Modeling the Energy Use of a Connected and Automated Transportation System

Introduction and Purpose

Early research points to large potential impacts of connected and automated vehicles (CAVs) on transportation energy use—dramatic savings, increased use, or anything in between. [1,2] Due to a lack of suitable data and integrated modeling tools to explore these complex future systems, analyses to date have relied on simple combinations of isolated effects. This paper proposes a framework for obtaining more realistic estimates of CAV impacts from increasing penetration of CAV technologies and for assessing technology and policy options to steer them toward favorable energy outcomes.

Current CAV modeling challenges include estimating behavior change, understanding potential vehicle-to-vehicle interactions, and capturing the effects of policies on CAV equipment (RSE) development and penetration rates. These gaps and others from the perspective of the future automated systems, NREL is integrating existing modeling capabilities with additional tools and data inputs to create a more fully integrated CAV assessment toolkit.

Possible Applications

This framework-wide scale will allow NREL and its research collaborators to address new and critical questions affecting the future of automation:

- What are the energy opportunities at the different levels of automation, from Level 0 (driverless environment) to Level 4 (full self-driving automation)? [1]
- What factors most affect which path automation might take? [1]
- What factors most affect the rate of CAV adoption and concurrent changes to the transportation system? [1]
- Do we expect “tipping points” where system behavior changes qualitatively depending on CAV penetration and automation algorithms? [1]
- How could system infrastructure deployment for vehicle connectivity influence CAVs in the transportation system? [1]
- What other energy technologies may either benefit from or facilitate increased automation? [1]

Possible Paths: Connected PEVs

Connected PEVs provide additional opportunities to support electrification. Connected CAVs (CCAVs) and connected PEVs (CPEVs) can work in tandem to achieve greater energy savings especially where CAV/PEV synergy leads to electrified fleet of automated taxis—with emphasis on improved operating cost/energy efficiency through changes like significant downsizing—leading to effects such as seamlessly linking personal and shared transportation systems and altering the urban form.

References

2. AVs and the Future of Transportation: Pushing the Boundaries of Automation, Transportation Research Board, National Research Council (2016).

Modular Software Tools

- Autonomie: http://www.transportation.anl.gov/modeling_simulation/PSAT/autonomie.html
- PARAMICS: http://www.paramics-online.com
- Visum: www.visum.com/products/visum-extract.html
- WAT: www.wat.com/products/wat.html

Appendix A: Notes on Energy and GHG Impacts from Connected and Autonomous Vehicles (CAVs)