenarios.
- Interaction and time delays of “stage gates” can summarize CAV scenario complexity.
- Synergies between technology pathways, CAV concepts, and adoption behavior lead to multiple potential end states.
- Freed time from driving appears to be a compelling CAV advantage.
- Long-term energy outcomes of various CAV scenarios differ by half an order of magnitude, contingent on deadhead miles, vehicle occupancy, and drivetrain variation.

Future Work: Extension to commercial delivery, application at an urban regional scale, and data enhancements are expected to improve understanding of tipping points for transition to large-scale CAV adoption.

Comparison of simulations with higher and lower L1 costs and behavioral preference for L4 vehicles: The figure shows regimes with (from left) little CAV adoption, L1 adoption, both L1 and L4 adoption, and L4 adoption. Fuel consumption without CAVs reflects vehicle efficiency improvements. The figure illustrates capabilities to explore different end states. (Source: NREL)