3.   Energy Efficient Mobility Systems

To strengthen national security, promote future economic growth, support American energy dominance, and increase transportation energy affordability for Americans, the Vehicle Technologies Office (VTO) funds early-stage, high-risk research. This research will generate knowledge that industry can advance to deploy innovative energy technologies to support affordable, secure, reliable, and efficient transportation systems across America. VTO leverages the unique capabilities and world-class expertise of the National Laboratory system to develop new innovations in electrification, including advanced battery technologies; advanced combustion engines and fuels, including co-optimized systems; advanced materials for lighter-weight vehicle structures and better powertrains; and energy efficient mobility technologies and systems, including automated and connected vehicles as well as innovations in connected infrastructure for significant systems-level energy efficiency improvement. VTO is uniquely positioned to address early-stage challenges due to its strategic research partnerships with industry (e.g., the U.S. DRIVE and 21st Century Truck Partnerships) that leverage relevant technical and market expertise. These partnerships prevent duplication of effort, focus DOE research on the most critical research and development (R&D) barriers, and accelerate progress. The partnerships help VTO focus on research that industry does not have the technical capability to undertake on its own—usually because there is a high degree of scientific or technical uncertainty or it is too far from market realization to merit sufficient industry emphasis and resources. At the same time, VTO works with industry to ensure there are pathways for technology transfer from government to industry so that Federally-supported innovations have an opportunity to make their way into commercial application.

The Energy Efficient Mobility Systems (EEMS) subprogram supports early-stage research to support industry innovation that improves the affordability and energy productivity of the overall transportation system. Initial DOE analysis indicates that the future energy impact of connected and automated vehicles is highly uncertain and may be quite large, ranging from a potential 60% reduction in overall transportation energy use to a 200% increase in energy consumption. EEMS applies complex modeling and simulation expertise, experience with data science and artificial intelligence, and high performance computing (HPC) capabilities unique to DOE National Laboratories to explore the energy and mobility impacts of emerging disruptive technologies such as connected and automated vehicles (CAV), information-based mobility-as-a-service (MaaS) platforms, and advanced powertrain technologies to identify and develop innovative mobility solutions that improve energy productivity, lower costs for families and business, and support the use of secure, domestic energy sources. The EEMS subprogram consists of four primary activities: the SMART Mobility National Laboratory Consortium, high performance computing-enabled data analytics, advanced mobility technology research, and core evaluation and simulation tools. The subprogram's overall goal is to identify pathways and develop innovative technologies and systems that can dramatically improve mobility energy productivity when adopted at scale. The EEMS subprogram is completing the development of a quantitative metric for mobility energy productivity (MEP), which measures the affordability, efficiency, convenience, and economic opportunity derived from the mobility system, which will be used by the program to evaluate success, and by the transportation community to inform planning decisions. The metric will be applicable to both light-duty and heavy-duty vehicles and systems.

Project Feedback

In this merit review activity, each reviewer was asked to respond to a series of questions, involving multiple-choice responses, expository responses where text comments were requested, and numeric score responses (*on a scale of 1.0 to 4.0).* In the pages that follow, the reviewer responses to each question for each project will be summarized: the multiple choice and numeric score questions will be presented in graph form for each project, and the expository text responses will be summarized in paragraph form for each question. A table presenting the average numeric score for each question for each project is presented below.

Table 3-1 – Project Feedback

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems007	Mobility Data and Models Informing Smart Cities	Joshua Sperling (NREL)	3-9	2.88	2.88	3.13	2.63	**2.88**
eems009	Modeling and Simulation of Automated Mobility Districts †	Venu Garikapati (NREL)	3-13	3.5	3.33	3.67	3.33	**3.42**
eems011	Integrated Mesoscale Urban Systems Modeling with Behavior, Energy, Autonomy, and Mobility (BEAM) to Explore Shared and Automated Vehicles and their Impacts on Energy and Mobility	Colin Sheppard (LBNL)	3-16	3.36	3.36	3.29	3.14	**3.32**
eems013	ANL Core Tools - Simulation †	Aymeric Rousseau (ANL)	3-22	3.67	3.5	3.67	3.5	**3.56**
eems016	Energy-Efficient Connected and Automated Vehicles (CAVs)	Dominik Karbowski (ANL)	3-25	3.25	3.5	3.38	3.5	**3.42**
eems017	Impact of Connected and Automated Vehicle (CAV) Technologies on Travel Demand and Energy	Josh Auld (ANL)	3-29	3.33	3.33	3.5	2.5	**3.25**
eems019	Smart Urban Signal Infrastructure and Control	H.M. Abdul Aziz (ORNL)	3-32	3.3	3.2	3.1	3.1	**3.2**

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems020	Multi-Scenario Assessment of Optimization Opportunities due to Connectivity and Automation	Jackeline Rios-Torres (ORNL)	3-36	3.3	3.4	3.1	3.2	3.31
eems023	The Whole Traveler Transportation Behavior Study	Anna Spurlock (LBNL)	3-40	3.42	3.42	3.58	3.42	3.44
eems024	Market Acceptance of Advanced Automotive Technologies (MA3T) - Mobility Choice: Analyzing the Competition, Synergy, and Adoption of Fuel and Mobility Technologies †	Zhenhong Lin (ORNL)	3-46	3.38	3.38	3.5	2.75	3.31
eems026	Expanding Regional Simulations of Connected and Automated Vehicles (CAVs) to the National Level and Assessing Uncertainties †	Tom Stephens (ANL)	3-50	3.17	3	3.33	3	3.08
eems027	Multi-Modal Energy Analysis for Freight	Alicia Birky (NREL)	3-55	3.1	3	3	3.1	3.04
eems028	Developing an Eco-Cooperative Automated Control System (Eco-CAC)	Hesham Rakha (Virginia Tech)	3-59	3.1	3.3	2.8	3.1	3.16
eems029	Boosting Energy Efficiency of Heterogeneous Connected and Automated Vehicle (CAV) Fleets via Anticipative and Cooperative Vehicle Guidance	Ardalan Vahidi (Clemson University)	3-64	3.3	3.5	3.4	3.1	3.39
eems030	Experimental Evaluation of Eco-Driving Strategies †	Wei-Bin Zhang (LBNL)	3-68	3.25	3.25	2.5	2.75	3.09

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems031	Traffic Micro-Simulation of Energy Impacts of Connected and Automated Vehicles (CAV) Concepts at Various Market Penetrations †	Hau Liu (LBNL)	3-71	3.25	3.38	3	3.13	3.27
eems032	Evaluating Energy-Efficiency Opportunities from Connected and Automated Vehicle (CAV) Deployments Coupled with Shared Mobility in California	Matthew Barth (University of California at Riverside)	3-76	2.75	3.25	3.25	3.25	3.13
eems033	Truck Cooperative Adaptive Cruise Control Operational Energy Consumption Test at Intersection with Active Traffic Signal Control	Xiao-Yun Lu (LBNL)	3-78	2.88	2.63	3.13	2.75	2.77
eems034	Optimization of Intra-City Freight Movement and New Delivery Methods	Amy Moore (ORNL)	3-82	3.25	3.5	3.5	3.17	3.4
eems035	Coupling Land-Use Models and Network-Flow Models	Paul Waddell (University of California at Berkeley)	3-87	3.38	3.25	3.25	3.13	3.27
eems036	Reinforcement Learning-Based Traffic Control to Optimize Energy Usage and Throughput †	Tom Karnowski (ORNL)	3-92	3.5	3.25	3.5	3.5	3.38
eems037	High-Performance Computing (HPC) and Big Data Solutions for Mobility Design and Planning	Jane MacFarlane (LBNL)	3-94	3.83	3.83	3.5	3.5	3.75
eems039	Fueling Infrastructure for Future Shared and Shared-Automated Vehicles	John Smart (INL)	3-97	3.33	3.33	3.08	3.42	3.31
eems040	Dynamic Wireless Power Transfer Feasibility	Omer Onar (ORNL)	3-101	3.13	2.88	3	3.13	2.98

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems041	ANL Core Tools - Hardware	Kevin Stutenberg (ANL)	3-104	3.6	3.5	3.3	3.3	**3.48**
eems042	High-Performance Computing (HPC) Enabled Computation of Demand Models at Scale to Predict the Energy Impacts of Emerging Mobility Solutions †	Jane McFarlane (LBNL)	3-108	3.5	3.5	3.5	3.5	**3.5**
eems043	Mobility Behavioral Responses to Transportation Network Company Services	Alejandro Henao (NREL)	3-110	2.89	2.83	3.17	2.67	**2.87**
eems044	Quantify National Energy Impact of Electrified Shared Mobility with Infrastructure Support	Joann Zhou (ANL)	3-115	3.25	3	3.5	3	**3.13**
eems045	Focused Validation and Data Collection to Support Systems and Modeling for Accelerated Research in Transportation (SMART) Activities	Eric Rask (ANL)	3-117	3.33	3.5	3.67	3.33	**3.46**
eems048	An Analysis of the Spatial Distribution and Impacts of One-Way Car-Sharing Programs on Transit Ridership and Energy Use †	Tom Wenzel (LBNL)	3-120	3.25	3.13	3.25	3.13	**3.17**
eems057	Urban Traveler – Changes and Impacts: Mobility Energy Productivity (MEP) Metric	Venu Garikapali (NREL)	3-125	3.33	3.5	3.33	3.17	**3.4**
eems058	Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium Tools and Process Development	Aymeric Rousseau (ANL)	3-128	3.31	3.56	3.75	3	**3.45**

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems059	Experimental Evaluation of Cooperative Automated Cruise Control (ACC) for Passenger Cars	Eric Rask (ANL)	3-132	3.13	3	3	2.75	3
eems060	Agent-Based Model and Data Collection for Inter/Intracity Freight Movement	Monique Stinson (ANL)	3-136	3.17	2.83	2.83	3	2.94
eems061	Regional Mobility – Chattanooga	Jibonananda Sanyal (ORNL)	3-139	3.33	3.17	3.17	3.17	3.21
eems062	Deep-Learning for Automated Vehicle (AV) Development	Robert Patton (ORNL)	3-142	2.44	2.61	2.67	2.44	2.56
eems063	Ubiquitous Traffic Volume Estimation through Machine Learning Procedure †	Venu Garikapati (NREL)	3-147	3.83	3.17	3.17	3	3.31
eems064	Modeling Connected and Automated Vehicles (CAVs) Transitions Dynamics and Identifying Tipping Points †	Jeff Gonder (NREL)	3-149	3	3	3.5	N/A	3.07
eems065	Analysis of Platooning Trucks to Better Understand Dynamic Air Flow †	Michael Lammert (NREL)	3-152	3.5	3.33	3.67	3.5	3.44
eems066	Livewire Data Platform – A Solution for EEMS Data Sharing †	Johanna Levene (NREL)	3-155	3.33	3.17	3.17	2.83	3.17
eems067	ORNL Connected and Automated Vehicle (CAV) Testbed †	Dean Deter (ORNL)	3-159	3.5	3.17	3.33	3.33	3.29
eems068	Demonstrate Mobility Energy Productivity (MEP) Benefit of Intelligent Electric Vehicle (EV) Infrastructure Design Using Agent-Based Models (ABM) †	Eric Wood (NREL)	3-162	3.25	3.25	3.75	3.25	3.31

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems069	Next-Generation Intelligent Traffic Signal for Multimodal, Shared, and Automated Future †	Andrew Powch (Xtelligent)	3-164	3.17	3.17	3.33	2.25	3.07
eems070	Development of a Connected and Automated Electric Vehicle with 4-in. Wheel Motors †	Jeffrey Wishart (Local Motors)	3-167	2.67	3	2.67	2.5	2.81
eems071	Plug-in Hybrid Vehicle Optimization Using Vehicle-to-Cloud Connectivity †	Earl Sharpe (Macchina)	3-169	3	3.17	3.33	3	3.13
eems072	Charging Infrastructure for Freight †	Yutaka Motoaki (INL)	3-172	3.5	3.5	2.83	3	3.35
eems074	Systems and Modeling for Accelerated Research in Transportation (SMART) Cities Topology – Curbs and Parking †	Stanley Young (NREL)	3-175	3	2.83	3	2.5	2.85
eems075	General Microsimulation to Meso-Simulation Workflow †	Xiao-Yun Lu (LBNL)	3-177	3.17	3.5	2.83	3.33	3.31
eems076	Workflow to Simulate Connected and Automated Vehicle Control under Realistic Traffic Conditions †	Dominik Karbowski (ANL)	3-181	3.25	3.25	2.5	2.5	3.06
eems077	Transportation System Control for Taxi/Transportation Network Company Simulations †	Josh Auld (ANL)	3-183	3	3	3	2.83	2.98
eems078	Simulation Model Results for Energy and Mobility Impact of Behavioral Scenarios in POLARIS †	Josh Auld (ANL)	3-185	3.5	3.17	3.5	3	3.27
eems079	Travel-Time Use and Value With Mobility Services †	Paul Leiby (ORNL)	3-188	3.5	3.5	3.38	3.13	3.44

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems080	Typology of Cities for Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium †	Paty Romero-Lankao (NREL)	3-191	3.25	3.25	3.25	3	3.22
eems081	Nationwide Energy and Mobility Impacts of Connected and Automated Vehicle Technologies †	David Gohlke (ANL)	3-193	3.75	3.5	3.5	3.25	3.53
Overall Average				3.27	3.24	3.24	3.05	3.22

† Denotes a poster presentation.

Presentation Number: eems007
Presentation Title: Mobility Data and Models Informing Smart Cities
Principal Investigator: Joshua Sperling (National Renewable Energy Laboratory)

Presenter

Joshua Sperling, National Renewable Energy Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:

The approach appeared solid to the reviewer, who commented that the project team has made significant progress toward addressing the technical barriers. The project is well thought out and organized by the project team and the U.S. Department of Energy (DOE), according to the reviewer.

Reviewer 2:

According to the reviewer, access to mobility-as-a-system (MaaS) usage data is indeed hard to come by. Still, the reviewer felt that a focus on airports and employer-provided mobility (EPM) takes a "let's analyze what we have instead of what we need" approach. The reviewer noted that a clearer path to collecting general MaaS data is lacking.
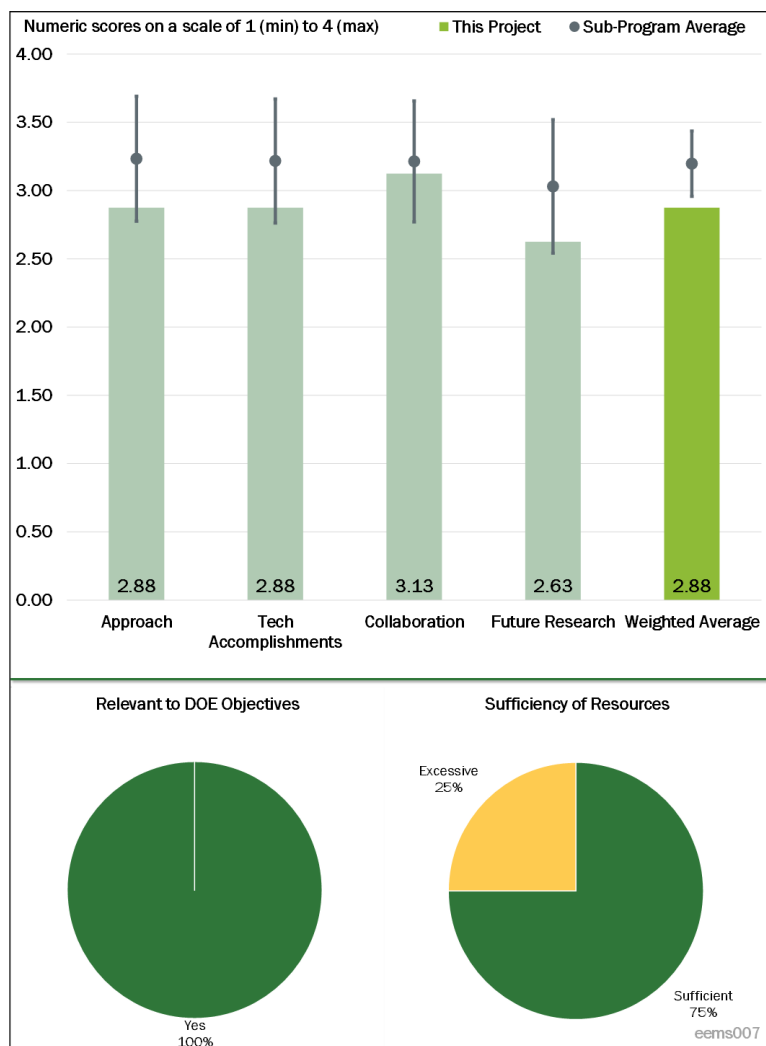

Figure 3-1 – Presentation Number: eems007 Presentation Title: Mobility Data and Models Informing Smart Cities Principal Investigator: Joshua Sperling (National Renewable Energy Laboratory)

Reviewer 3:

The reviewer remarked that the intent of the project is a good start at recognizing the changes in how society views transportation and the need to vary personal habits depending on expectations. The reviewer believed, at the start, all of the variables were thought of and accounted for when forming the parameters. The reviewer noted that the issue is, with such a large span of time to do the study and the quick pace of change, that new modes of urban transport have arrived. The inception of bicycles, electric bikes, and scooters in an urban environment have taken the place of Uber, taxis, buses, and trains, but also have a cost associated with them. Considering the information when the project was started, it is good, but as time goes on, framework changes may skew the results sought.

Reviewer 4:

The reviewer said that perhaps the project team tried to cover too many new mobility options in too many areas. It makes the project look like a collection of several mini data gathering and analysis efforts. The

reviewer found it difficult to draw any conclusions from the material presented. The reviewer would have preferred that the team focus on a few case studies and really put significant efforts into collecting and analyzing real-world data from these case studies.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer noted that the project team has made significant progress up to this point and has produced very interesting results.

Reviewer 2:

The reviewer thought that the project team did a good job gathering data. Right now, data have become a large roadblock with entities because of the fear of what is being done with the data. Rideshare companies, for instance, because of the competitive nature of their business, are not very willing to share anything that does not put them in a positive light. The reviewer wanted to know what criteria were used to determine what airports the information was gathered from and how those airports were picked. The reviewer said that a major airport that is frequently used has a large rideshare presence, but the traffic and parking do not seem to be shrinking. The reviewer also noticed that the cost is rising with the rideshare company on the trips to and from the airport; these costs may start rivaling the cost of fuel and parking combined.

Reviewer 3:

The reviewer stated that a lot of data are mentioned. It was unclear to the reviewer which data were "collected" through surveys or data logging by the project team versus "gathered" through requesting data from existing sources. The reviewer understood that the data obtained might be patchy, but suggested that perhaps more effort could be put toward data fusion and synthesis to make the most of the available data.

Reviewer 4:

The reviewer commented that the results presented are fine, and somewhat interesting, but focusing on non-broadly applicable case studies (airports, EPM) limits the usefulness of the results so far.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

It appeared to the reviewer that this is a nice collaborative effort between DOE and the U.S. Department of Transportation (DOT), mainly in conjunction with the help and contributions of other partners.

Reviewer 2:

The reviewer stated that there are many collaborators that provided data.

Reviewer 3:

It seemed to the reviewer that there was more information on EPMs, and the trends associated with what companies are doing to change the transportation mode of their employees as part of the employment package. The airport information does not seem as thorough.

Reviewer 4:

The reviewer remarked that, again, the project is fine, but more efforts to partner to get actual MaaS usage data would be more encouraging.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer believed that the project team is on the right track, but the project team needs to cover all the bases, such as demographics around the airport. The reviewer noted that the project team also needs to look at location and the airport size to get a more complete picture when trying to look at trends.

Reviewer 2:

Conducting a similar analysis to the airport analysis at other special trip generation locations would be interesting if backed up by solid data collection efforts, according to the reviewer.

The proposed use of a computer vision system to collect the types of data listed on the slide was unclear to the reviewer, who questioned what "occupancy" is referred to—vehicle occupancy or road-and-curb occupancy? The reviewer asked how such a system would differentiate transportation network company (TNC) vehicles from regular vehicles.

Reviewer 3:

With little time left, the reviewer stated that there is not too much likelihood of a course correction. A new project in this area should focus more broadly on acquiring MaaS data.

Reviewer 4:

The reviewer commented that the research questions that the project team plans to address are interesting and can add value. However, the reviewer could not see the connection between developing a deep-learning based, computer vision system for energy and mobility analysis and the potential benefits. The reviewer said that this would also require another set of skills, and it was not clear to the reviewer whether the project team has the skills on deep learning to deliver in a rigorous way unless the team considers collaboration with an academic institution.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

According to the reviewer, the point of this project is to identify trends. If the trends can be accurately determined, you can assess the best mode of transportation to concentrate efforts on for change. That is under the Vehicle Technologies Office (VTO) when you are forward looking to reduce congestion and also reduce emissions. The reviewer noted that a byproduct is convenience to make people want to change their mindset toward transportation as a means of travel if they must travel.

Reviewer 2:

The reviewer remarked that this project is absolutely aligned with the goals of Energy Efficient Mobility Systems (EEMS) and adds value to the whole Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility effort. The reviewer commented that it aims to address critical questions!

Reviewer 3:

The reviewer asserted that data are king!

Reviewer 4:

The reviewer acknowledged slightly more yes than no, and said that studied-use cases are too narrow to be broadly helpful.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that resources seem appropriate.

Reviewer 2:

The project team has the appropriate resources to deliver, according to the reviewer.

Reviewer 3:

In order for the next step to be fully achieved, the reviewer stated that the project team needs to gather more information pertaining to airports. The reviewer believed that data are starting to become available.

Reviewer 4:

The reviewer stated that the level of funding (listed as $1.655 million) would be appropriate for a large data collection project. However, most of the data obtained in this project seem to be from collaborators through data requests as opposed to collecting and logging data at the sites. This makes the level of funding look excessive.

**Presentation Number: eems009
Presentation Title: Modeling and
Simulation of Automated Mobility
Districts
Principal Investigator: Venu
Garikapati (National Renewable
Energy Laboratory)**

Presenter
Venu Garikapati, National Renewable
Energy Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
According to the reviewer, the approach
is very well designed with deep
thoughts in attacking the issues and
building a toolkit that can be easily
updated as technology advances. The
reviewer stated that there was a great
thought process on locations and
vocations of vehicles evaluated.

Reviewer 2:
The reviewer said that the project was
well planned and is on track to
achieving its objectives, albeit without
the implementation at various cities that
had been initially planned. The reviewer commented that these city "demonstrations" are critical to gaining
acceptance of the model for use by municipalities in conducting their planning. Sans these demonstrations, the
reviewer asserted that the project should seek other methods to gain user confidence in the modeling.

Reviewer 3:
The reviewer noted that the modeling framework is well defined, but the lack of real-world data to support it
remains a barrier that still needs to be addressed.

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer remarked that all the accomplishments have been met and the goals are relevant to project
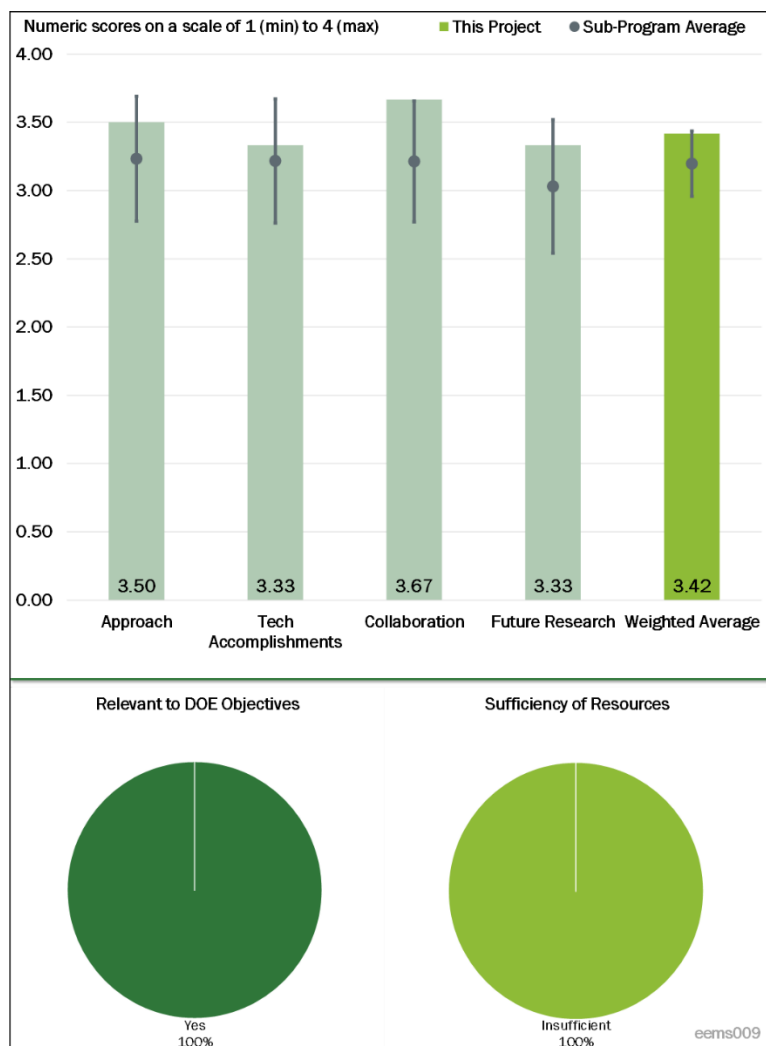success.

Figure 3-2 – Presentation Number: eems009 Presentation Title: Modeling
and Simulation of Automated Mobility Districts Principal Investigator: Venu
Garikapati (National Renewable Energy Laboratory)

The reviewer noted that Travel Demand, Simulator of Urban Mobility (SUMO), and Future Automotive Systems Technology Simulator (FASTSim) work is complete and one AMD has been evaluated. With this work complete, the reviewer commented that the project is well on its way to meeting technical objectives.

Reviewer 3:
The reviewer said that the mode choice model cannot be properly calibrated due to the lack of data. It is understandable that a revealed preference survey could not be done yet, but at least a stated preference survey could have been attempted. Without a proper mode choice model, the reviewer commented that the automated mobility district (AMD) toolkit would not be very useful.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer noted that a very strong project team has been assembled.

Reviewer 2:
The reviewer praised the great outreach to Greenville, academia, and industry to pull this off.

Reviewer 3:
The reviewer offered congratulations on getting the memorandum of understanding (MOU) in place with Greenville and the non-disclosure agreement (NDA) executed with Robotic Research.

It was unclear to the reviewer why the University of South Carolina is a subcontractor for energy consumption modeling, which is the core expertise of the National Renewable Energy Laboratory (NREL). Instead, the university would have been a perfect partner for doing the stated preference survey of local residents, according to the reviewer.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer stated that future research will enhance the utilization and effectiveness of the tools.

Reviewer 2:
The reviewer said that the proposed future research areas are interesting. It would be prudent to focus on validating the Greenville model before expanding to other AMDs.

Reviewer 3:
The reviewer commented that substitute work to gain model acceptance with users is necessary to replace the AMD demonstrations that will not be completed.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer stated that AMDs are a new form of providing mobility to travelers in small areas. The ability to model AMDs will help inform the design of energy efficient AMDs in the future.

Reviewer 2:
The reviewer noted that the project is very relevant. This tool will reduce emissions and congestion along with improving safety for the motoring public.

Reviewer 3:

The reviewer commented that this project has the opportunity to support municipalities in their planning for AMD introduction.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

If the main reason for not pursuing more data collection to validate the AMD model is due to limited funding, then the reviewer indicated that the resources for the current project are insufficient.

Reviewer 2:

The reviewer commented that the project team should be allocated more funding to collect more real-world data.

Reviewer 3:

As noted by the project team, the reviewer stated that resources will not be sufficient to complete the AMD demonstrations originally planned.

Presentation Number: eems011
Presentation Title: Integrated Mesoscale Urban Systems Modeling with Behavior, Energy, Autonomy, and Mobility (BEAM) to Explore Shared and Automated Vehicles and their Impacts on Energy and Mobility Principal Investigator: Colin Sheppard (Lawrence Berkeley National Laboratory)

Presenter
Colin Sheppard, Lawrence Berkeley National Laboratory

Reviewer Sample Size
A total of seven reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
According to the reviewer, the workflow is based on significant prior work to address current pressing questions. This is a very sound approach.

Reviewer 2:
The reviewer stated that the challenges are well defined for this project. Approximately 5.2% of the population currently works from home and is growing. That choice is not reflected in the models and is being seen as a viable alternative to commuting, according to the reviewer.
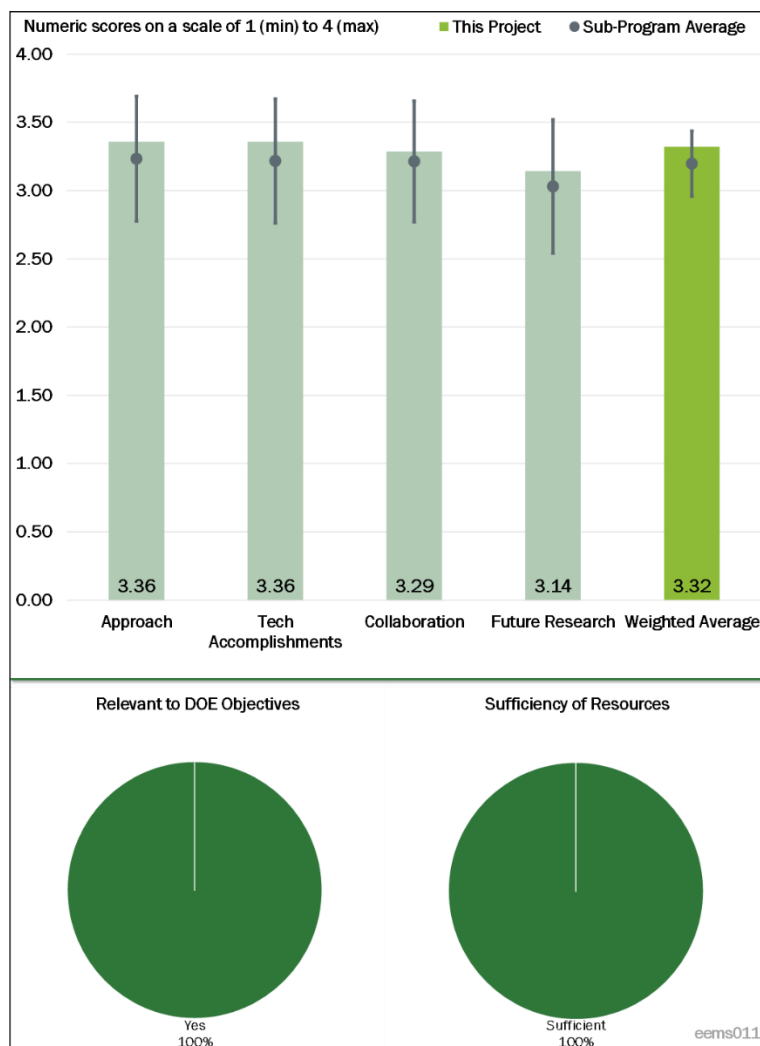

Figure 3-3 – Presentation Number: eems011 Presentation Title: Integrated Mesoscale Urban Systems Modeling with Behavior, Energy, Autonomy, and Mobility (BEAM) to Explore Shared and Automated Vehicles and their Impacts on Energy and Mobility Principal Investigator: Colin Sheppard (Lawrence Berkeley National Laboratory)

Reviewer 3:
The approach seemed reasonable to the reviewer, who would have preferred to see a bit more technical details and discussion. The reviewer could not see the connection with the coordinated adaptive cruise control (CACC) approach. Because it is hard to include all the technical information in a presentation, the reviewer said that perhaps the project team might want to consider reporting the results of their research in peer-reviewed conference proceedings or journal publications or even reports.

Reviewer 4:
The reviewed remarked that implementation was heavily emphasized with weak emphasis on important scientific questions, like generalizability, sensitivity, errors, etc.

Reviewer 5:

For the given objectives, the approach appeared to the reviewer to encompass most of the critical factors and interactions. The scope of the systems analysis problem is quite broad so it is hard or impossible to account for everything. It seemed to the reviewer that more emphasis could be placed on validation of the complete system simulation.

Reviewer 6:

The reviewer commented that the overall approach is good and intends to cover a lot of bases, but no public policy elements were included in this analysis. It was not clear to the reviewer how this work would be able to effectively help with mobility planning because it does not include the public policy changes needed to achieve widespread adoption of new mobility technologies.

Reviewer 7:

The reviewer commented that the approach to Behavior, Energy, Autonomy, and Mobility (BEAM) development seems very robust and well thought out.

According to the reviewer, there is a need for more robust analysis of error and confidence intervals, however. This is not late by any means, but rather just the right time. While a Monte Carlo analysis simulating distributions for each model input would be very helpful, the reviewer also believed there is a parallel activity needed to analyze error bands and confidence intervals component-by-component and then stack those up in the results, output, and visualizations. In other words, the reviewer noted that there is not only variability that should be analyzed in the inputs using Monte Carlo, but also error in the various submodels under the BEAM umbrella that should have more analysis. Unlike Monte Carlo of inputs, which is a random standard distribution, the reviewer stated that these internal model errors may be based on actual data and/or known unknowns in the model approach.

Another area of concern to the reviewer is the runtime. Having a 10-30 hour runtime to simulate a 24-hour day is a lot and borderline incompatible with big data analyses that could tease out interesting trends using machine learning techniques. This reviewer explained that if this runtime cannot be chased down through computational efficiency gains, high performance computing (HPC), broad use of parallel cloud processing, and/or caching prior results, that could present a very significant issue going forward.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer stated that the progress made looks to be aligned well with the project timeline. Capability has been established to look at potential future scenarios and refinements to the capability are underway. This is a very broad undertaking and improvements can always be made. This effort seems to have established a strong base capability that can be further refined and developed.

Reviewer 2:

According to the reviewer, the project has progressed and the project team has made significant accomplishments to date. The team has considered very well-thought out scenarios!

Reviewer 3:

According to the reviewer, the project appears to be on track, based on the results presented.

Reviewer 4:

The reviewer commented that the Technical Accomplishments for this project are very well defined. The Behavioral Refinements should also include telecommuting as an alternate mode.

Reviewer 5:

In order to study the energy and mobility impact of shared and automated vehicles, the reviewer said that the researchers implemented a workflow in BEAM and studied urban evolutions, behavioral changes, ride hail pooling coupled with transit, and CAV ownership and scheduling. Calibration and findings are considered for a limited number of scenarios.

Reviewer 6:

The reviewer stated that a large number of submodels were added over the past year (particularly March 2019), and the project team is to be commended for that. It is worth just ensuring that the validation activities remain robust as well. Not only are the individual models valid, but in combination; however the reviewer feared that there could be significant interactions, double-counting, etc., that may not be fully comprehended.

Reviewer 7:

The reviewer remarked that there were many questions to present on this presentation but there was no time to ask them. It was not possible to understand or assess technical progress and how it would ultimately be transferred to a usable tool that represents the real world. There were also a number of assumptions stated that were not explained or validated with data to be shown as true. Again, the reviewer could not question those assumptions.

The reviewer had some unanswered questions: on Slide 17, the reviewer asked does the model include how much energy would be wasted by a household connected autonomous vehicle (CAV). On Slide 18 for CACC, explain how to determine gains in a mixed fleet with non CACC vehicles. On Slide 22, the reviewer asked how, using urbanism, work from home affects the analysis results.

At one point, the presenter stated that total cost of ownership (TCO) was not used in the analysis of personal car cost because people only evaluate the cost of transportation as a fuel cost. The reviewer asked where the source of this assumption is and whether a focus group or survey supports this. It seemed to the reviewer to be quite shortsighted and assumes that people do not know what a full cost represents. The reviewer said that maybe financially inexperienced people think that way but not the general population.

To the reviewer, this shows that population behavior was not a part of this project. There were only assumptions that are not supported by a side study or data. The reviewer asked if these assumptions were made from anecdotal thoughts.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

This is a very complex project. The reviewer was impressed with the level of coordination across different components.

Reviewer 2:

Close collaboration with SMART Mobility team and also NREL was demonstrated, according to the reviewer.

Reviewer 3:

The various partners do seem very well integrated overall, according to the reviewer. The main opportunity might be for there to be more formal coordination between the Planning and Operations Language for Agent-based Regional Integrated Simulation (POLARIS) team and the BEAM team. A starting point might even be to create a matrix of features, inputs and outputs, and dots showing where POLARIS and BEAM share the same input, output, and feature, where they do not, and perhaps even something that neither of them has (but should).

Reviewer 4:

The reviewer commented that this discussion was not as polished as other sections. The roles of the universities were not made clear as were the activities undertaken by the laboratories. The reviewer said that there should have been some defined context of where the data supporting the graphs came from, both demographics and regions.

Reviewer 5:

It appeared to the reviewer that this is a nice collaborative project among several National Laboratories. The project team should consider engaging with other stakeholders (outside the Laboratory Consortium) to spread the word about this work so that the models can be adopted and used by the community, at least much more than was mentioned at the presentation (e.g., San Francisco).

Reviewer 6:

The reviewer noted that collaborations were almost all academic, and there was little or no input from real-world transportation agencies or providers. Data were acquired from outsiders but no other tasks were apparent. The reviewer commented that the real world is what is being modeled so without input from the real world on how these elements interface, how can a model system be built that is an accurate representation?

Reviewer 7:

The reviewer indicated that collaboration within the project as defined looks okay. However, there appears to be significant overlap with Argonne National Laboratory (ANL) tools and process work (EEMS058), especially with respect to POLARIS. It seems that better coordination here would help and be more effective. It was not clear to the reviewer how DOE views this; e.g., is the intent to foster competing toolsets for the SMART workflow?

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented that the work that remains seems to be well aligned and on target.

Reviewer 2:

According to the reviewer, Slide 32 perfectly reflects the future areas of research.

Reviewer 3:

Overall, the reviewer called the work excellent. The reviewer expected to see a little more on data sources rather than just modeling. It might be worth considering that some of the data sources going into this model may be poor, and some of the resources could or should be diverted into raising the quality level of those data sources. For example, the reviewer stated that vehicle capacity is now incorporated into the model on the supply side, and there is modeling to also approximate the demand for this (e.g., pooling assignments based on minimum sum of delays). However, the reviewer felt like the intersection of these supply and demand curves validated with actual data might be missing. The reviewer asked whether TNCs have data and would be willing to supply those data on actual ride share and actual occupancy of vehicles.

Reviewer 4:

The reviewer remarked that the project is nearing completion so a detailed work plan with milestones for next-up work was not presented. It looked more like a list of wrap-up tasks.

Reviewer 5:

Because there are only a few months left on this project, the reviewer stated that the current direction is set. It seems that there will be a lot of holes to fill after the project ends to make the products of this project usable.

Reviewer 6:

The reviewer encouraged the Principal Investigators (PIs) to reduce the search space for the optimization problem, which is combinatorial. Further integration with UrbanSim is currently planned. The reviewer noted that statistical interpretation of results and better validation were an important aspect that was not emphasized as a future step.

Reviewer 7:

While the future research activities listed are reasonable, the reviewer felt strongly that it is more important to the EEMS mission to establish confidence bounds around the results using the current version of the model before expending more resources to perfect the model. Monte Carlo simulations by varying key input variable values can be very informative exercise, and it is especially critical for the value of time variable because that is the essence of the behavioral refinement in BEAM.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

Clearly, the reviewer said that BEAM is at the core of the DOE objectives as it is used to predict future scenarios for various modes and the implications of those.

Reviewer 2:

The reviewer commented that this project acts as a cornerstone for much of the other research activities.

Reviewer 3:

The reviewer noted that it looks well aligned with the SMART workflow plan and the overall mission of the EEMS effort.

Reviewer 4:

The reviewer remarked that the project provides an excellent set of modeling tools for EEMS that can be eventually used from the community and make great impact.

Reviewer 5:

The mobility energy productivity integration and the study of energy impact is well aligned with the DOE objectives, according to the reviewer.

Reviewer 6:

The reviewer stated that this project has the potential to answer critical questions surrounding the energy implications of new mobility.

Reviewer 7:

This reviewer emphasized that the subject matter is very relevant, but the execution seems to be lacking in any achievement of long-term effectiveness.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The resources are sufficient at this point. The reviewer encouraged additional funding to transfer the model to other locations through collaboration.

Reviewer 2:

It seems to the reviewer like a lot of progress has been made for the substantial investment sent to the project team. Therefore, the resources appear to be sufficient.

Reviewer 3:

According to the reviewer, the resources seem to be adequate.

Reviewer 4:

The reviewer stated that there seem to be sufficient resources to complete what has been defined.

Reviewer 5:

The reviewer remarked that the budget seems aligned with the scope of the work, assuming most of the allocated funding covers heads.

Reviewer 6:

The project team has available resources to complete the remaining work.

Presentation Number: eems013
Presentation Title: ANL Core Tools -
Simulation
Principal Investigator: Aymeric
Rousseau (Argonne National
Laboratory)

Presenter
Aymeric Rousseau, Argonne National
Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer stated that the approach to
executing large studies by using
Advanced Model Based Engineering
Resource (AMBER) as a generalizable
task manager is a powerful way to
provide a lot of flexibility. The variety
of projects that have been executed is
impressive.

Reviewer 2:
The reviewer said that the approach is
updating Autonomie (vehicle energy
consumption, performance, and cost)
and AMBER (workflow management
for other models including Autonomie,
stochastic vehicle trip [SVTrip], RoadRunner, and POLARIS) models, which are all integrated in the EEMS
workflow model.

Reviewer 3:
Overall, the reviewer remarked that ANL has developed a great set of tools. Some of the tools are not
necessarily the most user friendly and could benefit from a more streamlined workflow and better user
interface. However, it is understandable that it is always a question of "bang for the buck." With limited
resources, the reviewer noted that it is a choice between making improvements to the functionality of the code
and the ease of use of the code. Improving the user interface, however, could increase its adoption in the
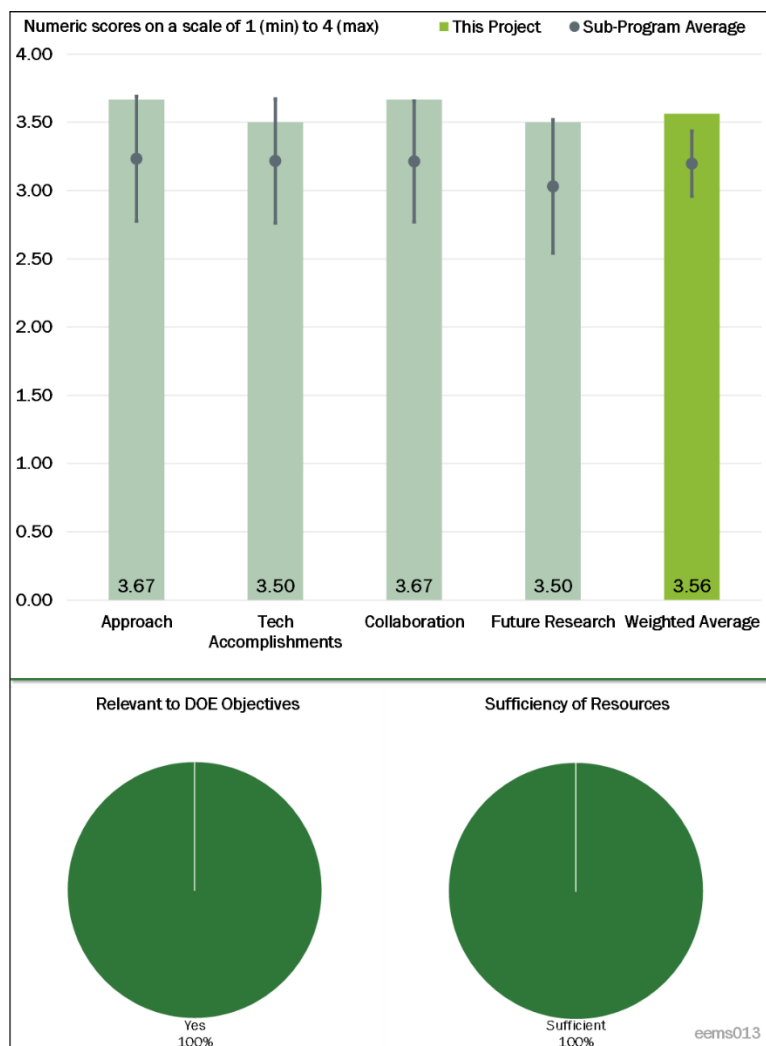industry and outside of the National Laboratories.

Figure 3-4 – Presentation Number: eems013 Presentation Title: ANL Core
Tools – Simulation Principal Investigator: Aymeric Rousseau (Argonne
National Laboratory)

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer commented that this project has developed additional workflows for AMBER to support VTO vehicle modeling and vehicle models for SMART Mobility fleets (light- and heavy-duty applications). AMBER compilation provides the ability to run models faster. Autonomie models have been correlated with all vehicles currently in the market and 80% of the vehicles considered correlated within 10% of energy consumption.

Reviewer 2:
A significant number of tasks have been completed. The exact schedule of deliverables was not indicated so relative progress is somewhat fuzzy. The reviewer noted that Slide 7 milestones could be interpreted in a number of ways and asked whether "Green" means complete and on time or just completed.

Reviewer 3:
While not a user of Autonomie, the reviewer was familiar with some of the aspects of Autonomie and the associated tools. Given the (almost) combinatorial explosion of vehicle and powertrain choices that need to be looked at, the reviewer welcomed any move toward establishing standard workflows. This would help eliminate mistakes and increase the throughput. Correlating the energy consumption to within 10% is very good, especially when performing the calculations without having access to the actual control strategy.

The reviewer stated that one aspect that is not quite applicable to this project, but perhaps more to EEMS058 (which this reviewer was not reviewing) is addressing some of the drawbacks of the SVTrip plus RoadRunner plus Autonomie combination. While SVTrip overall does an excellent job of generating stochastic trip velocity profiles, the reviewer thought that it is not particularly good at addressing velocity profiles of stop and go traffic in cities. The reviewer stated that perhaps developing a workflow that combines SVTrip with a microscale traffic simulation to accurately capture the start and stop behavior may be worthwhile.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer remarked that the large base of users definitely helps in providing valuable feedback and helps ensure that the tools have the right capabilities to address future needs.

Reviewer 2:
The reviewer found the list of collaborations and partnerships to be impressive.

Reviewer 3:
The reviewer noted that there are numerous tool users with 140 paid licenses institutions (61 companies and 79 universities). In addition, a number of DOE programs including the SMART Mobility Consortium, Advanced Research Projects Agency – Energy (ARPA-E), SuperTruck, Graduate Automotive Technology Education (GATE), and NextCar are supported. There are more than 20 current project partners listed.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
Overall, the reviewer stated that there is a good plan going forward. Developing workflows that do not require software licenses would be a huge benefit. The reviewer referenced prior comments regarding SVTrip. Some

of the workflows are somewhat cumbersome at this time, and making the whole process user friendly would be very helpful.

Reviewer 2:
The reviewer said that making AMBER flexible enough to handle "anything" is an admirable goal but asked if it were necessary.

Reviewer 3:
Enhancing workflow flexibility for AMBER, continual improvements to computational efficiency, and developing workflows that do not require licenses are all appropriate future activities. According to the reviewer, there are challenges in maintaining more than 30 tools that are currently used and vehicle dynamometer data.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer commented that this project supports the overall DOE objectives as Autonomie helps quantify vehicle level energy use, costs, and performance based on component models. This information is used to evaluate DOE VTO program benefits. AMBER is an important tool in the EEMS overall workflow of smart mobility. Both of these tools play an important role in helping to support research and development to reducing petroleum use (VTO goal).

Reviewer 2:
According to the reviewer, the tools developed support a wide variety of studies designed to advance or support DOE objectives.

Reviewer 3:
The reviewer said that the project supports DOE goals.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said that the resources are adequate at this time.

Reviewer 2:
The reviewer stated that the research team indicates that the funding planned is adequate.

Reviewer 3:
The reviewer commented that the $1.25 million annual budget (3-year effort) is significant, but the maintenance and upgrades for these tools are non-trivial. It would be interesting to see what the revenue from licensing the Autonomie model is and whether that is adequate for its ongoing maintenance and support. The AMBER model is needed for EEMS research along with other tools but development, operational, and maintenance costs should be considered in future follow-on work.

Presentation Number: eems016
Presentation Title: Energy-Efficient Connected and Automated Vehicles (CAVs)
Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

Presenter
Dominik Karbowski, Argonne National Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer commented that this project numerically investigated the potential of connected and automated vehicles in improving the fuel economy of transportation vehicles. The modeling approaches developed provided excellent tools for the research team to conduct the research work proposed.

Reviewer 2:
The reviewer found the approach to be very good. However, the savings are achieved primarily by less aggressive acceleration, which imposes a penalty on speed and responsiveness. The reviewer noted that it would be interesting to see how driver or occupant perception is influenced by this and how it trades off with fuel consumption savings.
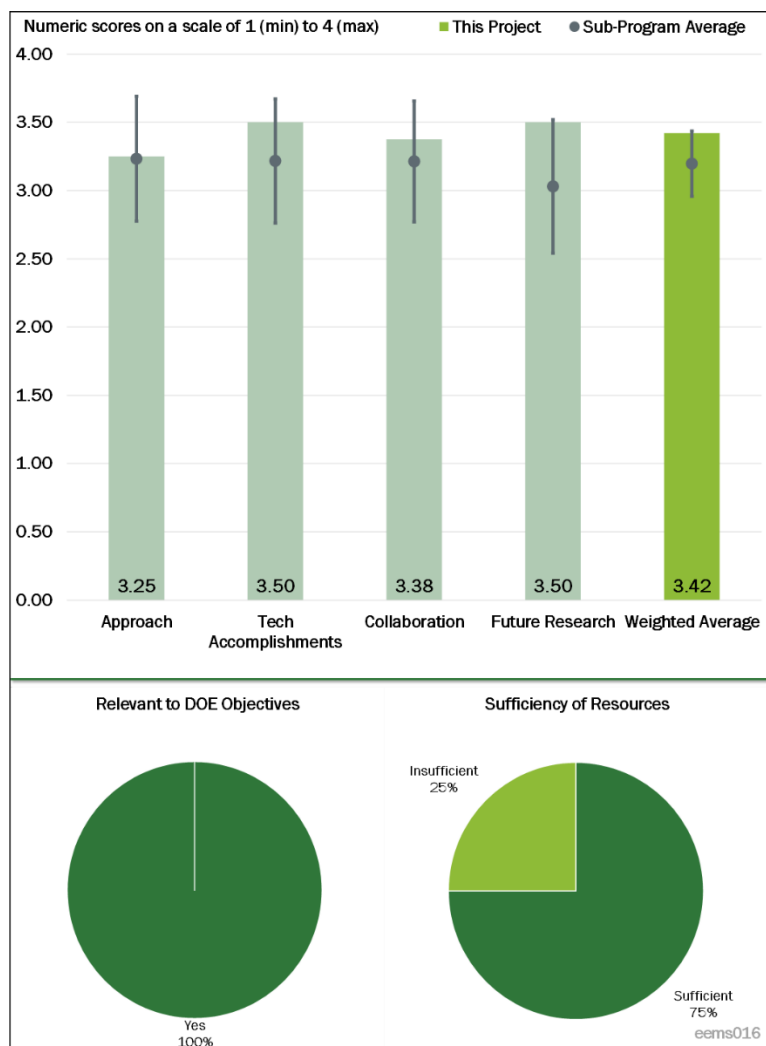

Figure 3-5 – Presentation Number: eems016 Presentation Title: Energy-Efficient Connected and Automated Vehicles (CAVs) Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

Reviewer 3:
Overall, the reviewer said that the approach is well thought out. The reviewer remarked that comprehension of vehicle driver control and powertrain interactions is essential to quantifying energy impacts, and the methods identified are appropriate to reach conclusions. The reviewer suggested three areas of improvement: further human driver-behavior classification, statistical sufficiency (for determining energy impact), and the consideration of travel time as part of the optimization problem.

Reviewer 4:
The reviewer noted that the project is well designed for understanding the basic tradeoffs among optimizing automated vehicles (AVs), adaptive cruise control (ACC), and CAVs for energy savings with and without factoring in advanced powertrain performance. By validating the model with the limited on-road testing of these vehicles, the reviewer stated that the design enables simulation of a range of optimization strategies for the test conditions available.

The reviewer commented that no information was provided in the design for forward work for fiscal year (FY) 2019 on how traffic volume or lateral vehicular movements (presumably lane merging and changing?) are to be addressed, including whether these conditions are being calibrated through advanced vehicle on-road performance.

It was unclear to the reviewer whether the human driver used to validate the baseline simulations was a professional driver or representative of on-road driving behavior in the United States. If the former, this is a significant limitation for which forward research is not noted. (Better still, a human driver baseline exhibiting the types of variability experienced in on-road driving would significantly improve upon a consistent human driver.) The lack of a baseline lead- optimized follow vehicle scenario is a significant oversight, according to the reviewer, given the intent to claim energy savings when the vehicles are in the opposite order.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
Substantial progress has been made in achieving the project aims, according to the reviewer.

Reviewer 2:
The reviewer remarked that the research team has competed the research work following the schedule proposed.

Reviewer 3:
The reviewer stated that the accomplishments among model validation, Eco-Driving controls, and energy impact are well presented.

The reviewer commented that model validation activities around the human driver model should be further explained. It was not clear to the reviewer what the baseline definition of human driving is, let alone the degree to which it is correlated.

Regarding the Eco-Driving controls, the reviewer stated that more information on the methodology and performance of the three algorithms (periodic, stop approach and departure, and car following) would be valuable. Specifically, the reviewer pointed to quantifying the energy benefits compared to drivability and travel time.

The energy impact summary charts were very helpful to the reviewer in understanding the output of the project and are well done. As part of future work, it would be nice to see one level deeper from an energy perspective to understand the underlying system and component impacts beyond engine and tractive energy reduction.

Reviewer 4:
The reviewer commented that validation of RoadRunner simulations with those test environments available appears to be robust, and the project has clearly demonstrated an ability to assess automated and connected vehicle performance under conditions approximating the test environment.

The reviewer advised that care should be taken though to always report results in terms of the actual driving conditions reflecting the test environment simulated and to represent results beyond what has been modeled— for example, level of service (LOS) A on higher functional class roadways. The reviewer stressed that this information should not be limited to a note at the end of the presentation, as has been done here.

The testing using 44 varied routes is fascinating and potentially very valuable, but the reviewer did not see enough information to meaningfully interpret the results presented. It was not clear to the reviewer what information about the routes, if any, was pulled from HERE Technologies, other than segment length and intersections. It was also not clear to the reviewer what it means to test two vehicles on these routes since there

is clearly traffic volume on these routes. More significantly, if traffic, lateral movements, etc. are not reflected in the simulations (as appears to be the case), the reviewer commented that mixed, suburban, and urban environments have not actually been tested because, by their nature, these involve traffic conditions yet to be incorporated into the project. If what was simulated were different frequencies of controlled intersections, then the results should be presented as such.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer stated that the collaboration level among the partners appears appropriate. The reviewer recommended further work with original equipment manufacturers (OEMs) to understand real-world constraints to be applied to Eco-Driving methods.

Reviewer 2:

The reviewer commented that there is good interaction with other teams needed to achieve the project aims. Because neither OEMs nor the Society of Automotive Engineers (SAE) is involved, there is a question about how well this would translate into implementable strategies.

Reviewer 3:

The reviewer remarked that this is a project completed by ANL with limited collaboration with other partners. The data provided by other partners may have helped this project team complete the proposed project work. However, as with all other projects completed by DOE National Laboratories, many partners have been listed, but the reviewer cannot justify if actual collaboration exists in this kind of project.

Reviewer 4:

The reviewer would like to have seen a brief discussion of how these project results compare with broader research on AV-connected vehicle (CV) vehicular simulations and performance. The lack of university partners seems surprising for a study area in which there is a significant university presence.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the proposed future research is exactly what needs to be done for this project.

Reviewer 2:

The reviewer liked that there will be an attempt to do a vehicle implementation measurement of real-world effectiveness. However, without some sort of standard for connected driving performance, the reviewer stated that the usefulness of the results will be limited.

Reviewer 3:

The reviewer commented that no information was provided in the design for forward work for FY 2019 on how traffic volume or lateral vehicular movements (presumably lane merging and changing?) are to be addressed, including whether these conditions are being calibrated through advanced vehicle on-road performance.

Reviewer 4:

The reviewer remarked that the research team proposed future research work in Slide 25 and that completion of this work should satisfy the delivery of this project. However, this team did not report any information about the difficulty in implementing the technologies proposed in this work. For example, the requirement for infrastructure and the capacity of the on-board computer needed for the vehicle to achieve the potential in

saving energy should be briefly explained. Also, the reviewer said that the time needed for vehicle to develop the optimized control and have it implemented in a timely manner is also something this team should report for future work.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer responded yes, and noted that Eco-Driving, with corresponding modeling and simulation, is essential to reducing energy demand on CAVs. Because shared CAVs have the potential of increasing overall energy usage on a transportation system level and through accessory loads on a vehicle level, implementing technologies to reverse this trend are essential.

Reviewer 2:

The reviewer observed that the project demonstrates what energy consumption reduction is achievable with new technological approaches, which is a key VTO objective.

Reviewer 3:

The reviewer stated that the integration of vehicular energy efficiency and on-road performance is critical in understanding the energy impacts of this new mix of vehicular drive trains and software. The reviewer recommended bringing forward information about this tradeoff, e.g., how much speed is sacrificed to maximized overall energy savings.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer indicated that the project progress indicates that resources allocated are sufficient.

Reviewer 2:

The resources appeared sufficient to the reviewer.

Reviewer 3:

The reviewer observed excessive project funding allocated to complete this research work. However, the funding is sufficient for this team considering the high operational cost of DOE National Laboratories and availability of the research facility in ANL.

Reviewer 4:

The reviewer remarked that the answer to this question depends in large part on what sort of inputs the project team will receive from EEMS076 on vehicle optimization in traffic. Even with an infusion of new information, the reviewer said that it is unlikely that the team will be able to readily simulate the range and variation of traffic conditions and mixed-fleet conditions to meaningfully estimate energy savings for urban or suburban environments.

Presentation Number: eems017
Presentation Title: Impact of Connected and Automated Vehicle (CAV) Technologies on Travel Demand and Energy
Principal Investigator: Josh Auld (Argonne National Laboratory)

Presenter
Josh Auld, Argonne National Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer stated that this project is an outstanding piece of work considering all of the inputs, scale of the modeling and analysis, and difficulty of getting one's hands around the problem.

Reviewer 2:
The reviewer noted that in its final stages, this project has shown that the approach undertaken has worked to address technical barriers, specifically the ability to integrate multiple model frameworks and methodologies.
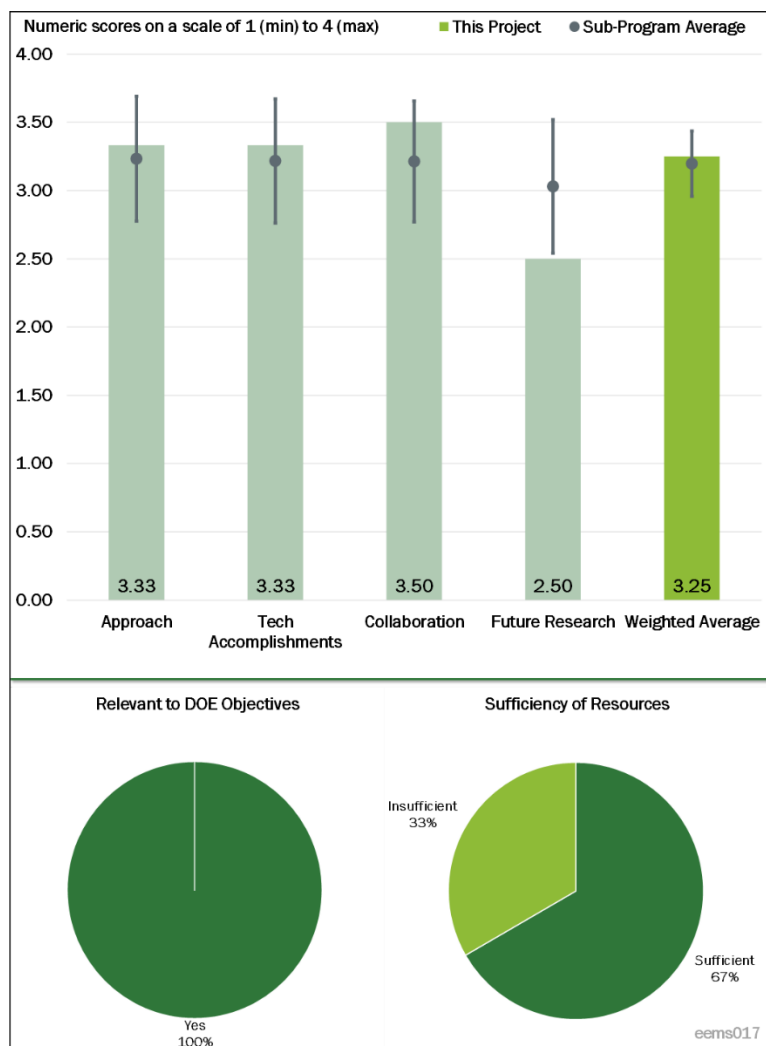

Figure 3-6 – Presentation Number: eems017 Presentation Title: Impact of Connected and Automated Vehicle (CAV) Technologies on Travel Demand and Energy Principal Investigator: Josh Auld (Argonne National Laboratory)

Reviewer 3:
The reviewer commented that the project requires a level of economic theory and perspective not evident here. There is neither inquiry into user costs under alternative scenarios and user responses to changes in those costs (price elasticity) nor into supplier behavior, particularly important in the fleet-share scenarios.

The reviewer stated that on the demand side, the stochastic representation of users enabled by POLARIS imparts significant value to this project. The lack of price variation in the POLARIS data sets, however, represents a significant barrier to a behavioral study such as this attempt to characterize user responses to changes in travel options and associated costs. The reviewer remarked that the external studies planned to overcome some of these limitations (e.g., time valuation studies) are not likely to be robust in the AV scenarios presented here, although some proxies may be feasible beyond the Lawrence Berkeley National Laboratory (LBNL) "chauffeur" study used to date.

The reviewer stated that on the supply side, the project seems to have modeled a single, system-optimizing provider rather than competitive firms in an economy-of-scale market. The study design does not appear to capture the nature of the mixed public-private nature of transportation for the service markets being studied: a

single (transit) provider without the ability to price discriminate (in the economics definition) and market providers with the flexibility to price discriminate, cream skim, and/or engage in predatory pricing (in the economics sense of these terms).

The reviewer indicated that cost information is largely missing from the materials provided, or how sensitive the results are to these price assumptions. The reviewer questioned what it would cost to privately own and operate a CAV and over what geographic region (if any) TNCs might operate profitably (recognize they have not been profitable to date in advantageous markets and labor is required for fleet maintenance even if not for driving).

Although this project demonstrates how integrated big data can be used to elicit insights into travel behavior, the reviewer noted that it is important to ensure the results are presented as reflective of the metropolitan area of Chicago, its specific mix of modal infrastructure, land use, travel preferences, weather, etc. Platooning is a lower level concern for this project, given the more fundamental economic context described above.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
According to the reviewer, the project has made progress as planned along proposed timeline and performance indicators. This includes the publication of results of joint effects of platooning and vehicle sharing at the regional scale and the quantification of the impact of connectivity and automation on traffic flow fundamental diagrams and energy.

Reviewer 2:
The reviewer stated that the project has clearly made progress in incorporating some of the household (HH) information available into the planned scenarios. The value of the results to date, however, are in question given the lack of characterization of costs of HH choices and assumptions about HH responses to those costs.

Reviewer 3:
The accomplishments provide answers to many interesting, difficult-to-answer questions. The reviewer believed that the PIs have partly addressed this issue before in response to last year's reviewer comments, but the reviewer felt that error bars are called for on the results bars.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer noted that the project team shows strong collaboration and integration among other project elements of the SMART Mobility Consortium as well as other academic partners.

Reviewer 2:
The reviewer said that the project team brings together the right groups of stakeholders (from a wide range of organizations) who can provide the best information and critique the results.

Reviewer 3:
The reviewer called this an ambitious, expansive project and the project team has developed an impressive array of participants, including universities. The apparent lack of participation by Departments of Economics with an industrial organization focus, however, is telling and a recommended next step.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that the next steps are a logical progression from the work already completed. The reviewer stated that the project team should also compare results with BEAM, given similar inputs.

Reviewer 2:

The reviewer stated that the project provided no indication of how it would validate its results going forward (e.g., extension to another Metropolitan Planning Organization [MPO]). The project team indicates an interest in incorporating some benefit-cost literature, but these studies tend to be fairly particular in the concepts the team addresses and are not likely to be good fits for incorporation into the POLARIS data sets.

Reviewer 3:

Proposed future research lacks a real-world implementation connection, according to the reviewer. For projects in the EEMS program to be truly successful, the reviewer remarked that the future research proposed must address plans to obtain feedback from real-world implementers of relevant mobility systems and then get the insights gathered by the research into the hands of implementers.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer asserted that the project is a key element in the DOE objective of measuring the energy consumption impact of various coming technologies on the transportation and mobility system.

Reviewer 2:

The reviewer indicated that this project supports overall DOE objectives by obtaining new insights into the energy efficiency gains afforded by CAVs.

Reviewer 3:

The reviewer stated that the project attempts to address the eternal "if we build it, will they come" question without which it is really impossible to gauge the energy impacts of emerging transportation technologies or their applications.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

Resources are sufficient to achieve the stated milestones in a timely fashion, according to the reviewer.

Reviewer 2:

The reviewer noted that no work appears to have been delayed by the amount of funding provided.

Reviewer 3:

The reviewer stated that substantial additional resources would be needed to develop realistic estimates of consumer and supplier responses to transportation costs and market conditions.

Presentation Number: eems019
Presentation Title: Smart Urban Signal Infrastructure and Control Principal Investigator: H.M. Abdul Aziz (Oak Ridge National Laboratory)

Presenter
H.M. Abdul Aziz, Oak Ridge National Laboratory

Reviewer Sample Size
A total of five reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:

The reviewer said that the barriers were well identified. There should have been a clarification on the education and licensure regarding the traffic signal systems being optimized. According to the reviewer, from the presentation and the actual Annual Merit Review (AMR), there seemed to be a lack of fully understanding the travel demand modeling of the project.

Reviewer 2:

The reviewer stated that in FY 2019 this project is applying the statistical analysis to impacts of the CAV penetration rate on signal control performance. Distributed control with gradient approximation techniques and gross domestic product (GDP)-weighted energy equivalence of safety at intersections are also used.
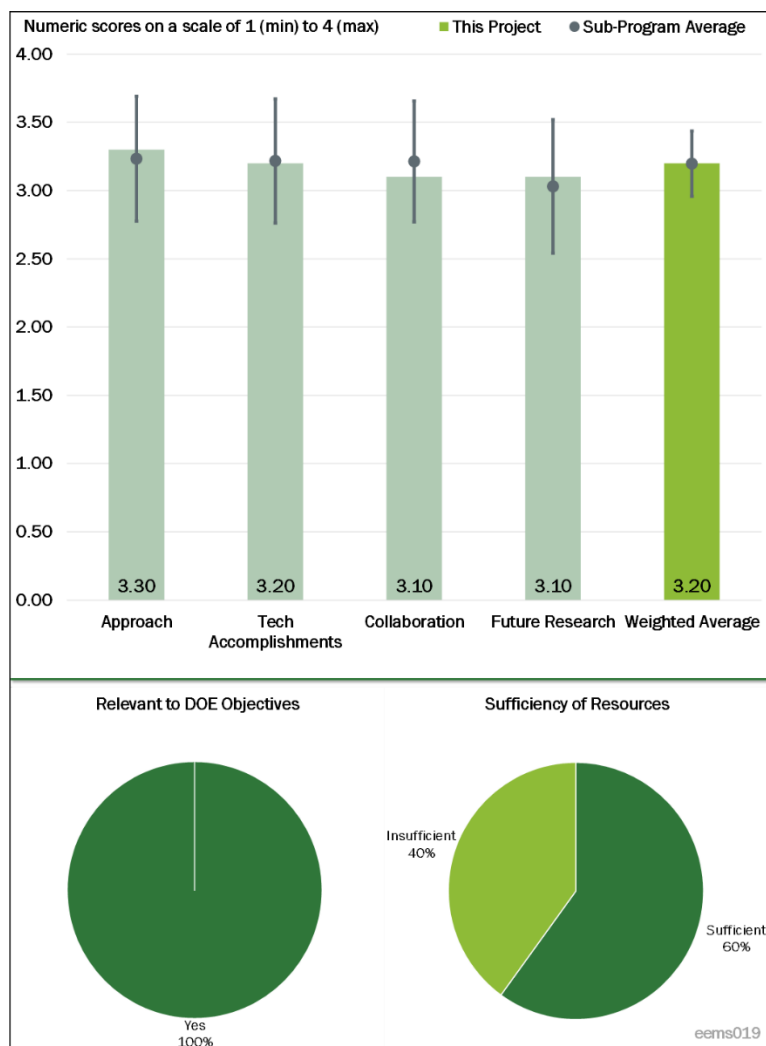

Figure 3-7 – Presentation Number: eems019 Presentation Title: Smart Urban Signal Infrastructure and Control Principal Investigator: H.M. Abdul Aziz (Oak Ridge National Laboratory)

Reviewer 3:

The reviewer remarked that the technical approach seemed to be structured well to answer the key questions at hand. However, it was not clear to the reviewer whether the controls approaches will deliver optimized results compared with other approaches. Perhaps this was addressed in earlier phases of the project. This is the third year of a three-year project. The reviewer had one suggestion for future reviews: have a slide or two recapping relevant progress and findings to date to properly set the context for describing the new work.

Reviewer 4:

The reviewer stated that the approach taken has settled to a set of well-bounded simulations that target the generation of answers to specific questions. This is a good evolution for this project. The reviewer liked that the project team had begun their analysis with perfect-world performance assumptions for the communications and connectivity because they form a bounding case that can be modified in future analysis.

Reviewer 5:

The reviewer noted that the project team seems to have defined the problem well and had no specific suggestions.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer said that analysis on assessment of CAV market share impact has been completed and five scientific papers have been developed.

Reviewer 2:

It seemed to the reviewer that the project team had made strong progress confronting less-than-complete-communication and has included xEVs.

Reviewer 3:

The reviewer commented that the project should have engaged traffic engineers with actual traffic optimization experience.

Reviewer 4:

This reviewer remarked that the project has made good progress and produced useful insights from Tasks 1 and 2 that were presented at AMR. The reviewer's impression was that results from Tasks 3 and 4 are pending. The only criticism is that one might expect strong results from three out of four of the tasks at this point because the presenter indicated that the project was 80% complete.

Reviewer 5:

It was unclear to the reviewer that work has addressed the main questions behind the objectives as comprehensively as needed. Additionally, it is unclear how robust the conclusions are from the completed studies. For example, this reviewer noted that a broader range of intersection scenarios may have to be considered. It was unclear whether or not this has been considered.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer remarked that the project team exhibited clear knowledge of what the other team members are pursuing and several of the team members constructively participated in responding to the reviewer questions.

Reviewer 2:

The reviewer noted that collaboration includes four universities and NREL (PI for Urban Science Pillar of the SMART Mobility Consortium).

Reviewer 3:

The reviewer found synergy among the project team in the documentation, but stated that there were gaps in the presentation during the AMR. The team should consider a review of the energy equivalence of safety Task 4. The reviewer asked if these numbers include energy expended by queued vehicles as a result of a crash.

Reviewer 4:

Collaboration was limited, according to the reviewer, and suggested that this work might benefit from more interaction with universities that have significant controls expertise and have been engaged with defining controls for intelligent transportation systems.

Reviewer 5:

The reviewer stated that contributions from others outside the PI's team are not clearly stated.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development path

Reviewer 1:

According to the reviewer, the remaining project work includes developing an algorithm to account for low penetration rate of CAVs and a framework for pedestrian-priority intersection control. Several papers and reports are also planned for FY 2020.

Reviewer 2:

The reviewer commented that the project is nearing its end so there is not a lot of time to propose too many changes. But, the close-out plan seems sufficient.

Reviewer 3:

The reviewer remarked that a brief summary of future work was given without plans or milestones so it was not clear to the reviewer how completely thought out the proposed work is. The next steps for project work this year looked okay.

Reviewer 4:

The reviewer suggested that future modeling for an optimized traffic control system should include an arterial network and a grid-network found in an urban core.

Reviewer 5:

The reviewer said that future work is perceived as Tasks 3 and 4. The significance of the planned work product was unknown to the reviewer because there appears to be no sensitivity study regarding traffic loading; therefore, it appeared to the reviewer that the result may apply to only a single set of traffic loading of the intersection. Also, the reviewer commented that Task 3 analysis does not consider or document the amount of energy required to perform the sensing at a given distance, which is significant in that this DOE study is supposed to quantify energy consumption. The reviewer found the description of the Task 4 work to be vague.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer remarked that the project supports overall DOE objectives to increase the knowledge base of CAVs with respect to energy consumption. This project's initial results have added to the knowledge of what penetration states of CAVs are necessary to significantly affect energy consumption using intersection control mechanisms. According to the reviewer, the answer appears to be greater than 50% CAVs.

Reviewer 2:

The reviewer stated that this project contributes to system control and multi-vehicle control aspects through micro-traffic flow (part of the EEMS end-to-end modeling workflow). This, in turn, supports increasing mobility without increasing energy consumption; hence, directly supporting the VTO goal of reducing petroleum use.

Reviewer 3:

This reviewer stated a qualified yes, and commented that objectives are aligned to the SMART Mobility Consortium objectives at a high level. This project seems very focused on design of controls for vehicle-to-anything (V2X) systems. There may be alternative approaches to more broadly addressing the key underlying questions that do not involve such a burdensome controls design approach. The reviewer asked a related question about who the customer is for the controls being designed as part of this work.

Reviewer 4:

While the reviewer personally questioned the likelihood of greater than 30% or 50% penetration of connectivity (especially with the current stalled efforts to require dedicated short-range communications [DSRC]), DOE seems to believe in this future. This reviewer had no criticism on DOE relevance given DOE direction, particularly at the early parts of this project.

Reviewer 5:

The reviewer indicated that it is relevant, but should model both arterials and grid systems.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that resources in terms of funding levels seem to be aligned with the scope of the work.

Reviewer 2:

Budget seems about right for the work completed, according to the reviewer.

Reviewer 3:

The reviewer commented that the inclusion of traffic engineers with signal optimization experience would greatly enhance the value of this project.

Reviewer 4:

The reviewer noted that only FY 2019 funding ($605,000) is shown for this 3-year effort.

Reviewer 5:

It appeared to the reviewer that this project has bitten off more than it can address thoroughly within the given period of performance. It has made some initial progress but there is a lot more work to do to fully address the questions posed by the project.

Presentation Number: eems020
Presentation Title: Multi-Scenario Assessment of Optimization Opportunities due to Connectivity and Automation
Principal Investigator: Jackeline Rios-Torres (Oak Ridge National Laboratory)

Presenter
Jackeline Rios-Torres, Oak Ridge National Laboratory

Reviewer Sample Size
A total of five reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The overall approach looked excellent and robust to the reviewer. It appeared to the reviewer that all of the important factors are incorporated into the research including not only energy efficiency analyses (as a primary output), but also factors like miles traveled and safety.

Reviewer 2:
The reviewer stated that the goal of the project is to explore optimization of energy efficiency of full and partial CAV market penetration scenarios. The project approach includes simulation assessment of optimal coordination for real-world scenarios.

Reviewer 3:
The reviewer commented that the research approach is well thought out and leverages off of research done in previous years.

Reviewer 4:
The reviewer stated that a main objective of the work is to assess the energy savings potential of CAV technology deployment; however, the important effect of vehicle auxiliary loads from CAV technologies has been neglected. It sounds like future work is intended to address this, but it was not clear to the reviewer that the importance of increased auxiliary loads was fully understood. Related to this, the reviewer remarked that the work should more formally define what level of automation is being assumed for the scenario studies.
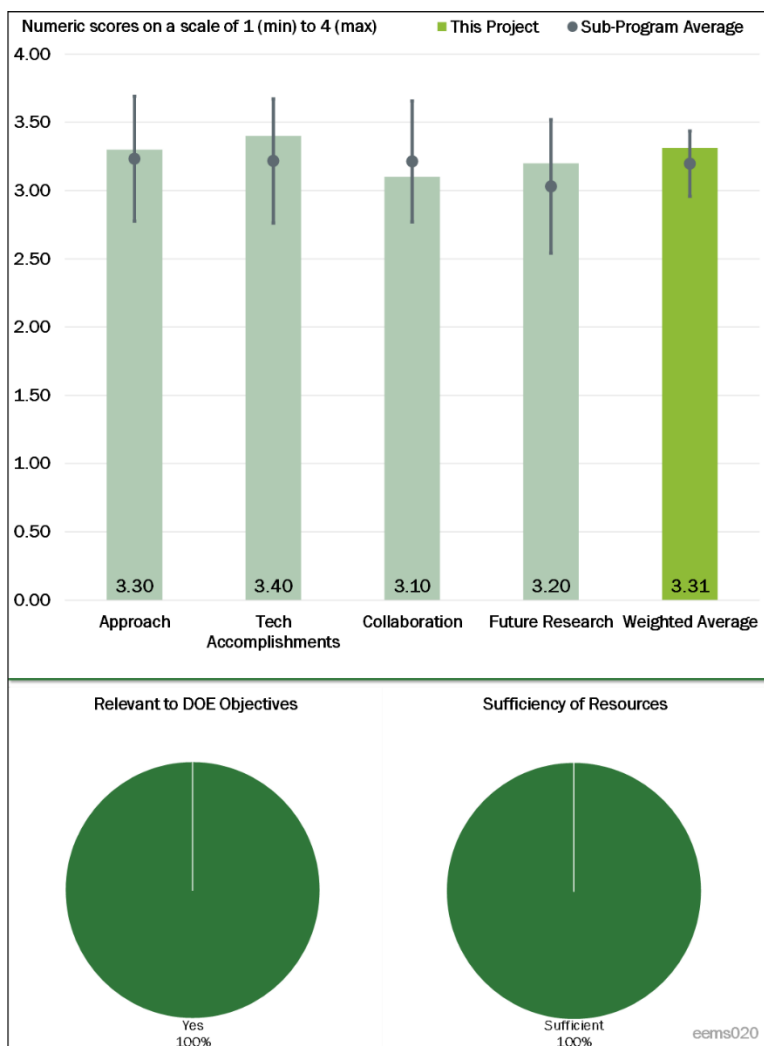

Figure 3-8 – Presentation Number: eems020 Presentation Title: Multi-Scenario Assessment of Optimization Opportunities due to Connectivity and Automation Principal Investigator: Jackeline Rios-Torres (Oak Ridge National Laboratory)

Reviewer 5:

Regarding approach, the reviewer had two comments. The first concerned why the entrance ramp is prioritized for study. The reviewer agreed that it presents as a safety case to be solved, but did not expect that there is a large amount of fuel to be saved relative to other traffic use cases, such as work zone slowdowns, etc. The second comment was that the reviewer thought that there needed to be more traffic scenario studies.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer observed that accomplishments include CAVs on-ramp analysis, adaptation of optimal coordination of CAVs to interconnected scenarios (urban and highway corridors), and partial CAV penetration considering heterogeneous traffic. Use of high-fidelity fuel consumption models and baseline traffic scenario are ongoing.

Reviewer 2:

The reviewer noted that the research team has shown excellent progress thus far. Results have included adaptation of optimal control of CAVs to integrated scenarios, including mixed traffic scenarios. Results have also demonstrated controller ability to improve fuel economy and reduce travel time even with 100% CAVs.

Reviewer 3:

Although the project appears slightly behind schedule, the reviewer stated that the accomplishments are relative to the goals.

Reviewer 4:

The technical accomplishments looked great to the reviewer and are yielding interesting insights into CAV impact in a number of areas. The reviewer appreciated the analysis into ramp road safety through the analysis of speed and acceleration volatility. Also, the initial insights into reduced fuel consumption, increased fuel economy, and increased total miles traveled is great to see. The reviewer would have appreciated some confidence intervals on at least some of the outputs though to understand the variability in the output. The reviewer understood at this point these may be more point solutions, but an analysis of variability will become more important as this project matures.

Reviewer 5:

The reviewer commented that the capability developed to look at traffic corridors looked impressive. Work is needed to couple with more realistic models for fuel consumption, according to the reviewer.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

According to the reviewer, the project team has shown good collaboration with laboratories (Oak Ridge National Laboratory [ORNL] and ANL) and academia, and are in discussions with AT&T.

Reviewer 2:

The reviewer stated that there are collaborations with the SMART Mobility Consortium partners (five laboratories) and two universities (Delaware for human-in-the-loop experimental data and Tennessee on safety).

Reviewer 3:

The reviewer commented that it was good to see that the partnerships have been expanded.

Reviewer 4:

The reviewer remarked that the collaboration is adequate, but could be enhanced with some partners in the technology space (Google, Apple, automotive OEMs, etc.) as well as perhaps other input from, for example, Federal or state DOTs to opine on the safety analyses.

Reviewer 5:

Collaboration within the SMART Mobility Consortium looked good overall to the reviewer. There seem to be several projects addressing the same questions around energy impacts of CAV technologies. The reviewer said that it looks like there could be an opportunity for tighter coordination and/or consolidation.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer affirmed the appropriateness of future research to explore impacts of optimal coordination applied to simulated traffic scenarios based on real-traffic data and the effects of communication instabilities in the overall performance of the control.

Reviewer 2:

According to the reviewer, the researcher has laid out a well-conceived future plan involving integration of multiple, optimized control scenarios into one overall framework.

Reviewer 3:

The reviewer said that the next steps and areas to be looked into for future work looked reasonable, but there was not much detail given about future work. The only information given was high level.

Reviewer 4:

The reviewer commented that there appears to be a relevant list but the reviewer would have liked to see the explanation expanded and further defined.

Reviewer 5:

The reviewer echoed the suggestion on Slide 20 that there needs to be future research on agent diversity. As part of this, the outputs need to also show some level of distribution. For example, Slide 14 shows that total miles traveled increases overall; this likely increases in the aggregate (i.e., the total area under the "miles traveled by each agent compared to the baseline histogram" is positive). However, the reviewer indicated that that could still mean that some of those agents actually traveled fewer miles (i.e., their travel time increased in certain scenarios). The reviewer suggested that it might be useful to know and understand these. Also, seeing families of distributions for different scenarios may show, for example, a tighter distribution for some scenarios, which might be more ideal even if the average is lower than a wider distribution with a higher average.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer stated that this work is the core to the EEMS and DOE objectives of understanding future mobility scenarios and their impact on energy, safety, and other factors.

Reviewer 2:

The reviewer said that the project supports the overall DOE VTO objectives of petroleum reduction by exploring optimization opportunities to increase energy efficiency of different CAV market penetrations under diverse traffic scenarios.

Reviewer 3:

The reviewer found this work to be relevant to DOE with a focus on energy impacts of full and partial CAV penetration rates.

Reviewer 4:

The reviewer remarked that the project is on track to support the full model.

Reviewer 5:

The reviewer commented that the work is relevant to the objectives of EEMS and the SMART Mobility Consortium. As mentioned previously, several projects seem to be trying to address the same question so there may be opportunity to consolidate efforts.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

It seemed to the reviewer that a fair amount of work has been accomplished for the given funding, and that should be maintained. It was not clear to the reviewer that more funding would have yielded far greater results, or that less funding could have accomplished the same amount of work. Therefore, the funding seems sufficient.

Reviewer 2:

The reviewer stated that $1 million for a 3-year effort seems appropriate given the objectives and scope.

Reviewer 3:

The reviewer said that funding level seems appropriate for the scope of the work and project timing is on target.

Reviewer 4:

The reviewer commented that this work appears to be correctly funded.

Reviewer 5:

The reviewer said funding is sufficient.

Presentation Number: eems023
Presentation Title: The Whole Traveler Transportation Behavior Study
Principal Investigator: Anna Spurlock (Lawrence Berkeley National Laboratory)

Presenter
Anna Spurlock, Lawrence Berkeley National Laboratory

Reviewer Sample Size
A total of six reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer commented that this project is based on an approach that is intended to define many elements of the changing mobility market. The reviewer praised this project as being the first project evaluated by the reviewer that has recognized the need for an understanding of the market behaviors of mobility users in order to understand how the adoption of future mobility elements will likely proceed. According to the reviewer, it was refreshing to see that understanding market forces that drive behavior is critical to understanding how advanced mobility will be accepted in the marketplace.
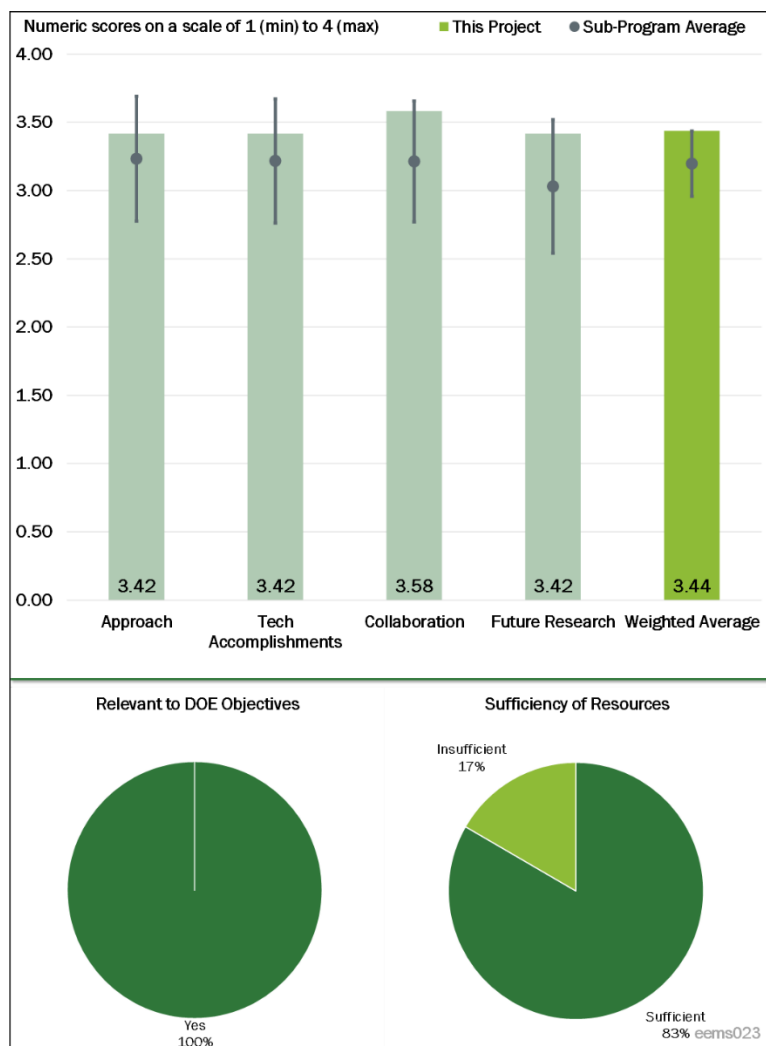

Figure 3-9 – Presentation Number: eems023 Presentation Title: The Whole Traveler Transportation Behavior Study Principal Investigator: Anna Spurlock (Lawrence Berkeley National Laboratory)

Reviewer 2:
The reviewer found the approach to be good with a broad Phase 1 survey and an in-depth Phase 2 survey follow-on to collect vehicle travel data via Google maps. Detailed statistical analysis addressed appropriate research questions that look at a variety of decisions that impact traveler behavior. Ten publications are planned to share the results not only within the EEMS SMART Mobility Consortium but also with the general public.

Reviewer 3:
The reviewer noted that this project undertook a scope of work that is of very large magnitude and the project is well designed to be able to meet the technical barriers identified head-on.

Reviewer 4:
The reviewer stated that the approach is generally good and is now showing results. It is good to focus on driver-level barriers and how driver response to technology varies among different groups of people, as this is

ultimately a limiting factor for these new mobility technologies. If drivers and customers resist the technology, uptake will be slow or nonexistent.

The reviewer remarked that the project team is focusing on the right future technologies (EVs, TNCs, e-commerce) that have the largest unknowns for customer acceptance. The approach to address reasonable population dimensions that either do not change or change predictably is good and means that the team will get useful answers. The reviewer indicated that the team is using a comprehensive survey supplemented by global position system (GPS) data collection to add details to the survey conclusions. The team has a clear understanding of the benefits and limitations of the survey-based approach and the conclusions that can be derived from such surveys. The reviewer said that the results are still beneficial.

The reviewer commented that it is good to see that the project team has been documenting the survey and other actions being taken in the project so that others could replicate the process for their own regions. The reviewer recommended that the project team consider how DOE can best take advantage of this replicability and expand the ultimate impact of the project. Another key consideration for the project team that could help others replicate the results more successfully would be some ideas on how future projects can limit the issue of survey self-selection.

Reviewer 5:
The reviewer said that the presenters are aware of numerous technical barriers and have taken steps to overcome them. The reviewer expressed concern about the small percentage of questionnaires returned as that, in the reviewer's opinion, indicates that the sample is self-selected and biased.

Reviewer 6:
The reviewer commented that incorporating behavioral insights into mobility modeling is important and valuable. This project seems less focused to the reviewer than it might be and is attempting to provide analysis on a huge range of topics based on the availability of the data set. But, it was unclear to the reviewer whether the data or analysis methods are optimal to investigate those topics. One of the early articles is about effects of children at home but does not purport to address how that may be changing with the advent of emerging mobility options, which is a key question for EEMS. The reviewer opined that the fact that the survey respondents were not representative limits the applicability of findings.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer remarked that data collection has been completed for Phase 1 (1,045 responses; 900 was goal) and Phase 2 (301 responses; 200 was goal). The data set for Phase 1 has been de-identified and shared with 21 SMART Mobility researchers; the Phase 2 data set is being processed. The reviewer noted that several reports on Phase 1 Survey analysis results have been published. The reviewer found insights to be good from Phase 1 survey preliminary analysis on impacts of travel choice by family growth (impact of children), in-home deliveries (e-commerce), and ride-hailing price sensitivity (impact on mass transit).

Reviewer 2:
The reviewer remarked that the researchers exceeded their goals for response rates. The project is on schedule, and some products were delivered early. The reviewer commented that there is more work underway than initially envisioned.

Reviewer 3:
The reviewer stated that the survey approach included an understanding of the varied age groups, varied family status, varied employment, and varied income levels. It covers many of the most pertinent groups that must be understood.

Reviewer 4:

For this year, the reviewer indicated that the project team has shown many more specific outcomes and accomplishments, which made it much easier to understand the overall benefits of the project. The team has showed a number of useful accomplishments this year and the summary of priority analyses in the presentation listing the analysis description, analysis status, and publications was extremely helpful in identifying the breadth of work. The reviewer stated that the team has completed a considerable amount of research output with a total of 10 papers and analyses to be completed by the end of the fiscal year.

According to the reviewer, the team has exceeded its goals for surveys received for both phases, which is a great accomplishment for survey-based work. The PI has expressed a clear understanding of how the survey sample has self-selected as wealthy and smarter, which is good for framing the survey results and limitations. The reviewer commented that the team has done considerable data sharing from its survey results to other SMART research partners, which is a good concrete collaboration that should yield benefits. The reviewer expressed interest in seeing if this dataset were included in the data products for the LiveWire project under development. According to the reviewer, the team has provided some interesting insights regarding low-income group interest in pooled ride hailing (partly because of its low upfront cost to users), but the reviewer wanted to know what this tells us about the uptake for other technologies in this income group. The age-related information is valuable to quantify some of the intuitive conclusions being made about younger generation habits. Because these younger populations represent the future of transportation, the reviewer asked how their differing attitudes on transport-can be leveraged to-yield benefits.

The reviewer asserted that there are some interesting implications around the findings that online delivery of goods is supplementing but not necessarily replacing household shopping trips. It may be that e-commerce will not have any benefit for energy use versus conventional shopping, or a very low benefit. According to the reviewer, this makes the DOE technology research about what vehicles deliver these goods even more important.

The reviewer noted that the analysis of ride-hailing price effects on mass transit changes helps confirm some assertions that low-cost ride hailing will draw riders from transit. It was interesting to the reviewer to see that ride hailing (if priced reasonably low) actually increases mass transit use for those who are close to (but not next to) a station. This could have implications, potentially, for collaboration between transit agencies and ride-hailing companies.

Reviewer 5:

The reviewer said that the accomplishments and progress made are good; however, there are significant milestones and accomplishments that must be made in very short order to meet the project conclusion deadline in the fall of 2019.

Reviewer 6:

The reviewer stated that the project is 75% complete with 3 months remaining on a 3-year plan. The reviewer noted that researchers determined not to collect data for another region, which the reviewer found unfortunate due to the self-selection bias of the existing data. Journal articles are in draft form.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer indicated that the PI has done an excellent job of uniting a very diverse group of project participants across the SMART Mobility Consortium in order to produce fundamental research and modeling inputs for a vast amount of future work.

Reviewer 2:

The reviewer noted that there is a partnership of three National Laboratories (LBNL, Idaho National Laboratory [INL], and the National Renewable Energy Laboratory [NREL]) and three universities (Berkeley,

Stanford, and Carnegie Mellon). Phase 1 survey data are being shared with 21 Smart Mobility Consortium researchers and will inform other EEMS research projects.

Reviewer 3:

The reviewer commented that the project team is collaborating well with other DOE SMART researchers and enabling beneficial sharing of data outputs from the project. The collaboration between multiple laboratories and academic institutions is reasonable for this type of project.

Reviewer 4:

The reviewer stated that there is a long list of collaborators, with 10 research papers planned.

Reviewer 5:

The reviewer remarked that the project team is sharing data widely across the SMART Mobility team, which could be very useful, though the fact that data are not representative may make the use of data by others problematic. The level of collaboration among the laboratories is high (e.g., judging from joint articles), but collaboration with the academic community is less clear.

Reviewer 6:

The reviewer found the collaborations to be extensive and quite varied. To be outstanding, the reviewer said that there needed to be more comprehensive collaborations with local stakeholders, i.e., government agencies would be required.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the project team has provided a well-thought-out and extensive response to previous reviewer comments that shows its understanding of the datasets and to improving the future work plans. The team is setting some ambitious goals for finishing all these analysis papers this year to wrap up the current project.

According to the reviewer, the team has obviously thought carefully about next steps based on the FY 2020 suggested research questions. The questions the team has developed are insightful and should provide a good basis for possible future work. The reviewer remarked that the team's consideration of work regarding underserved communities is useful and such work is underrepresented in DOE analysis, at least explicitly.

Reviewer 2:

The reviewer said that there was a good list of future topics. Understanding how lifestyle changes affect transportation is a key area. The impact of micro-mobility is a huge factor in transportation energy trends. The reviewer suggested that it is worthwhile investigating whether automated vehicle equipment will reach a price point where it becomes practical to make e-bikes and e-scooters into automated vehicles and what the consequences would be as automation could tame scooter chaos. Investigation of perceptions is key. According to the reviewer, marketing is likely to be a bigger force in the coming transportation revolution than technical merits. Investigators should consider the extent to which government marketing is appropriate. The reviewer noted that a propaganda drive by the U.S. government was effective in reducing car ownership and encouraging car sharing during World War II. Climate change may be an existential crisis that demands government intervention.

Reviewer 3:

The reviewer noted that this project is in its third and last year, ending on September 30, 2019. Completion of Phase 2 survey data analysis and publication of the remaining reports (10 planned in total) are appropriate

targets. The reviewer remarked that there was a good no-go decision to not extend the survey to another geographic location as that would limit the ability to conduct in-depth analysis on the existing dataset and limit sharing the results via fewer publications.

Reviewer 4:

The reviewer commented that the proposed future research is immense, but logical given the fundamental nature of the information being collected. The reviewer said that it will be critical for research to remain focused on energy relationship for any future research funded by DOE.

Reviewer 5:

The reviewer found there to be an extensive and interesting collection of papers in the progress. Given the importance of getting data that are applicable outside of the Bay area and more representative in economic terms, the reviewer commented that it would seem crucial to address the data shortcomings. It is not clear to the reviewer that this is contemplated.

Reviewer 6:

To be outstanding, the reviewer said that the research would have required an extension of this process to at least one other city to be surveyed or a collaboration with another city to take the process and enact it under this project team's guidance. According to the reviewer, making sure that the process is clearly captured and learning is incorporated into a fully documented process for future use are critical elements that will cause this project to have the highest value.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

This project supports the DOE objectives probably more so than the other projects that the reviewer has evaluated. This is because it is not a modeling exercise that is so academic but instead a fact-gathering exercise that could drive decision making efforts of cities that are faced with creating policy for new mobility.

Reviewer 2:

The reviewer commented that this project supports the overall DOE objectives as it contributes to travel behavior understanding and supportive data to inform transportation-as-a-system modeling and scenario analysis. It also directly contributes to the EEMS overall workflow of smart mobility, which in turn supports increasing mobility without increasing energy consumption: hence, directly supporting the VTO goal of reducing petroleum use.

Reviewer 3:

The reviewer said that the project is definitely relevant to VTO objectives as it is exploring the consumer responses at a detailed level to possible future technology choices, with implications for consumer uptake and ultimately energy savings.

Reviewer 4:

The reviewer noted that the effects of demographics on transportation choices has been undervalued in planning. It will be useful to characterize how much (if any) influence it has.

Reviewer 5:

It was not clear to the reviewer what "overall DOE objectives" this question is referencing. Regarding the EEMS vision of "an affordable, efficient, safe, and accessible transportation future in which mobility is decoupled from energy consumption," this project would plausibly provide information supporting that vision.

Reviewer 6:

The reviewer said proposed future research lacks real-world implementation connection. For projects in the EEMS program to be truly successful, the future research proposed must address plans to obtain feedback from

real-world implementers of relevant mobility systems and then get the insights gathered by the research into the hands of implementers.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer pointed out that the allocated resources ($3.2 million) are sufficient to achieve the project objectives (collaboration of three National Laboratories and three universities) and milestones (10 publications on detailed analysis of collected traveler survey and trip data) in a timely fashion (over a 3-year period).

Reviewer 2:

According to the reviewer, the project team appears to have sufficient resources to have completed the work successfully.

Reviewer 3:

The reviewer indicated that resources have been sufficient for the project to meet its objectives.

Reviewer 4:

According to the reviewer, resources are sufficient to complete what was described as future project work. It should be noted that the documentation of the process must be a part of this future work.

Reviewer 5:

The project has a higher level of funding than most, but the scope at this point is quite large. Hence, the sufficiency of funding was unclear to the reviewer, especially given the "no-go" decision on additional data collection.

Reviewer 6:

It seem to the reviewer that this project area could benefit from additional resources that would allow higher caliber and greater breadth of surveying to sufficiently build data sets.

Presentation Number: eems024
Presentation Title: Market
Acceptance of Advanced Automotive
Technologies (MA3T) - Mobility
Choice: Analyzing the Competition,
Synergy, and Adoption of Fuel and
Mobility Technologies
Principal Investigator: Zhenhong Lin
(Oak Ridge National Laboratory)

Presenter
Zhenhong Lin, Oak Ridge National
Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this
project.

Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.

Reviewer 1:
The reviewer stated that the approach is
a logical expansion of existing VTO-
funded tools and shows value in
adopting these tools for new
applications. The expansion is covering
an area of vehicle choice modeling that
is not as well understood as the reviewer
asked how consumers will make choices
about transportation services in a shared
and connected world. This is very
important to understand, according to
the reviewer, particularly if these
choices have a negative impact on
energy. The approach is covering the
right level of disaggregation and household segmentation to assess how these different households make
choices. The reviewer added that that it is also covering an adequate list of future vehicles and is competing
these new, shared and connected modes against more conventional car ownership models, an aspect that needs
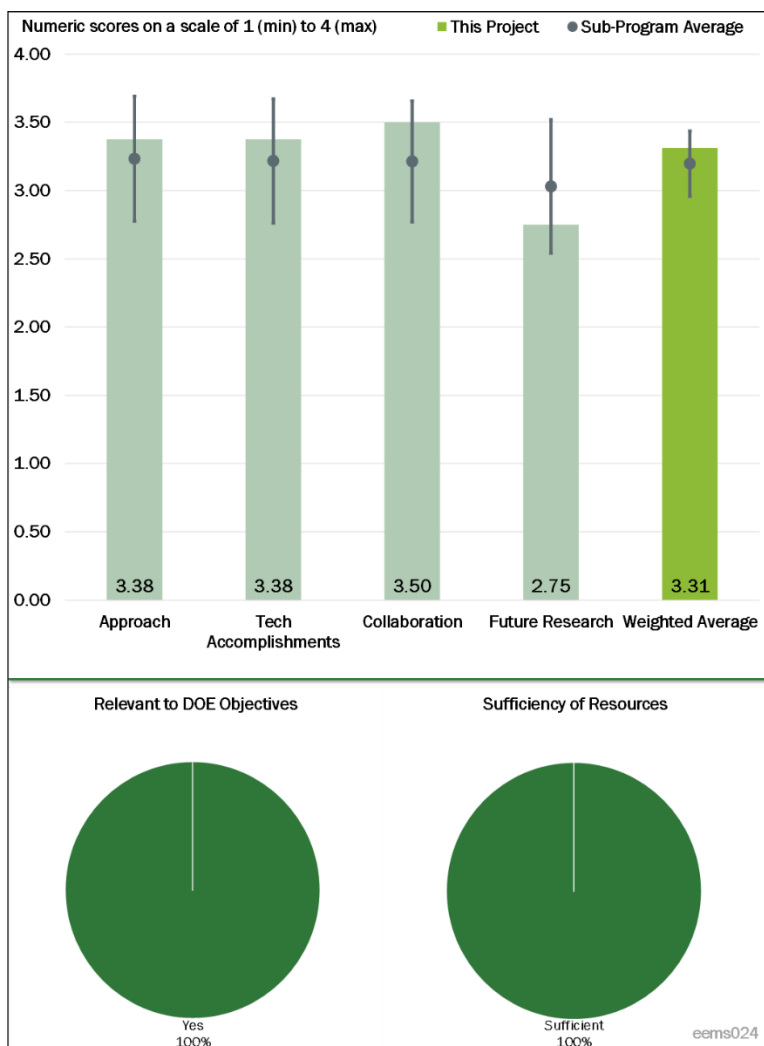to be studied.

Figure 3-10 – Presentation Number: eems024 Presentation Title: Market
Acceptance of Advanced Automotive Technologies (MA3T) - Mobility Choice:
Analyzing the Competition, Synergy, and Adoption of Fuel and Mobility
Technologies Principal Investigator: Zhenhong Lin (Oak Ridge National
Laboratory)

Reviewer 2:
The reviewer stated that the project makes a strong effort to model future consumer decision drivers with
respect to transportation choices and quantifies the energy impacts of those decisions. The analysis is
performed for the 2030 and 2050 timeframes. The reviewer said that an indicator of the quality of the analysis
is that it includes the energy required for CAV sensor functions as an independent cost variable. The dependent
variable appears to be personal miles traveled (PMT), which is a surrogate for energy usage.

Reviewer 3:

The reviewer commented that the use of the Market Acceptance of Advanced Automotive Technologies (MA3T) model as the basis for this work is appropriate and found the mobility choice options explored in this project to be fairly comprehensive.

Reviewer 4:

The reviewer indicated that the approach to performing the work was good in that it offered leverage of a previously developed model to address new technical barriers.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer remarked that the research team has invested considerable time into understanding the vehicle choice landscape and how shared and automated vehicles might compete or complement conventional vehicles. It is good to see that the team is considering several scenarios for CAV hardware and sensor power draws in its analysis as these can be considerable and have an effect on overall energy use. The reviewer noted that energy-use considerations do not have much influence on the drivers for shared and connected vehicle choices, which will have implications for future implementation of these vehicles (and potentially result in higher energy use overall, as other studies are beginning to show). The results are extensive, crossing multiple scenarios of shared and connected mobility characteristics and examining uptake across a broad range of household types.

Reviewer 2:

The reviewer commented that the analysis that was presented at AMR showed several results that predicted cumulative PMT in two different timeframes based on the modeled transportation choices made by diverse demographics. The results presented also indicated that there had been significant work performed in modeling the individual exemplar characteristics of the population constituents.

Reviewer 3:

According to the reviewer, the project is on track to meet the remaining milestone of publishing scenario results on market penetration of CAVs and shared mobility at national and local levels in June 2019.

Reviewer 4:

The reviewer said that the project team has achieved interesting and useful results.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer stated that the slides demonstrate clear coordination among the project team and other teams in the SMART Mobility Consortium, from the inflow of data from Autonomie, FASTSim, and WholeTraveler to the outflow of data to other modeling tools in the end-to-end modeling workflow.

Reviewer 2:

The reviewer said that the project team is collaborating with a good range of SMART Laboratories and academic institutions. The focus on laboratory and academic partners in this project is appropriate given the scope of work.

Reviewer 3:

The reviewer remarked that the analysis uses inputs from partners LBNL, ANL, and NREL. It leverages significant previous investments in the WholeTraveler Study, Autonomie, and POLARIS models, and SUMO and FASTSim models.

Reviewer 4:

The reviewer stated that the project team is working well across project partners in the SMART Mobility Consortium, and it is leveraging inputs from the WholeTraveler Study led by LBNL.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the current project is scheduled to conclude at the end of this fiscal year and the remaining tasks to publish results to assist with other EEMS and SMART work are reasonable. The questions presented as the basis for future work are intriguing, particularly the question of how shared and automated vehicles will draw out latent demand for travel that is not currently filled with conventional vehicles.

Reviewer 2:

The reviewer indicated that the proposed future research is appropriate but does not address all the remaining challenges and barriers.

Reviewer 3:

The reviewer suggested that the project team add scenario analysis that can provide insight into modeling of fuel type (internal combustion engine, hybrid electric vehicle, plug-in hybrid electric vehicle, plug-in all electric vehicle) when considering the automated versus regular vehicles.

Reviewer 4:

The reviewer commented that the future work listed in the presentation slides are high-level "bullets" and are vague. The "Travel demand: need, want, and time budget" bullet appears to be complementary to the work performed to date. Subsequently, this reviewer stated that the project needs to spend more effort communicating the future work vision by including the rationale for each bullet.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer commented that this project is relevant to VTO goals as it seeks to understand the choices that individual consumers will make when faced with a variety of shared and automated vehicles and the energy implications of different choices. VTO needs to understand these choices and implications in order to identify future research needs to improve efficiency.

Reviewer 2:

The reviewer said yes. The work is relevant because it considers CAVs-related energy characteristics in future decisions of travelers and has an overall energy consumption metric for the analysis. This is consistent with the mission of the EEMS Program.

Reviewer 3:

The reviewer remarked that the project supports overall DOE objectives by offering insights into how human behavior and choice among emerging technology transportation options can impact energy efficiency.

Reviewer 4:

The reviewer said that the ability to predict market adoption of new mobility technologies is critical for all aspects of planning in response to the introduction of these technologies.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer found that the resources available to the project appear to be sufficient to complete the project by the end of this fiscal year.

Reviewer 2:

The reviewer reported that the project is showing initial results that indicate that the planned analysis is being carried to completion.

Reviewer 3:

The reviewer commented that the funding for this project seems to be on the low end as compared to other projects in the EEMS portfolio, but it is sufficient for this type of modeling project.

Reviewer 4:

The reviewer stated that while this project has an overall smaller budget, the return on investment is solid because it builds off of existing modeling capabilities.

Presentation Number: eems026
Presentation Title: Expanding Regional Simulations of Connected and Automated Vehicles (CAVs) to the National Level and Assessing Uncertainties
Principal Investigator: Tom Stephens (Argonne National Laboratory)

Presenter
Tom Stephens, Argonne National Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer remarked that the objective of understanding the national impact of CAV technology on energy and mobility is important to overall EEMS and VTO energy efficiency objectives. Without this national understanding, the reviewer said that it will be difficult to assess whether CAV technology will be at all beneficial from energy and mobility standpoints. The intention of the project team to estimate future impacts under plausible conditions that yield an understanding of some cause-and-effect relationships is a useful addition to the literature and discussion around future CAV impacts (which are largely unknown at this point despite many claims being made).

The reviewer commented that the project team is conducting a comprehensive top-down and bottom-up approach to understand CAV impacts, which will allow the team to compare and contrast results from differing methods. The use cases of adaptive cruise and highly automated passenger vehicles will bracket the potential impacts for low and high levels of automation. The top-down and bottom-up approaches take different but logical paths to determining national impacts.

Reviewer 2:
The reviewer stated that the objective of this project is to estimate potential energy and mobility impacts of CAVs at the national level. This includes methods to estimate potential CAVs technology adoption rates, to aggregate detailed results of case studies to the national level, to give technical and behavioral outcomes at the regional and national levels, and to deliver estimates of national level energy and mobility impacts of CAVs.
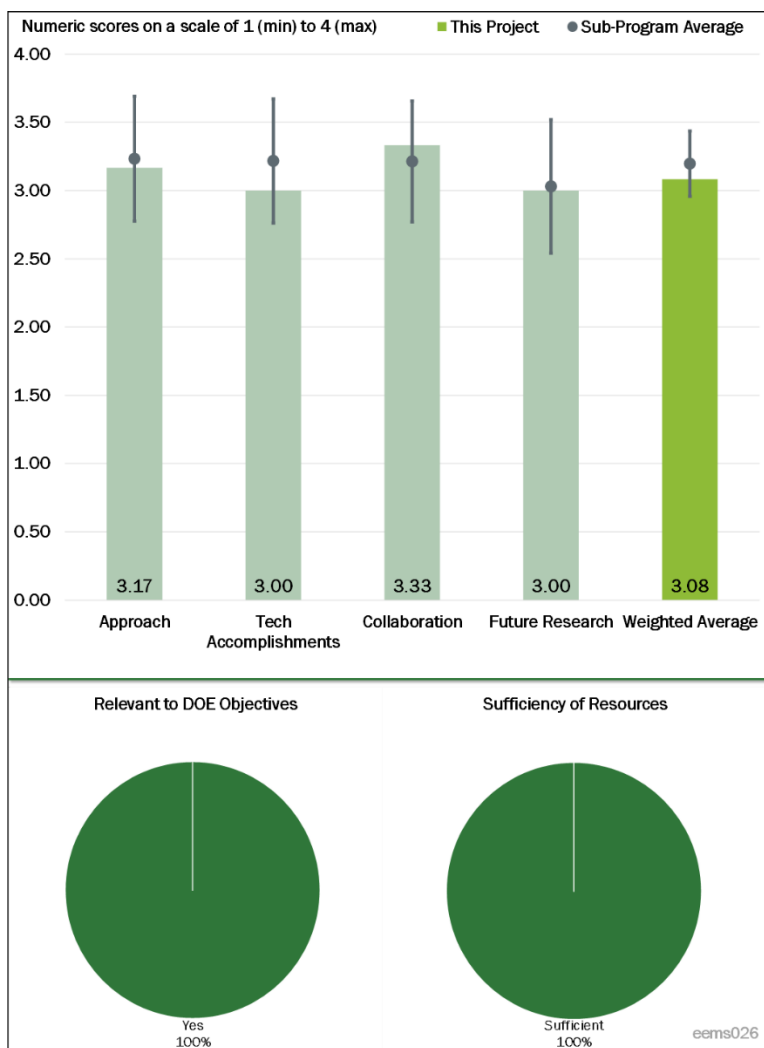

Figure 3-11 – Presentation Number: eems026 Presentation Title: Expanding Regional Simulations of Connected and Automated Vehicles (CAVs) to the National Level and Assessing Uncertainties Principal Investigator: Tom Stephens (Argonne National Laboratory)

The reviewer noted that this project originally implemented two approaches to the national level analysis. A top-down approach used economic (producer and consumer behavior) modeling to estimate demand and to determine energy and travel effects from summary representation of results and response functions from larger, disaggregated spatial models. The bottom-up approach focused on estimating potential adoption and utilization of CAVs by different user groups and used detailed results from simulations of travelers and vehicles to expand to a national level. The reviewer mentioned that specific use cases being examined include CACC and highly automated passenger vehicles (private and shared). While the original approach appeared basically sound and feasible, it has proven to be somewhat ambitious and too expansive in scope. As a result of the extensive data requirements, the bottom-up approach has been ramped down over the last year with remaining efforts focused on the top-down approach.

Early in the presentation, the reviewer noted that three high-level barriers are presented including the computational difficulty of modeling large-scale transportation systems; the accurate measurement of transportation system-wide impacts of CAVs; and the complex role of the human decision-making process in mobility systems. It appeared to the reviewer that the project has made some progress in addressing these barriers, but in many ways it also seems to highlight and reinforce the difficulty in overcoming them.

The reviewer stated that a detailed, comprehensive discussion is provided on the project approach, especially for the top-down and somewhat the bottom-up approaches. The top-down approach emphasizes the use of Connected and Automated Vehicle Energy Simulation (CAVESIM) for dynamic market and economic modeling, with the goal to produce insights and response information at the national level with regards to demand, efficiency, ride sharing, congestion, energy use, and other factors. Within CAVESIM, representative travelers behave according to a constrained utility (preference) maximum.

Reviewer 3:

The reviewer stated that the project team is doing the best it can with limited data and an inability to aggregate regional data and results to national results and conclusions. Building on the available data leaves many potential errors that cannot be quantified. For example, determining charging availability in 0.25 mile (mi) x 0.25 mi grid cells using data that include Level 2 chargers does not seem appropriate to a determination of charging availability for ride-hailing scenarios. The reviewer said that it is not credible that ride hailing would be taken out of service long enough to charge at Level 2.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

According to the reviewer, the accomplishments include some valuable insights about high-level trends in energy use with CAV technology, particularly in understanding how price signals may affect technology adoption. Considering the breadth of completed work and the completion date of the project coming up in 2019, more publications would have been useful (only two were listed this year).

The project team was able to develop the framework for the bottom-up approach but ran into difficulty in acquiring the right data to feed the bottom-up models. This is a common issue with many projects of this type, both with data that are available but too costly to purchase and data sets that are not available at all. Hopefully, initiatives within the DOE VTO team to collect and analyze data sets, particularly for medium- and heavy-duty (MD and HD) vehicles, will help with this gap and the team can leverage this in future projects.

Reviewer 2:

The project has generated a reasonable list of accomplishments from the top-down approach. The reviewer mentioned that within CAVESIM, representations of light-duty vehicle (LDVs) and a simple heavy-duty vehicle (HDV) have been undertaken. Sensitivity analysis and formulation of CAV vehicle miles traveled (VMT) and energy impacts with pooling have been conducted with ongoing testing on versions with shared and pooled TNC rides. The reviewer noted that benchmarking to the SMART Mobility "work-data flow" has

been conducted with scenario assumptions and results and insights from micro- and meso-scale model runs. Demand and VMT for a wide range of demand and technology scenarios, which are now being benchmarked, were explored. Results indicated to the reviewer that accounting for vehicle sharing (pooling) alters economic cost, time cost, and travel demand responses. The reviewer stated that energy use depends on the extent of ride pooling and route (VMT) contraction benefits of pooling. National VMT and fuel use vary with full travel cost for CAVs compared to manually controlled vehicles (MCVs) CAV VMT outcomes could vary by 25%-30% depending upon assumptions of CAV technology and mileage-based costs up to $0.20 per mile.

The reviewer found that technical accomplishments for the bottom-up analysis, however, seemed to be more a work in progress with final tangible results yet to materialize. A framework has been developed though and exercised for rolling up detailed results for vehicles and travelers (bottom-up), and some bottom-up methods can expand some regional results to the national level.

Reviewer 3:

The project team has progressed in spite of the difficulty in aggregating results to the national level. Results have been generated and the sensitivity of results to changes in input assumptions has been evaluated in selected scenarios. More sensitivity work should be a priority in light of the sparsity of actual data supporting developing analyses at the national level.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer found that relatively extensive collaboration and coordination exists among the other project team members including ORNL, NREL, University of Illinois at Chicago, and the University of Maine. The roles of the team members are sufficiently detailed. The CAVESIM model has strong connections to other SMART models including benchmarking to POLARIS and BEAM results and behaviors and identification of a list of inputs to use from other SMART studies. CAVESIM also uses vehicle technology penetration cases fromMa3T-Mobility Choice (MA3T-MC) and contributes to the updated Bounds report on National Energy and Mobility Impacts of CAVs. The project is incorporating outputs from additional SMART Mobility performers.

Reviewer 2:

The reviewer commented that the laboratory partners appear to have been used very effectively. Models developed by other laboratories have been incorporated into the project (e.g., Electric Vehicle Infrastructure Projection Tool [EVI-Pro]). The reviewer cautioned that care should be taken to recognize the limitations and uncertainties associated with these models and the potential for the effects of these uncertainties to propagate to the national level.

Reviewer 3:

The reviewer reported that the project team has established a good collaboration among several National Laboratories and academia. This is appropriate given the scope of the project. The team is well connected to other projects in the SMART Mobility Consortium as well. An indirect or second-order collaboration for data to support the bottom-up approach could be useful if a logical partner(s) could be secured.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer stated that the project team presents a reasonable list of future research activities as well as existing barriers to implementing them. Future research activities include: further refinements to CAVESIM; analyzing changes in energy, mobility, and cost for SMART Mobility scenarios; updating literature review and

synthesis; and further contributing to overall program insights on mobility energy productivity (MEP) impacts. Challenges include incorporating research results (from the Mobility Decision Science pillar) to CAVs adoption modeling, extending top-down CAVESIM models and methods to shared and HDVs, and uncertainties with regards to input assumptions of scenarios and functional dependencies.

As the project is nearing its end date, the reviewer suggested that it may be beneficial to narrow further and focus on identifying some very specific (preferably quantifiable) and achievable near-term research activities to maximize its ultimate value within the SMART Mobility portfolio.

Reviewer 2:
The reviewer noted that the future research approach is logical given that the project is in its last year. Leveraging the common SMART Mobility scenarios will be valuable. The future work ideas for follow-on are somewhat vague and it was unclear to the reviewer whether the project team is planning to or able to solve some of the issues with the bottom-up approach.

Reviewer 3:
According to the reviewer, the "bottoms up" approach to future work will continue to develop results (varying RTP from 0% to 100%), but will not evaluate the veracity of these results by testing assumptions and determining sensitivities. Future work should consider determining the uncertainties of existing results as important as generating additional results.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer commented that the project is relevant to EEMS, VTO, and DOE objectives as it is focused on estimating the potential energy and mobility impacts of CAVs at the national level. In the future, CAVs will play an increasingly important role and understanding the dynamics they bring to the transportation sector is essential to maximize their potential benefits while minimizing potential energy and consumer drawbacks.

Reviewer 2:
Clearly, the reviewer stated, a determination of the energy reduction benefits (or lack thereof) of ride hailing in the context of varying charging infrastructure support provides overall guidance to the direction of the SMART Mobility effort.

Reviewer 3:
Understanding the national-level impacts of connected and automated vehicle technologies is directly relevant to EEMS and VTO objectives, according to the reviewer.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
As originally scoped, the reviewer commented that this was a very expansive project with many high aims. More recently, the project has been refocused to a more manageable effort. Given this reduced scope, the resources for this project are sufficient.

Reviewer 2:
The reviewer stated that the project team appears to have sufficient funding resources to achieve goals. Additional resources to close data gaps could be helpful, whether through additional funding for data purchases or collaboration with data sources.

The reviewer indicated that progress appears to be moving on schedule and the proper expertise appears to be available to conduct the work. Unfortunately, data are lacking so many assumptions must be made to move the work forward.

**Presentation Number: eems027
Presentation Title: Multi-Modal Energy
Analysis for Freight
Principal Investigator: Alicia Birky
(National Renewable Energy
Laboratory)**

Presenter
Alicia Birky, National Renewable
Energy Laboratory

Reviewer Sample Size
A total of five reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer found the approach to be
logical and consistent with other EEMS
SMART activities as it builds on prior
work in other projects (good leverage of
past investment). There is value in
connecting this work with the other
analytical efforts within EEMS for the
Chicago area as it leverages and
complements these other projects.
According to the reviewer, the use of
the Freight Analysis Framework is
sensible as it is the main data set for
understanding freight flows in the
United States, and the PI clearly
demonstrates an understanding of the
data set's limitations and opportunities (and is using external data sources such as INRIX to calibrate models).
The framework for scaling up the Chicago findings (still being completed) to a national level could provide
some interesting results; the reviewer hoped that this will not run into challenges that other scale-ups have seen
relative to a lack of data.

The reviewer commented that the PI's approach to looking at the freight movement problem with a unique
methodology is valuable; the freight industry has different motivators and the models used to analyze them
should be different from passenger cars. The reviewer said it was sensible to look at this from a shipper's
perspective as they are the agents that make the decisions on freight modes (balancing cost and time). Creating
separate MEPs for intra-city and inter-city freight mobility makes sense as these two applications will have
different operational characteristics and efficiency drivers.

Reviewer 2:
The reviewer reported that this project has a strong overall approach to answering the questions defined a few
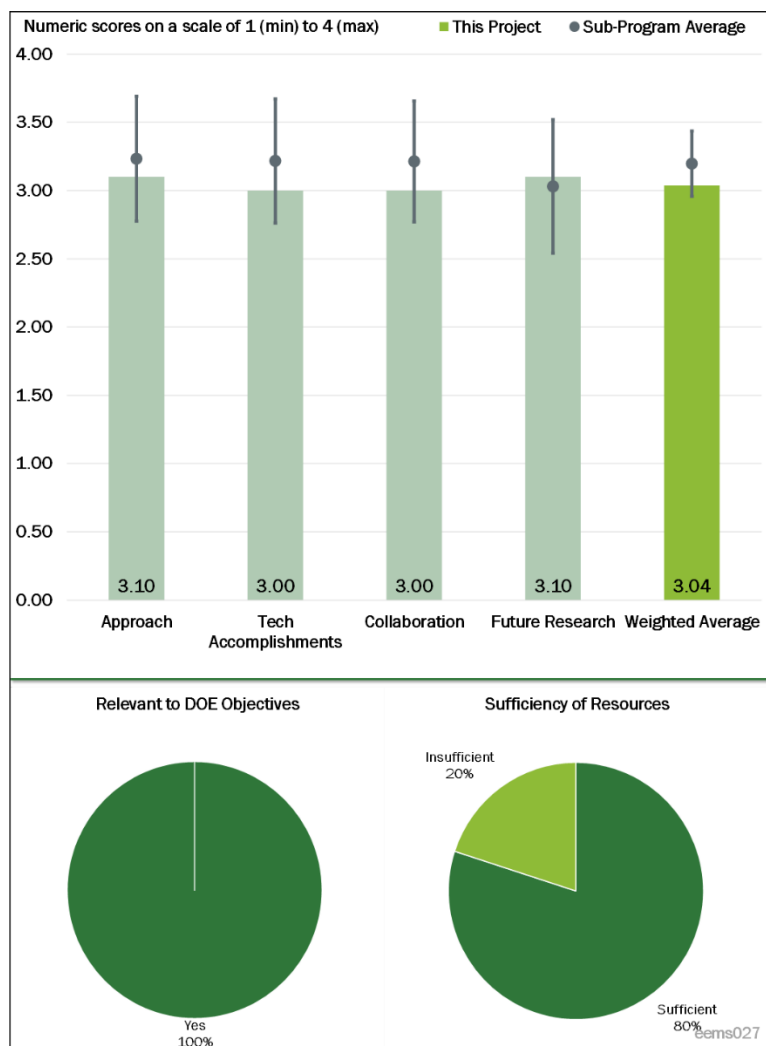years ago.

Figure 3-12 – Presentation Number: eems027 Presentation Title: Multi-
Modal Energy Analysis for Freight Principal Investigator: Alicia Birky
(National Renewable Energy Laboratory)

Reviewer 3:

The reviewer said that the approach seems on track to provide a sub-model; however, it seems that much of the focus is on trucks even though it is a multi-model simulation. Nothing was presented on rail freight.

Reviewer 4:

The reviewer stated that the project team must have multiple commercial partners to be effective in this project.

Reviewer 5:

The reviewer commented that the project seems to have multiple objectives and is somewhat unfocused in what it is trying to accomplish. The project design does not seem to focus on either ensuring a full modal picture (e.g., including rail, port, and air), on inter-city freight movement, or on emergent freight technologies (including freight-company logistics). According to the reviewer, the project design does a nice job of teasing out intercity truck freight information from the Freight Analysis Framework (FAF), but this only addresses truck movements. The project design seems to be weighed down by the use of POLARIS, with its focus on intracity movements, and without an apparent contribution of how intracity movements—particularly how different modes have different spatial requirements in navigating through congestion—impact intracity modal choices by private firms.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer commented that the project team appears to be on track to finish the specific scenarios outlined by the PI, including some additional details. The team has made refinements to the scenarios this year that make them more realistic, such as the limitation of possible platooning miles to just those with trucks traveling close to each other in time and space. The team has done solid work to convert FAF tons moved into trucks moving freight and has added to the data resources with sub-FAF zone information.

According to the reviewer, the work to create an intra-city freight MEP based on previous work in passenger MEP appears to be progressing well and is logically based on passenger MEP work (focused more on time to deliver freight than cost). The project team has connected with the Columbus data sets from its Smart City efforts, which should provide a useful basis to implement and test this with a rich data set. The framework development will set the stage for useful future work. The reviewer said that the project team has clearly addressed some challenges presented by prior-year AMR comments.

Reviewer 2:

Accomplishments are occurring and meeting goals, according to the reviewer. Freight movement is a very complex thing to model and we should be conscious of how valid the modeling will be.

Reviewer 3:

The reviewer observed that the work was very good in zone modeling and data collection.

Reviewer 4:

It was difficult for the reviewer to assess if the accomplishments are on track to fulfill model obligations. The reviewer would like to have seen some initial representative results.

Reviewer 5:

It was unclear to the reviewer why the technical accomplishments at this late stage in this intercity freight project are focused on intra-city freight movement. It did not appear to the reviewer that emerging technologies have been incorporated into the study. The reviewer noted that there was no information supplied about the critical multi-model network on which the project results seem to hinge and asked whether this is a physical network. If so, the reviewer wanted to know what segments and nodes, including across rail and highway, the

project encompassed. The reviewer asked about whether they were dispatchable and how are distribution and transfer logistics are factored in. The reviewer stated that it was hard to understand how this project will be wrapped up in FY 2019 (or even in FY 2020 with carry expenses) when the multi-modal network is still a work in progress.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer found good collaboration of the project team with ANL, the Texas Transportation Institute (TTI), and University of Illinois at Chicago (UIC), as well as with INRIX. This is a collaborative project as part of the broader EEMS SMART initiative. The project team has made the breakdown of which partners are responsible for which tasks very clear in the presentation, which is useful for understanding the collaboration.

Reviewer 2:
The reviewer stated that collaboration has been expanded from prior years.

Reviewer 3:
The reviewer pointed out that fleet partners need to be involved.

Reviewer 4:
The reviewer commented that it was difficult to attract industry partners. There was good work on bringing in Texas A&M and maybe other industry consortium-type partners who can be very valuable in bringing the industry input into a project such as this.

Reviewer 5:
The reviewer stated that the project appears to lack partners (at least brought in in a timely enough way) with significant experience and expertise in logistics and the economics of logistics in intercity freight technologies and markets. Non-laboratory partners seem to have had a limited role in the project design and execution.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The future research plan for the remainder of the project looks reasonable and should be feasible to complete in the remaining few months of the project. The ideas for follow-on work are valuable for building on the experience gained in this project. The added collaboration with the 21st Century Truck Partnership (21CTP) and LabTRUCK Consortium will be useful in adding perspective, although it may be challenging to get sufficient and timely input from 21CTP members during the project. The reviewer encouraged work on supply chain understanding for e-commerce as this is important to understand; other EEMS projects are showing some mixed results for energy use with e-commerce.

Reviewer 2:
Given the complexity, the project team is learning fast about areas that can be investigated that are appropriate and valuable. The reviewer thought that the team has a good methodology going forward and relevance for future DOE plans and strategies is very strong. Future budgets should support this.

Reviewer 3:
The reviewer said that the project team is on track to produce a very important planning tool.

Reviewer 4:
The reviewer found the list of future work to be good.

Reviewer 5:

The reviewer remarked that it is helpful that the project is up front about the need for good emerging technology and cost data; however, the path forward is not laid out in any level of detail indicative of having made good progress in designing these next steps.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer found this project to be relevant to DOE VTO objectives as it provides a fundamental understanding of freight truck movements in the United States as a means to understand energy use and duty cycles at a more detailed level than is currently known.

Reviewer 2:

The reviewer commented that this is a very important component of a larger model to assess freight energy expenditures for the United States.

Reviewer 3:

The reviewer indicated that this project is very relevant and changing, as we speak, with e-commerce, etc.

Reviewer 4:

The reviewer said that this work will help reduce congestion and improve miles per gallon (MPG) if properly applied.

Reviewer 5:

The reviewer asserted that the basic question of how changing freight transportation technologies and logistics could change the modal distribution of intercity freight movements is central to understanding how freight energy requirements may change. The project would better align with public purpose if it differentiated between the net energy savings of profit-maximizing firms utilizing new technologies, and how R&D and/or infrastructure investments might affect future freight patterns and energy needs.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the resources for this project should now be sufficient with the added funding received in 2018-19 in response to reviewer concerns.

Reviewer 2:

According to the reviewer, there are sufficient resources for the project.

Reviewer 3:

The reviewer said that resources seem appropriate for now and the focus going forward will be key.

Reviewer 4:

The reviewer remarked that resources do not appear to have been a significant constraint on technical progress. The reviewer expected this budget to be adequate for a first- or even second-order exploration of intercity freight energy use under a variety of future technology and cost factors.

Reviewer 5:

The reviewer stated that the project does not appear to be on track to finish with a validated model.

**Presentation Number: eems028
Presentation Title: Developing an Eco-Cooperative Automated Control System (Eco-CAC)
Principal Investigator: Hesham Rakha (Virginia Tech)**

Presenter
Hesham Rakha, Virginia Tech

Reviewer Sample Size
A total of five reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer commented that the simplified hybrid electric vehicle (HEV) fuel consumption model that has been developed is very interesting and could prove to be very useful for large-scale computations in other projects in the future—especially because seeking out global optima is not really the goal, given all of the errors inherent in the system. However, the claimed benefit of at least 20% fuel savings seems excessive; it would help if the baseline scenario is laid out clearly. For instance, when the U.S. Environmental Protection Agency (EPA) fuel consumption numbers are published, the testing
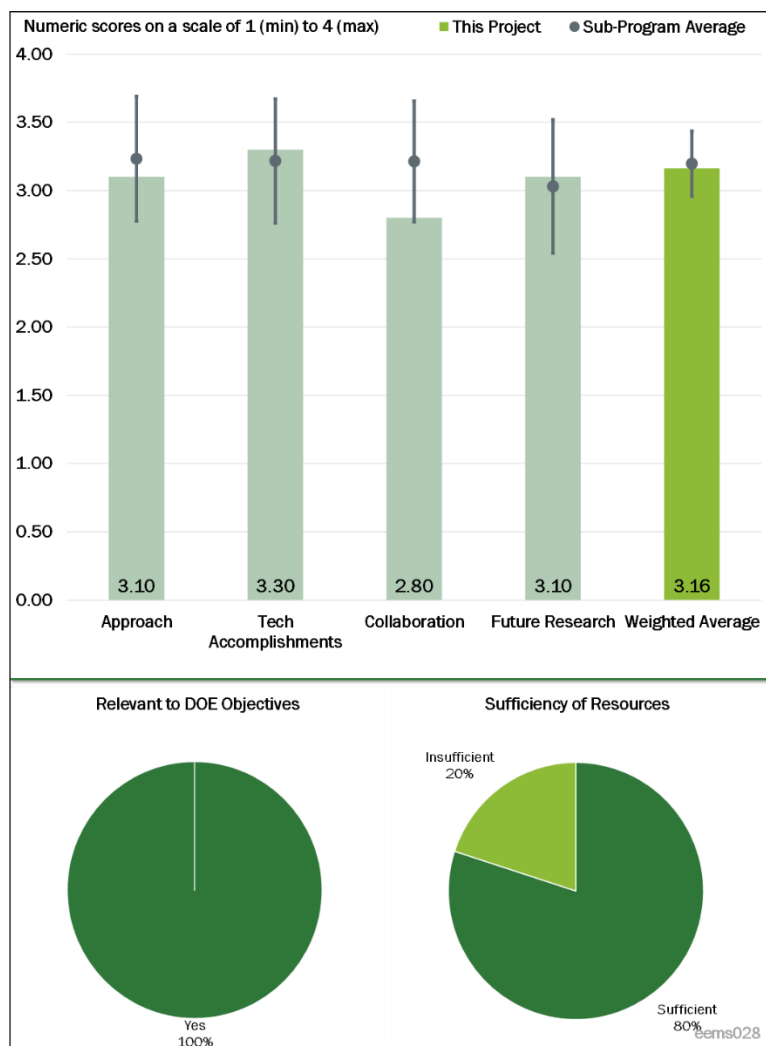

Figure 3-13 – Presentation Number: eems028 Presentation Title: Developing an Eco-Cooperative Automated Control System (Eco-CAC) Principal Investigator: Hesham Rakha (Virginia Tech)

follows a very specific protocol, and the test may be repeated by an independent entity by following this protocol. Because the proposed approach is likely not repeatable, the reviewer suggested that perhaps providing a range of fuel savings rather than a single number would be warranted. The reviewer noted that treating the 20% as the lower end of the range—and emphasizing at least 20%--the numbers shown on Slide 7 do not necessarily support the claim. If that is taken in conjunction with the large delays associated with eco-routing and then using another metric to evaluate the benefit (i.e., mobility energy productivity [MEP], developed by DOE), these numbers would not look as attractive. This reviewer inquired about the definition of MEP.

Reviewer 2:
The reviewer commented that the framework to define this problem seems very well done, and the efforts to characterize HEV fuel economy is a notable improvement from previous years. Now that there is a model, the reviewer felt that there is not enough priority for a more realistic effort to validate the model. Even though real-car evaluation might not be feasible, the reviewer felt that there are other VTO-developed tools (both fuel-economy simulators and multi-agent flow simulators) that would make for more compelling results. The

reviewer granted that it may be that there are others (likely sponsored by VTO) that are better positioned to do the validation, and the contributions of this project to this research theme are strong and appreciated.

Reviewer 3:

The reviewer said that the general approach seems rigorous. However, the presenter seemed to indicate that the energy savings analysis did not take into account energy requirements of the CAV systems—on-board and off-board—which can be enormous (e.g., Hamza et al. "Modeling the effect of power consumption in automated driving systems on vehicle energy efficiency for real-world driving in California" presented at the 2019 annual meeting) and could entirely offset the estimated 20% savings found in this project.

Reviewer 4:

The reviewer found the premise of offline computation to enable city-wide eco-routing to be valuable. However, the project fails to focus on or discuss real-world considerations of response time (communication and processing) requirements, data throughput, and the energy impact of cloud computing and communications of onboard sensors and processing requirements. It was unclear to the reviewer why low-level vehicle controls (eco-predictive control) are included as part of the work.

Reviewer 5:

The reviewer stated that the approach is heavily focused on developing the controls for the envisioned system. It currently does not address full energy accounting, including the energy needed for the controls (e.g., computing power, sensors, and actuators). It is important to do the full energy accounting to assess the net energy impacts of the proposed system.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer remarked that the project has led to useful insights, such as the reduction in benefits with higher technology penetration and the necessity of a feedback system for routing (not a predictive system). Also, the reviewer noted that much work seems to have been accomplished even though the project is only 40% complete. No milestones were to occur before June 2019; so, this reviewer saw no indication that the project is behind schedule.

Reviewer 2:

The reviewer had no issues of concern.

Reviewer 3:

The reviewer liked the simplified fuel consumption model. However, the project status is somewhat confusing. It appeared to the reviewer that the project started in 2017 and should be completed in less than a year from now. The completion percentage shows 40% on the overview slide, but the summary slide shows 80%-90% completion on "Budget Period 1." The reviewer asked if there is another budget period, given that the project ends in June 2020.

Reviewer 4:

The reviewer found the preliminary results for eco-routing to be encouraging. Future work should consider which factors will affect fuel and energy consumption. Because the travel-time increase is so large, the reviewer said that there needs to be a way to tradeoff between energy savings in determining the optimal operation. In addition, extra vehicle miles traveled should be considered (due to additional infrastructure and vehicle costs).

The reviewer commented that the HEV model fitness is surprising, especially using scaling factors to other vehicles, given the differences in hybrid propulsion systems. It was unclear to the reviewer if the average error is from total fuel used over a given cycle or a weighted average or variance across time.

Reviewer 5:

The reviewer found that the progress presented was around design and testing of the individual control elements. The fidelity of the analytical work was not clear to the reviewer, particularly with respect to vehicle energy analysis. The fidelity of the fuel consumption estimation method for HEVs that presented seemed very crude or low. Overall, the reviewer's concern is that the fidelity of the analytical work may not be sufficient for the energy impact assessments being made.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer said that the project does not have partners. It looks like all funding goes to the Virginia Tech (VT). There are unfunded partners so some collaboration appears to be happening.

Reviewer 2:

Given that funding was purely for Virginia Tech Transportation Institute (VTTI), the reviewer remarked that there still appears to be collaboration with other entities, though the contribution of Volkswagen on this project is not clear from the presentation.

Reviewer 3:

The reviewer commented that the project has no DOE or laboratory partners, and other partners are not funded by the project. There is collaboration with academic partners, but the extent was unclear to the reviewer.

Reviewer 4:

The reviewer highly encouraged collaboration with government Laboratories (like ANL). A portion of the modeling and simulation work is redundant with existing projects. While overlap and different approaches are welcome, it made sense to the reviewer to leverage the existing capabilities. The project could then better spend its resources and focus on eco-routing, which truly is unique among the projects.

Reviewer 5:

As the slides state, the reviewer noted that there is actually very little cross-institution collaboration on this project. One direction would be to identify other potential partners with extensive experience with more complex and detailed simulation tools, and then seek some collaboration, even if it is informal. The reviewer had the idea that perhaps VT could send one of the student investigators to a National Laboratory for a summer. The reviewer also encouraged EEMS or VTO leadership to take an active role in teaching VT about these tools by making introductions, etc.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer found that most future work seems consistent with original project concept.

In the early eco-routing testing, the researchers found substantial energy savings but excessive delays for battery electric vehicles (BEVs); fortunately, the reviewer stated that the project team proposes to address this problem by looking for compromise solutions through multi-objective functions.

Reviewer 2:

The reviewer commented that the proposed future research is appropriate. Priority should be placed on an Eco-Cooperative Automated Control (Eco-CAC) System assessment and sensitivity analysis to address technical barriers.

Reviewer 3:

According to the reviewer, the typical power draw for sensors and actuators for an autonomous vehicle are said to be in the range of 1 kilowatt (kW)- 2 kW. The reviewer asked how many of these sensors can be eliminated by offloading the computations to a central computer (in that "link"), whether there are any net energy savings, and also what the cybersecurity implications of this approach are.

Reviewer 4:

The reviewer stated that a list of next steps was presented that looked okay for the scope of the project. High-level timing was given. Further detail was not given.

Reviewer 5:

As Virginia Tech is a university, the reviewer was not surprised to see that most of the proposed future work was well within the comfort zone of the PI's laboratory, i.e., work with mostly an academic flavor. The reviewer described this as fine and well, and hoped that VTO manages this project so its results move to a more realistic implementation. Only then will this work reach its full potential of teaching best practices in CAV traffic management.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer responded yes and noted that the project does support overall DOE objectives. Coordinated systems have a significant impact on overall energy use. Most other projects focus on coordination with a single vehicle perspective or city-wide simulation without coordination. The reviewer stated that this project addresses an important gap.

Reviewer 2:

The reviewer said that of course, it is relevant. This research helps the greater penetration of electrified vehicles and autonomy.

Reviewer 3:

Maximizing energy savings of CAV operation is highly relevant to the mission of EEMS, according to the reviewer.

Reviewer 4:

The reviewer noted that CAV traffic modeling is clearly a key area for EEMS and VTO.

Reviewer 5:

Generally, the reviewer stated that the work is relevant to EEMS objectives. However, in order to do proper assessment of energy impacts, the reviewer remarked that complete energy accounting must be the focal point, rather than just development of control strategies.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Wise, Jeremy

Resources appeared adequate to the reviewer as evidenced by the current completion rate of project tasks.

Reviewer 1:

The budget looked reasonable to the reviewer for the scope of the work.

Reviewer 2:

The reviewer noted that the total project funding appears to have been spent in FY 2017-2018 even though the project is only 40% complete.

Reviewer 3:

The reviewer actually found this hard to evaluate, as it is not obvious who and how many people are working for the PI. A suggestion from the reviewer for the future is to list the people that are supported by this project, and perhaps attach a brief "what they did" with their share of the funding.

Reviewer 4:

The reviewer found the funding numbers on the "Overview" slide to be confusing. The VTTI share of the total project funding is $84,000, but the VTTI share for FY 2017 and FY 2018 are $$84,000 plus $168,000, which is approximately $252,000.

Presentation Number: eems029
Presentation Title: Boosting Energy Efficiency of Heterogeneous Connected and Automated Vehicle (CAV) Fleets via Anticipative and Cooperative Vehicle Guidance
Principal Investigator: Ardalan Vahidi (Clemson University)

Presenter
Ardalan Vahidi, Clemson University

Reviewer Sample Size
A total of five reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer found that the approach squarely addresses all three of the barriers. The design of the project has some sophisticated features and the validation features, such as entity visualization and hardware-in-the-loop (HIL), add value and credibility to the project.

Reviewer 2:
The reviewer appreciated the effort to connect modeling results to real-world information.

Reviewer 3:
The reviewer noted that the approach addresses well the first objective: "Propose anticipative and collaborative guidance schemes for CAVs to lower energy use," but appears to be missing important aspects of the second objective: "Obtain energy impacts for a mixed traffic fleet" as there was nothing said about accounting for energy requirements of the CAV controls (computing power, sensing, and actuation). The reviewer stated that it is important not to neglect this because it can offset most or all of the benefit gained from advanced control strategies.

Reviewer 4:
The reviewer remarked that it will be helpful to have simulation and vehicle-in-the-loop (VIL) results within the same project and to show the dependence of energy savings on technology penetration. It would be useful to have some information on how the approach relates to other projects in same area. For example, the reviewer said that the objective and results for this project appear to relate to optimization of system energy use, while EEMS028 seeks to minimize energy use for an individual vehicle (and percentage savings shown for that project is higher).
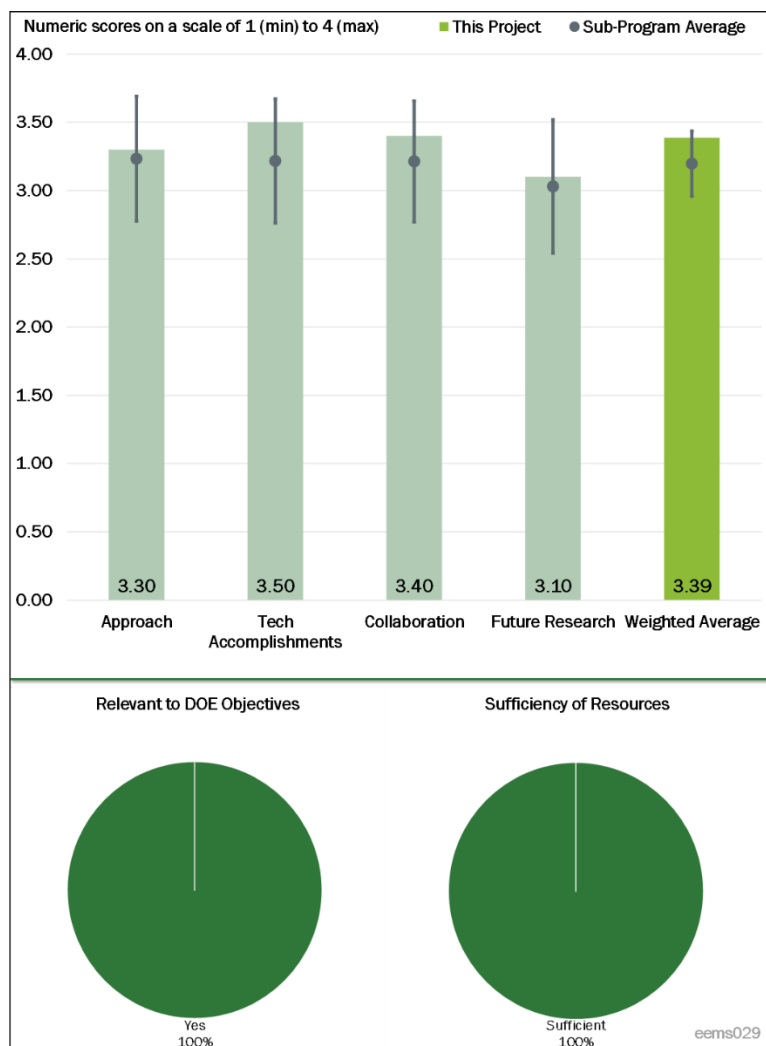

Figure 3-14 – Presentation Number: eems029 Presentation Title: Boosting Energy Efficiency of Heterogeneous Connected and Automated Vehicle (CAV) Fleets via Anticipative and Cooperative Vehicle Guidance Principal Investigator: Ardalan Vahidi (Clemson University)

Reviewer 5:

The reviewer commented that this kind of work has the (less) tangible benefit of training future engineers and researchers, and so the involvement of multiple graduate students and post-doctoral researchers is great.

The reviewer mentioned that there are some AVs (not necessarily fleets) already deployed on the road and asked if anyone has looked at collaborating with any of those companies to understand some of the issues they may be facing.

The reviewer brought up a presentation by Eric Rask from ANL at the 2019 AMR, which talked about how engine efficiency can drop during autonomous driving under certain circumstances. This is presumably because engines are generally designed to handle peak loads, and autonomous driving tends to shave off the peaks; this causes the engine to run more in part-throttle conditions, increasing pumping losses. The reviewer asked if the simulations showed that.

Other publications by ANL have referred to the string stability and the consequent increased fuel consumption of AVs when they are not connected. The reviewer inquired if there had been any similar observation when dealing with vehicles in the fleet that are not connected.

The backup slide (Slide 31) on fuel rate estimation indicates the uncertainty in any predicted fuel efficiency benefit. Given the somewhat large variation, the reviewer wanted to know if there is a better way to estimate the "true" benefit of CAVs.

modeling

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer stated that the project presentation demonstrated that all the major objectives have been achieved.

Reviewer 2:

The project appeared to the reviewer to be on track based on stated milestones.

Reviewer 3:

The reviewer said that there was very good progress with impactful results. The reviewer wished that the assumptions used to generate data for the slides had been listed, as pointed out during question-and-answer.

Reviewer 4:

According to the reviewer, the project has delivered some interesting capabilities with respect to modeling, simulation, and VIL testing. There is still a ways to go on completeness of energy accounting and analysis of variations in energy impacts based on baseline noise factors, such as driver behavior.

Reviewer 5:

The reviewer referenced prior comments. Given the level of uncertainty in measuring the fuel economy benefit (fuel flow being just one), the variety of driving scenarios is another one. Generally, it appeared to the reviewer (with no offense meant to the investigators) that if the project team is trying to measure fuel economy benefits in realistic driving conditions, "accuracy" is a pipe dream. The reviewer asked how the team can prove that the measurement is accurate and whether repeating the measurement under a different set of conditions would help in that regard. The reviewer referenced prior comments, and asked if there was a better way to estimate the "true" fuel consumption benefit.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer remarked that the work flow and results indicate that each of the partners significantly contributed to the project results. The workflow also indicates that the project leveraged state-of-the-art capabilities, facilities, and tools during several stages of the analysis.

Reviewer 2:
The reviewer said that the project team structure makes sense with defined roles and responsibilities and the reviewer had no issues here.

Reviewer 3:
There is substantial involvement of partners, according to the reviewer.

Reviewer 4:
The reviewer said that collaboration is very good.

Reviewer 5:
The reviewer noted that the collaboration with ANL is good, but it seems somewhat contrived for the purpose of showing collaboration.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer remarked that each of the future work description statements is clear. Each future work objective appears to have the potential to provide significant marginal value added and complements the previous work products.

Reviewer 2:
The reviewer stated that future work was presented as a list of key next steps, which make sense for the scope of the project. More information about work plans and timelines was not presented.

Reviewer 3:
Responses to earlier reviewer comments on communications latency and various types of errors were unclear to the reviewer, who said that this would be a good area to improve on in future work.

Reviewer 4:
The reviewer judged the future work as good because it was disappointing that the presentation file is so large and the reviewer did not have the proposed list downloaded.

Reviewer 5:
The reviewer noted that the project is nearing completion, and it appears that a quarter of the original scope remains to be completed. A good part of it involves testing, which requires access to the test track. The reviewer asked if the remaining time is sufficient to complete the project.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer commented that it is important to understand the true benefits of increasing CAV penetration, both in terms of infrastructure investment and fuel-saving potential. Even though different projects may show

results that do not always align with other projects, it seems to imply that there is much we still have to understand, and no single project can possibly paint the complete picture for us.

Reviewer 2:

By demonstrating the potential to reduce energy consumption through CAV technologies, the reviewer stated that the project would support the EEMS vision of "an affordable, efficient, safe, and accessible transportation future in which mobility is decoupled from energy consumption."

Reviewer 3:

The reviewer remarked that the project is directly relevant to DOE's objective to quantify the energy impacts of CAVs as evidenced by its study results showing energy consumption reduction as a function of CAVs penetration and traffic volume.

Reviewer 4:

The reviewer found the results of this study to be very relevant. The potential fuel savings are impactful and this is an area that should be further studied and supported in order to push out more CAVs.

Reviewer 5:

According to the reviewer, the objectives seem aligned with EEMS goals. Energy impact assessments need be sure to include complete energy accounting in order to deliver real value to the EEMS effort.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewed noted that the project shows significant results using the allocated resources and is on track to continue producing useful results.

Reviewer 2:

According to the reviewer, the budget seems aligned with the scope of the work.

Reviewer 3:

The reviewer said that there is no indication of insufficient resources. The budget has been nearly spent and the project is approaching completion.

Reviewer 4:

The reviewer commented that this was a great job with resources.

Reviewer 5:

The reviewer stated that the project is almost complete.

Presentation Number: eems030
Presentation Title: Experimental
Evaluation of Eco-Driving Strategies
Principal Investigator: Wei Zhang-Bin
(Lawrence Berkeley National
Laboratory)

Presenter
Wei-Bin Zhang, Lawrence Berkeley
National Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.

Reviewer 1:
According to the reviewer, the approach
includes upfront analysis of
unproductive fuel consumption,
collection of real-world traffic data, and
field experimentation of eco-driving
technologies. The project has a
relatively short duration of only 1 year
but is likely to collect valuable
information on the potential for
efficiency improvements as a result of
eco-driving technologies.

Reviewer 2:
The reviewer commented that the
approach to quantifying unproductive
fuel use at the national level is well designed from the perspective that it leverages previous research on the
subject. It could use improvement by refining the project's definition of "unproductive" because the
productivity benefits regarding driver safety (in the case of stop signals) and roadway throughput (for speeds
above 65 miles per hour [MPH]) are not considered in the analysis. The real-world data collection methods for
realistically estimating fuel saving from eco-driving strategies have big potential but need additional design-of-
experiments efforts and coupling with modeling tasks to better exploit the data.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.

Reviewer 1:
In the first 6 months since it has been re-scoped, the reviewer reported that a large set of existing work on eco-
driving technologies has been reviewed and R&D needs have been identified to fill in estimation gaps.
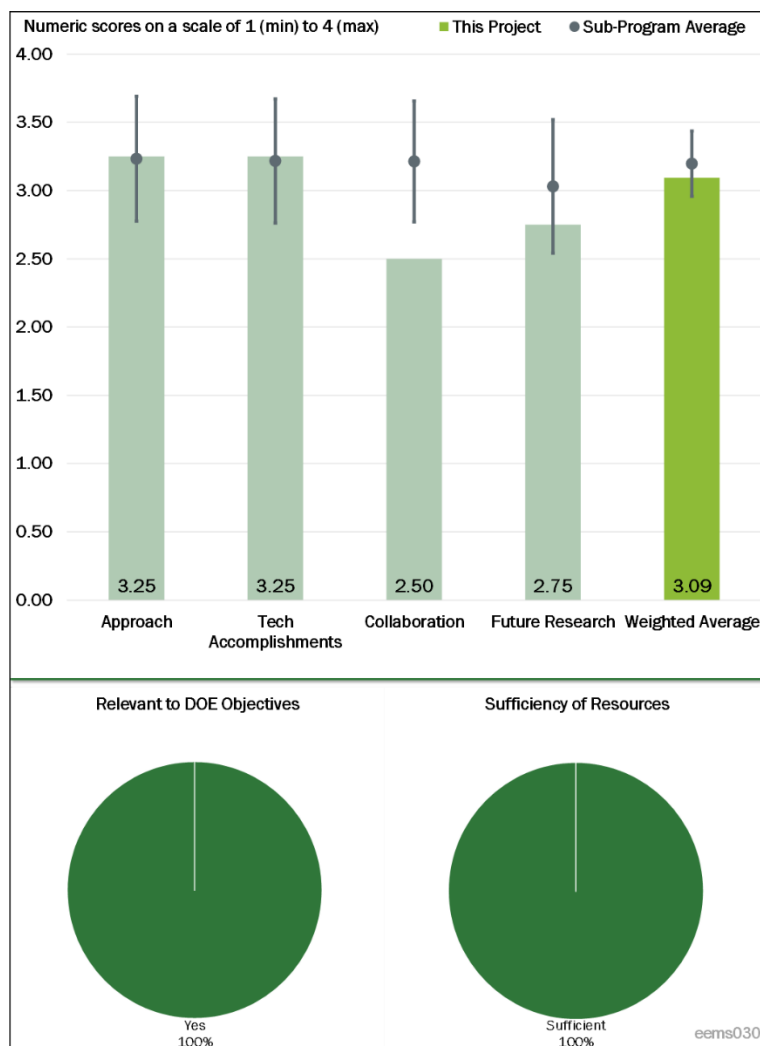Opportunities for saving energy through eco-driving technologies have been identified.

Figure 3-15 – Presentation Number: eems030 Presentation Title:
Experimental Evaluation of Eco-Driving Strategies Principal Investigator: Wei
Zhang-Bin (Lawrence Berkeley National Laboratory)

Reviewer 2:

The reviewer remarked that the project has made visible progress in addressing its objectives and has produced some bounding estimates of potential energy consumption from eco-driving strategies. The demonstration of real-world data collection shows good progress but needs to be complemented by additional work plans and strategies to increase the utility of the data collection capability.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer stated that there are collaborations with ANL on CAVs and Autonomie and with San Jose State University on trip decomposition analysis.

Reviewer 2:

The reviewer would like to have seen much clearer mapping and data product definitions of this project's outputs as inputs to the other EEMS or DOT R&D tasks. The reviewer would also like to have seen clearer mapping and data definitions of the inputs that this project receives from other projects or partners. Adding this structure will likely help to increase the utility and value of this project team's unique efforts and capabilities.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer liked that the project plans includes applying a risk mitigation strategy to collect data with a drone instead of a static sensor (due to budget and time constraints). In general, the benefits from future work for this project would likely be significantly increased by integrating this project with a gaming task and a modeling task. The gaming task could use inputs from this project's studies and data collection to generate scenarios and structure future experiments. The modeling task could use the data collected to inform its models and generate requests for data on real-world phenomenology. Ideally, the gaming staff would have subject matter experts (SMEs) from multiple domains. Make no mistake, the reviewer advised, this project's potential is worthy of future work.

Reviewer 2:

The reviewer indicated that there is appropriate future work on this relatively short (1 year) project, which includes intersection data collection and analysis in parallel with eco-driving demonstration. A broader eco-driving technology in-use data set would likely be helpful but is not in the scope of the project.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said that the collected data, models, and analysis from this study will become inputs to the relevant work under the SMART Mobility program. This project supports the overall DOE objectives as the results will inform the EEMS overall workflow of smart mobility, which in turn supports increasing mobility without increasing energy consumption; hence, directly supporting the VTO goal of reducing petroleum use.

Reviewer 2:

The reviewer stated that this project supports DOE objectives to explore potential energy consumption impacts of CAVs. It appears to have unique real-world data collection capabilities that have the potential to significantly enhance the future productivity of DOE EEMS R&D efforts. One area of unique value added is the potential to help inform and validate other EEMS modeling projects.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

As re-scoped, the reviewer commented that the project now has sufficient funding ($400,000 total for 1 year) to collect field data and conduct the analysis.

Reviewer 2:

Given the current state of this project's integration with other EEMS projects, the reviewer reported that it has enough resources. However, if the project achieves enhanced coordination with experiment design and modeling tasks, this project's real-world data collection capability will likely require and deserve greater resources.

**Presentation Number: eems031
Presentation Title: Traffic Micro-
Simulation of Energy Impacts of
Connected and Automated Vehicles
(CAV) Concepts at Various Market
Penetrations
Principal Investigator: Hau Liu
(Lawrence Berkeley National
Laboratory)**

Presenter
Hau Liu, Lawrence Berkeley National
Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer commented that the
objective of this project is to simulate
energy saving benefits for cooperative
adaptive cruise control (CACC)
operation on a freeway pipeline section
and a 20-kilometer (km) freeway
corridor and to simulate various CACC
management strategies. The project is
modeling the traffic network in Aimsun
and implementing cruise control (CC)-
ACC-CACC modeling in MicroSDK. A
simple freeway pipeline area and
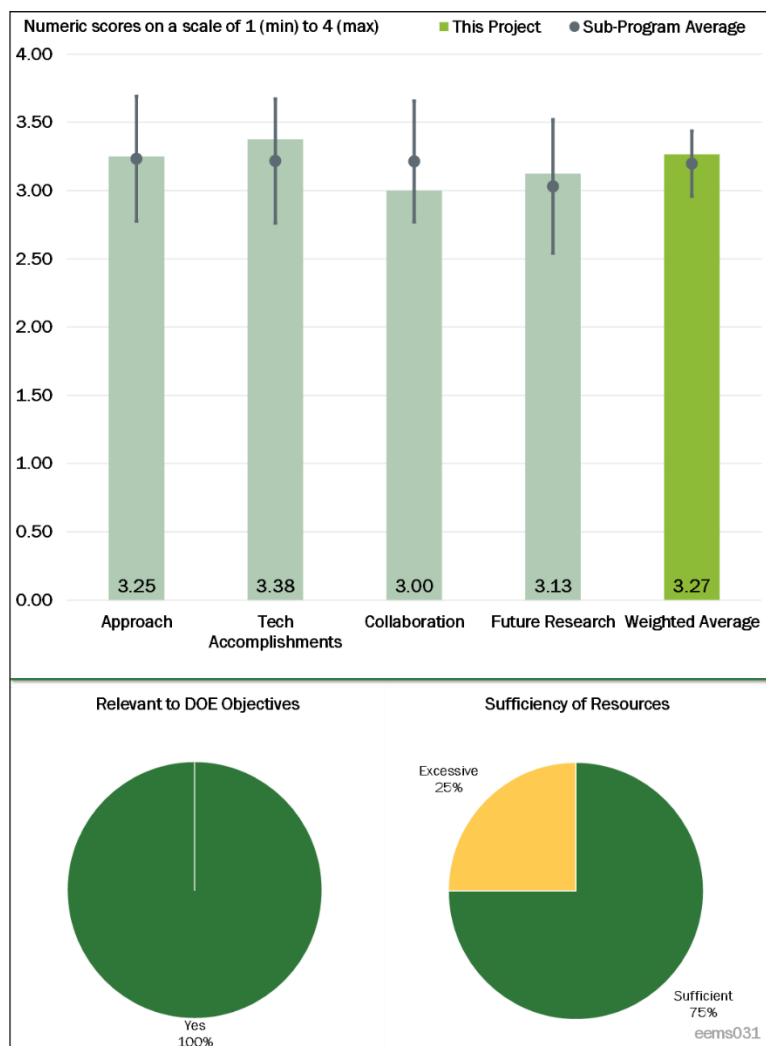freeway corridor traffic with CACC for

Figure 3-16 – Presentation Number: eems031 Presentation Title: Traffic
Micro-Simulation of Energy Impacts of Connected and Automated Vehicles
(CAV) Concepts at Various Market Penetrations Principal Investigator: Hau
Liu (Lawrence Berkeley National Laboratory)

State Route (SR)-99 Northbound (NB) is being modeled. The project is examining active traffic management
strategies that have been field tested including: coordinated ramp metering (CRM), variable speed advisory
(VSA), CACC managed lane strategy (ML), and equipping manually driven vehicles with vehicle awareness
devices (VAD). Ultimately, the project is analyzing CACC fuel savings and traffic flow implications with a
variety of penetration levels and active traffic management strategies.

Specifically, the reviewer stated that the project is addressing identified barriers including energy consumption
evaluation in freeway and arterial corridor traffic scenarios with different CAV market penetrations and traffic
improvement in the case of low CAV market penetrations. Overall, the project appeared well designed to the
reviewer and is clearly feasible.

Reviewer 2:
The reviewer found that the methodology proposed is an excellent way to leverage the available information
and tools to answer the questions posed for the study.

Reviewer 3:

The use of traffic microsimulation in conjunction with self-coded human driver, ACC, and CACC behavioral models made sense to the reviewer. On the other hand, the use of the Motor Vehicle Emission Simulator (MOVES) model for fuel consumption estimation may not provide accurate results, especially in the case of CACC. The reviewer asked whether the project team adjusted fuel consumption rates from MOVES for the aerodynamic effect on fuel consumption of the following vehicles in CACC strings.

Reviewer 4:

Overall, the reviewer found the approach to be good, and interesting fuel economy results are being achieved. A couple of areas for improvement are to explain "why" fuel economy and traffic capacity trends are observed. There are a lot of data presented, but minimal explanation of the data. Without any clear explanations of why these trends are occurring, the reviewer said it can be difficult to suggest future actions. There should also be more description of the powertrain(s) used. One would expect that these results might vary dramatically based on powertrain configuration (e.g., internal combustion engine [ICE] type, number of transmission speeds, xEV, etc.). It seemed to the reviewer like these results are based on the same vehicle throughout so it would a great improvement to mix that up a bit (and make it clear what was used). The reviewer stated that it would also be good to add some stochastic nature to the modeling since human behavior is involved.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

Overall, this project has achieved a number of technical accomplishments that include showing that CAVs improve traffic and energy savings when market penetration is above 40%, ACC makes energy efficiency worse because of instability to traffic flow, and CACC at higher penetration levels (above20%) leads to energy efficiency improvements with up to 15%-20% energy efficiency improvement at 100% penetration. Additionally, CACC can improve freeway capacity up to 50% (at 100% penetration) while maintaining constant vehicle fuel economy. CACC performs better at isolated bottlenecks or in pipeline applications than in complex corridors.

Another accomplishment mentioned by the reviewer included that VAD and ML strategies substantially enhanced freeway performance under medium- and low-CACC market penetration cases. Based on results from the SR-99 corridor, the VAD strategy benefits mobility but reduces energy efficiency. The ML strategy has negative impacts on both mobility and fuel consumption. Overall, increased levels of CACC and VAD reduce congestion and improve mobility.

In addition, the reviewer stated that CACC controller designs need improvement for better energy performance, and at low CAV penetration levels, vehicles are likely to be in ACC mode, which increases congestion. The project is using vehicle to infrastructure (V2I) variable speed limit (VSL) to resolve the low CAV market penetration problem for traffic performance improvement. Modeling uses predictive control applied for VSL determination, with no vehicle to vehicle (V2V) connection assumed. Simulations are being conducted on I-66 inside the Washington, D.C., Beltway. Results preliminarily indicate minor advantages in total travel time, total delay, average speed variation, and total number of stops at the minor expense of flow at merging situations. As such, VSL can be used by V2I-based ACC vehicles (or low market penetration of CAVs less than40%) for traffic performance improvement.

With a strong list of demonstrated technical accomplishments, the reviewer found that the project has clearly made significant progress as measured against performance indicators and is on schedule. It has provided strong insights into how to transition to higher levels of CACC for better energy efficiency and throughput while mitigating some of the downsides of the transition period at lower CACC penetration levels.

Reviewer 2:

The reviewer found excellent progress to completing the project objectives. Tasks completed to date provide appropriate insight.

Reviewer 3:

The reviewer commented that models seem to be up and running and results are available. This is a large accomplishment by itself. The reviewer suggested adding powertrain types to see how that influences the results and describe in much more detail "why" fuel economy and traffic flow trends are observed. The results seem counter-intuitive on the surface to the reviewer so they will need a clear and thorough description to avoid misunderstandings or false conclusions.

Reviewer 4:

The reviewer asked what the level of traffic congestion is in the simulation. The reviewer said it would be nice to also see a sensitivity analysis with respect to congestion level.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer stated that there is significant leveraging of results from other complementary projects.

Reviewer 2:

Collaboration seemed sufficient to the reviewer, and communication between multiple projects appears to be in place.

Reviewer 3:

The reviewer said that there appears to be appropriate coordination across relevant project team in the modeling workflow.

The project team could benefit from collaboration with vehicle fuel consumption modeling experts. For example, the reviewer believed that NREL has performed measurement of fuel consumption from CACC vehicles. That real-world data could have been used to adjust fuel consumption models for vehicles in CACC string.

Unlike other projects, the reviewer noted that there is no collaboration outside of the SMART Mobility Consortium.

Reviewer 4:

The reviewer noted that this is a strictly an LBNL project, which has not presented collaborations with any other entities with the exception of mentioning other National Laboratory partner projects in the EEMS Modeling Workflow. It may be taking place, but if not, the reviewer stated that it would have been beneficial to have a least one other entity (National Laboratory, industry, or governmental) actively involved to provide additional perspective and validation. This would potentially provide additional thought pathways, as well as further support validation and acceptance of results.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the proposed work addresses limitations of the work done to date and is appropriate for refinement of the conclusions from this work.

Reviewer 2:

The reviewer said that the proposed future research is logical.

Reviewer 3:

The reviewer stated that the project ends soon so future work seems reasonable. Focusing on why fuel economy is changed and different powertrain technologies would be beneficial, but may not be possible before the project end.

Reviewer 4:

The reviewer noted that future research proposes to simulate the fuel-saving benefit of CACC vehicle operation along a freeway corridor with active traffic management (ATM), including VSL and VSA, coordinated ramp metering, and coordinated merge. Subsequently, future research proposes to build a more accurate fuel consumption estimation model for arterial intersection operations in microscopic simulation and simulate CACC fuel savings benefits along an arterial corridor with active traffic signal control (ATSC). Finally, future research would simulate the combined fuel-saving benefits for CACC vehicle operation in a full traffic network with a freeway corridor with ATM and arterial corridors with ATSC, and coordination of the two traffic control systems. In short, future research proposes to build on the progress already achieved with CACC and management strategies, expand to include V2I and infrastructure to vehicle (I2V) techniques to further increase benefits, and ultimately broaden to full network assessment including arterial corridors. This is a pretty good strategy, but the reviewer felt it may be too expansive in scope, potentially too complicated, and could lead to highly dispersed results, which could be unusable in practice. The reviewer stated that it may be better to stay largely focused on the V2V elements of CACC and management strategies through further validation and optimization of the results. In this way, research results can provide solid CACC targets, inform future R&D activities, and help establish reasonable implementation strategies in a timely fashion, especially with regards to bridging the early "valley of death" scenarios when CACC is only implemented at limited percentages on the nation's roads.

The reviewer commented that the project has identified some challenges moving forward, including establishing reliable communications V2V to get further benefits and that different vehicles use different communication methods.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer remarked that vehicle energy savings in real-world traffic are mainly affected by factors at three levels: meso- and macroscopic traffic patterns, local vehicle following behavior, and vehicle level control and powertrain characteristics. Progressive market penetration of CAVs and ATM change traffic patterns significantly and can lead to significant energy savings and improved traffic flow. Field testing of CACC impacts on energy savings at the traffic level is not feasible. As such, the ability to accurately model and simulate the benefits and drawbacks of CACC and other CACC management strategies in various scenarios is essential in implementing robust strategies to achieve widespread adoption of CACC. According to the reviewer, widespread adoption of CACC would lead to significant energy savings and improved traffic flow, which supports VTO and DOE's overall objectives.

Reviewer 2:

The reviewer indicated that evaluating energy impacts of CAV applications is important for designing future CAV and transportation systems that are more energy efficient.

Reviewer 3:

The reviewer stated that the project answers key questions about the potential effectiveness of technologies for traffic congestion and throughput improvement and the impact on energy consumption.

Reviewer 4:

The reviewer said, "Yes" as the project looks at the fuel-economy impacts of newly emerging and future vehicle automation systems.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that this is a nearly 3-year, $681,000 project, which appears on schedule and which has not openly conveyed any funding challenges. As such, and combined with solid technical accomplishments, funding resources appeared sufficient to the reviewer to complete requirements and achieve project fruition.

Reviewer 2:

The reviewer noted that work is 90% complete with funding provided so far. The research team has not indicated a need for additional funds to complete the project.

Reviewer 3:

The reviewer said that resources seem sufficient.

Reviewer 4:

The reviewer remarked that the level of funding seems a bit excessive for such a traffic micro-simulation project.

Presentation Number: eems032
Presentation Title: Evaluating Energy-Efficiency Opportunities from Connected and Automated Vehicle (CAV) Deployments Coupled with Shared Mobility in California
Principal Investigator: Matthew Barth (University of California at Riverside)

Presenter
Matthew Barth, University of California at Riverside

Reviewer Sample Size
A total of two reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer commented that the project is ambitious, especially in combining data and modeling of vehicle technology and behavioral aspects, as well as simulation and field testing. It was not clear to the reviewer from the presentation how successful this has been.

Reviewer 2:
The reviewer stated that the topic is certainly of interest, and the presentation makes clear how challenging it will be to fully model this CAV future. However, the presentation provides several updates or accomplishments without clarifying whether the issue is now resolved or what needs to be done to resolve it. The reviewer said that there are many nuggets of interesting ideas, but the work does not feel well organized—such that issues are identified, prioritized, attacked—with reporting of whether the result is satisfactory or needs more work. The reviewer remarked that perhaps the topic is just too big for one project.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer found that the accomplishments reported are interesting and show promise, but very few feel finished. It would be better if each accomplishment slide identified a publication, either submitted or with a near-term deadline. With such little time left, one gets concerned which, if any, will be finished by September, especially if some of the PI's students are away for the summer.
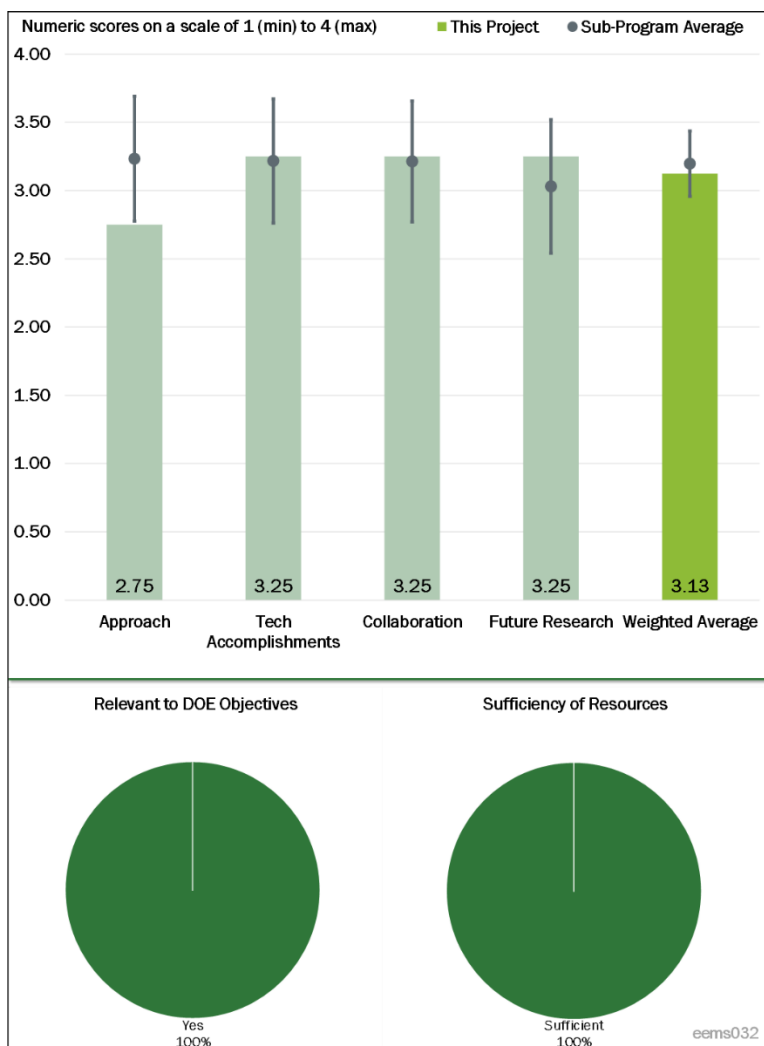

Figure 3-17 – Presentation Number: eems032 Presentation Title: Evaluating Energy-Efficiency Opportunities from Connected and Automated Vehicle (CAV) Deployments Coupled with Shared Mobility in California Principal Investigator: Matthew Barth (University of California at Riverside)

Reviewer 2:

According to the reviewer, the project appears to be generally on track; one milestone is listed as "ongoing" beyond the planned completion date.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

From the presentation, it seemed to the reviewer that there is one primary partner (NREL) and several others with varying degrees of interaction. The reviewer appreciated the organization of his collaboration slide. One can see that the PIs have tried hard to reach out to necessary or helpful partners.

Reviewer 2:

There seems to be substantial collaboration with a variety of partners, according to the reviewer.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The identified future work looked fine to the reviewer, but not realistically defined for the remainder of this project, which ends in a few months. For a follow-on project, the reviewer encouraged shrinking the scope and going deeper on those few issues. Also, the reviewer asked whether there will be any harmonizing between the problem structure and the framework presented in many of the other EEMS presentations.

Reviewer 2:

The reviewer stated that the presentation mentions increased accessory loads; this warrants additional evaluation and quantification. The discussion of challenges and barriers in the presentation suggests that there is a long way to go to determine the validity of the modeling and results (e.g., lack of data to calibrate). Nonetheless the proposed future research made sense to the reviewer (use model to evaluate impact for two locations; extrapolate to state level; evaluate policies to mitigate adverse impacts), though only as a preliminary step to determine the utility of this type of modeling and not with the expectation of valid results at this time.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

As the presentation notes, the reviewer stated that the project would "support policymakers in steering CAV and shared mobility development in an energy-favorable direction."

Reviewer 2:

The reviewer noted that, of course, this work is in scope. Somehow, the reviewer felt like this high-level planning should be done by VTO, and then VTO funds efforts to address particular issues.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer reported that there is no indication of insufficient resources. The project is nearly ended with funding mostly spent and milestones largely met.

Reviewer 2:

The reviewer remarked that this is hard to evaluate. There was no sense of how the funds are divided, how many (if any) Riverside students are involved, or even the extent of NREL's funding share.

Presentation Number: eems033
Presentation Title: Truck Cooperative Adaptive Cruise Control Operational Energy Consumption Test at Intersection with Active Traffic Signal Control
Principal Investigator: Xiao Lu-Yun (Lawrence Berkeley National Laboratory)

Presenter
Xiao-Yun Lu, Lawrence Berkeley National Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:

The reviewer stated that the approach is logical and addresses the key question of the potential for how the interaction of CACC and ATSC will yield energy consumption reductions through reduced total traffic delay. The combination of real and simulated trucks (HIL) in a real-time traffic simulation is an interesting approach to the problems of testing multiple vehicles in the real world (cost, consistency, etc.) The logic for the energy minimization algorithm is sensible and should be relatively easy to implement.
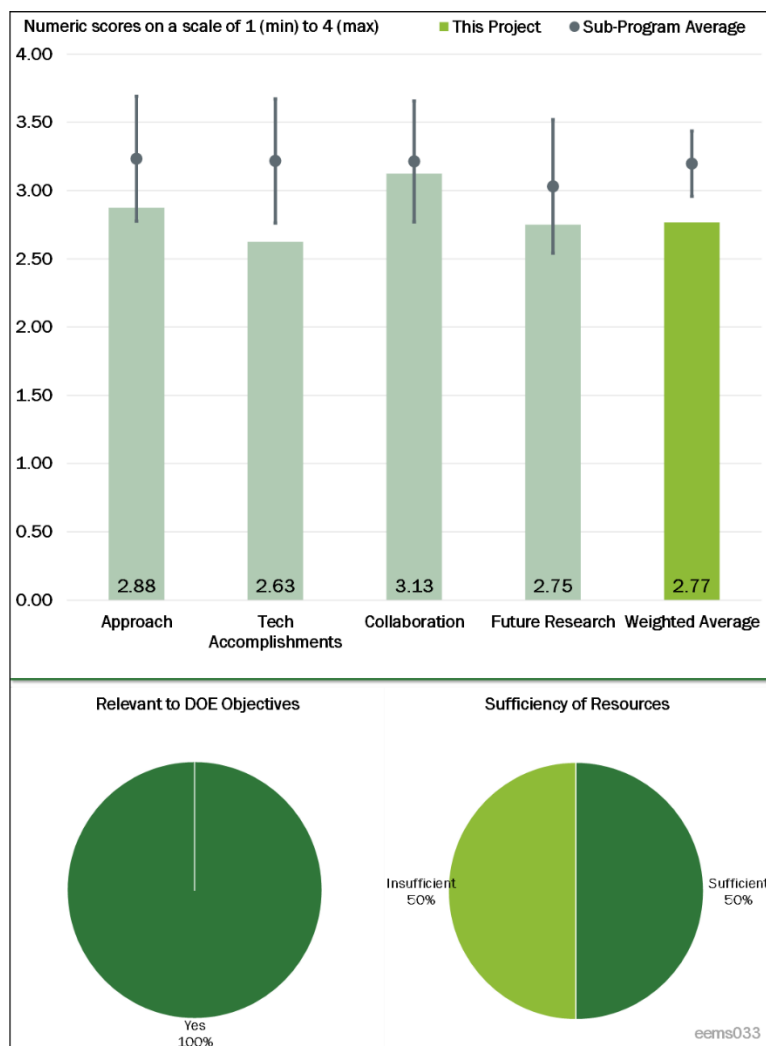

Figure 3-18 – Presentation Number: eems033 Presentation Title: Truck Cooperative Adaptive Cruise Control Operational Energy Consumption Test at Intersection with Active Traffic Signal Control Principal Investigator: Xiao Lu-Yun (Lawrence Berkeley National Laboratory)

Reviewer 2:

The reviewer indicated that the approach seems disconnected, but should deliver the objective. It seemed to the reviewer that this project expects to continue.

Reviewer 3:

The reviewer noted that the work proposed will address the technical barriers in this research area. However, the reviewer did not see the progress in this $1 million project in mitigating these barriers.

Reviewer 4:

The reviewer commented that the vehicles are not the latest or the best suited for this project. A hybrid system with launch assist should be used. The data collected will quickly be outdated and irrelevant with advanced systems that will outperform these vehicles.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer said that DSRC is not an established communication protocol. The arguments still go on for 5.9 versus DSRC. Both protocols should be established for the project.

Reviewer 2:

The reviewer stated that there are a number of deliverables that will be completed in November after the project deadline and asked how this is being accomplished. The reviewer was not sure how each of the deliverables maps to the objectives.

Reviewer 3:

The reviewer found that the project team has made reasonable progress toward completing its goals for this project although it appears that some of the tasks will extend beyond the current end date of the project. The algorithm and HIL development has been completed to demonstrate the benefits of combining CACC with the cooperative signal algorithm; it was interesting to the reviewer (but not unexpected) to see that the signal algorithm is not needed at very high levels of CACC market share. The simulation movie shown as part of the presentation was interesting, but it would be helpful if the PI were to provide some narration explaining the key parts of the simulation and highlight where the reviewers should focus attention to make the simulation more useful and understandable.

Reviewer 4:

The reviewer found that project progress is far behind in completing the research work promised. The research team only completed the modeling part of this project, but fell behind in hardware development and system integration. The reviewer was not confident this team will be able to complete the research work by the end of this project, especially with the limited research funding left.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The project team is a very strong team consisting three National Laboratories, one university, and maybe also an industry partner (Volvo). Each party has its own objectives and work described. However, the contribution of NREL and INL for this project so far is not clear to the reviewer from the presentation.

Reviewer 2:

The reviewer commented that the project team is connecting with other EEMS laboratory work as well as leveraging previous U.S. DOT FHWA research projects for truck CACC technology and findings. The reviewer said that this shows good cross-agency collaboration. The PI mentioned that DOT has initiated a new project on truck platooning field operational testing in the response to a question about collaborating with industry, but it was not fully clear to the reviewer how the DOT project and this one were specifically related.

Reviewer 3:

The reviewer remarked that there is strong cooperation with the few Laboratories. It seems the project could have been more robust with some industry partners, even at a very small level of involvement. This could even be a good place for an industry group to have been involved, such as SAE and the Technology Maintenance Council (TMC).

Reviewer 4:

 According to the reviewer, LBNL seems to be using much more resources with very limited contributions to the project. The $407,000 that LBNL received can be much more effectively utilized with the other contributors. The reviewer suggested this be revisited and reevaluated with some external resources.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer found the future research work to be a logical extension of current accomplishments and research needs. The addition of emissions testing will be useful to quantify this aspect of the project and may spur interest in these systems at the local level.

Reviewer 2:
The reviewer commented that it does not seem that the project is on track to meet its goals. Future research is identified, but the project ends in two months.

Reviewer 3:
The reviewer stated that the proposed future research does not bring new ideas beyond what industry and research institutes are currently working on.

Reviewer 4:
The reviewer noted again that the latest vehicle technology should be utilized with launch assist.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer commented that the project is definitely relevant to VTO goals as it seeks to reduce energy use by limiting idling time at traffic signals using a cooperation between CACC and V2X technology. It feeds the microscopic traffic simulation aspect of the EEMS workflow.

Reviewer 2:
The reviewer said that this is a very relevant project, which will give us pathways to reduce emissions and congestion.

Reviewer 3:
The reviewer said yes, but it seemed to the reviewer that the benefit of using trucks in ACC in urban environments to help with congestion is not too practical. This whole project relies on it.

Reviewer 4:
According to the reviewer, it is relevant to DOE's goal in improving energy consumption of transportation systems. The work conducted in this project could be very useful for industry although it does not bring ideas beyond the current research program conducted in universities and industry.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewed noted that the resources appear to be sufficient to achieve the goals of the project.

Reviewer 2:
The reviewer observed that the review did not prove that the objectives will be accomplished in the timeline provided.

Reviewer 3:
The reviewer stated that LBNL's contributions and cost should be reevaluated.

Reviewer 4:

The reviewer was not confident that the funding left is sufficient for this project team to complete the research work left. It seemed to the reviewer that this team has fallen behind in completing the research work promised.

Presentation Number: eems034
Presentation Title: Optimization of Intra-City Freight Movement and New Delivery Methods
Principal Investigator: Amy Moore (Oak Ridge National Laboratory)

Presenter
Amy Moore, Oak Ridge National Laboratory; Victor Walker, Idaho National Laboratory

Reviewer Sample Size
A total of six reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer commented that the overall objective of this project in examining the potential energy savings for new freight delivery methods adds a useful data set to the body of EEMS literature. Considerable discussion is ongoing about the possible effects of e-commerce and marquee technologies, such as drones, so some solid analytical and modeling work from an objective source like ORNL and INL will be useful.
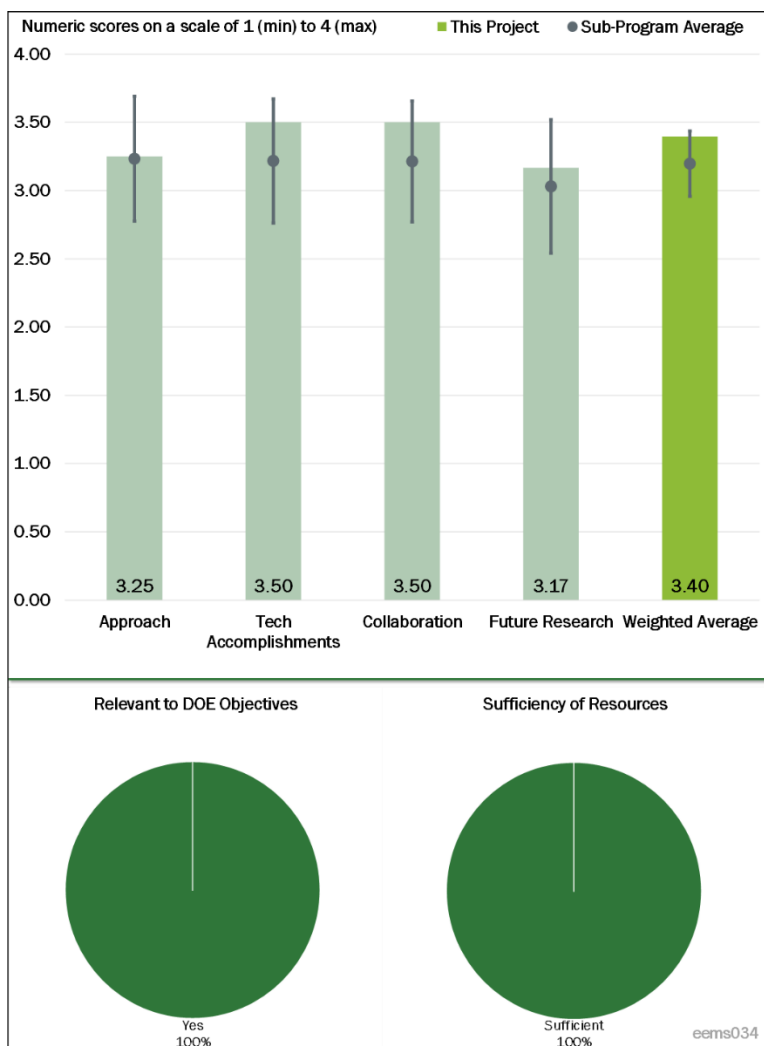

Figure 3-19 – Presentation Number: eems034 Presentation Title: Optimization of Intra-City Freight Movement and New Delivery Methods Principal Investigator: Amy Moore (Oak Ridge National Laboratory)

According to the reviewer, this work is making good use of existing data sets and approaches with the POLARIS framework in expanding local impacts of these technologies to a broader region (builds on past and ongoing work elsewhere in EEMS). The four-step approach is very logical and builds from basics to the final conclusion. The reviewer noted that the project team is looking at the right new technologies that are currently the subject of much discussion in the industry (vehicle electrification, drones, automated ground delivery, etc.)

Reviewer 2:
The reviewer noted that the project approach is well thought out: investigate technology, gather delivery data, and model scenarios. It is interesting and needed work to assess new technology opportunities for improving intra-city freight delivery.

Reviewer 3:
The reviewer has been reviewing this project for a few years and it seems that this three-year work is to set a baseline understanding for final mile delivery technologies and some high-level analysis. The reviewer said that the work is not as detailed as needed going forward, but it is a strong start.

Reviewer 4:

The reviewer stated that the approach taken was very good and innovative. The reviewer would like to have seen some additional market segments studied beyond United Parcel Service (UPS), i.e., grocery store delivery.

Reviewer 5:

There are a number of barriers that are not well addressed, according to the reviewer. For instance, the energy usage of drones is not holistically quantified. For example, the life cycle cost and operational costs are not currently accounted for. Also, the validity of the finding relies on how realistic the generated tours are. It would be a great improvement if the researchers can obtain UPS tours for Chicago and run the analysis given those tours.

Reviewer 6:

The reviewer stated that this research estimates the energy consumption of freight delivery in the Chicago area using a model developed by this project team. Limited experimental data have been derived from the energy consumption of a few drones. The energy consumption of electrical vehicles and traditional diesel vehicles were made available in other projects. The work presented in this project is to some extent useful but the tool used seems not revolutionary. The reviewer commented that the conclusion reached does not provide results beyond what can be estimated using engineering judgement.

The reviewer offered two concerns about the energy results presented by this team. The first concern is that the team did not clearly point out if the energy consumption by drone and EV has been converted to chemical energy, such as diesel equivalent with the chemical energy (such as coal or natural gas) to electrical energy considered. Based on the data presented, the reviewer suspected that the project team may have the electrical energy and diesel fuel chemical energy compared on the same basis, which is not correct. The second concern is that recycling drone batteries will consume energy and money. The cost estimate of drones, based on the price of batteries, may not accurately reflect the cost of drones if used in large scale. The team should consider the recycling cost. ANL has been awarded large research funding to investigate the recycling of batteries and should be able to provide input to this team.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer reported that the researcher estimated progress at about 85%. Significant results were achieved in better understanding of drone technology, its challenges, and its benefits. The research team also accomplished significant modeling results, including POLARIS and geographic information system (GIS) layers, for supporting further analysis.

Reviewer 2:

The reviewer said that this project team has achieved the progress and accomplishment described in this project. The experimental data and numerical model are able to perform the work promised in this program.

Reviewer 3:

The reviewer appreciated how freight modeling was used to perform the energy analysis.

Reviewer 4:

The reviewer found that the project team's work on drone testing adds a novel data set to the literature, particularly the relationship of weight, altitude, and temperature to energy use. The finding that the drone needs significant energy to remain in the air regardless of payload may have implications about total energy savings potential for these devices, particularly in light of the fact that energy use for highly loaded drones is comparable to that of an efficient on-road vehicle. The reviewer asked what the benefit is of drones beyond

energy. Drone analysis may feed research needs to the electrification team at VTO because of the short life cycle of these batteries.

The reviewer said that the project team has made a significant effort to communicate its research results to the broader community through presentations and publications. The Transportation Research Board (TRB) presentations should be particularly useful in this regard.

The reviewer remarked that the project team has made good use of available data in Columbus and Chicago to understand the potential for differing UPS delivery scenarios in an urban or suburban environment. The analysis shows that considerable energy savings can be achieved through delivering from a depot to a storage locker, which makes sense as it limits both the number of stops and total trip distance, but it was a bit unclear to the reviewer whether the team had considered the impact of a customer needing to travel to the locker to pick up the package. If the assumption is that the customer will pick the packages up as part of another trip (e.g., a work-home cycle), then the savings are real; but, if the customer will make a special trip to the locker, then the last mile from the locker to the home (the ultimate destination) will require additional energy. The work is good as a framing for future discussions, however.

Reviewer 5:
The reviewer remarked that the researchers made sufficient attempts at generating the tours and studying the energy estimates under different scenarios. The estimated values as mentioned before may be hard to sell because the errors are not quantified and also because the researchers did not consider an outcome where more than one of these scenarios could take place simultaneously in the future.

Reviewer 6:
Again, it seemed to the reviewer that there is significant learning about these various new methods, but not a great deal of results or data coming from the work. Not being too critical here, as these are so new, but the reviewer would look for more detail in future reviews as the reviewer believed on-going work should be funded into this as robot deliveries, bicycles with cargo bays, etc., are emerging. So, there are even more options coming.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer indicated that the research team includes multiple Laboratories (ORNL, INL, ANL, and NREL), UPS, and a Chicago regional planning organization. The role of each project team member has been well defined within the context of the project.

Reviewer 2:
The reviewer noted that the project team is collaborating with multiple EEMS Laboratories, including NREL for UPS GPS traces for freight deliveries. The team is also collaborating with UPS and several MPOs to combine the team's efforts with POLARIS on household shopping characteristics to cover the gap on parcel delivery movements. This has been a good effort to use existing laboratory collaborations to close project data gaps effectively.

Reviewer 3:
The reviewer commented that this is a collaboration project among numerous DOE National Laboratories, which has been a tradition in many DOE-funded projects. The data presented in this PowerPoint file show the input from different laboratories.

Reviewer 4:
Multiple groups are closely collaborating toward the main objective of the project, according to the reviewer.

Reviewer 5:

In this case, staying focused with one parcel company is okay as the reviewer said that there is no need for a big group of fleets.

Reviewer 6:

The reviewer found good, in-depth collaboration with current partners, but felt that a few other market segments need representation.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

According to the reviewer, there are plans to study energy consumption for different types of drones and to obtain Chicago tour data from UPS. The integration with POLARIS is also ongoing.

Reviewer 2:

The reviewer found a good list presented.

Reviewer 3:

The reviewer remarked that the project team is figuring out the key next analyses that will be valuable to the DOE and industry. The reviewer suggested being very focused on defining the scope of the next, ongoing project on this topic.

Reviewer 4:

The researcher stated that this project is nearly done but the remaining work is logical to conclude this effort. The proposed work beyond this project seems reasonable but is less specific and concrete; more details would be useful here to understand where the project team would like to take its findings next.

Reviewer 5:

The reviewer said that this project will be complete in 3 months. The work proposed reflects what this project team can complete before the end of this project. The future work presented in Slide 41 has not addressed the barriers presented in Slide 3.

Reviewer 6:

The reviewer indicated that the PI provided some general thoughts on future plans, but lacked details and specificity. The reviewer asked whether additional technologies will be researched or the research expanded along with additional delivery data and/or additional regional efforts within Chicago or its suburbs.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

According to the reviewer, energy analysis proves the relevance of intra-city improvements required. Additionally, the reviewer very much liked the addition of publications and references as that slide helps prove the relevance.

Reviewer 2:

The reviewer observed that this project is very relevant as it covers the new shipping and shopping modes that will likely have significant impact on intra-city freight energy use.

Reviewer 3:

The reviewer noted that new delivery technology will one way or the other materialize in the future and it is critical to study the energy impact of such systems.

Reviewer 4:

The reviewer reported that this work supports DOE programs in the areas of freight delivery efficiency and energy reduction.

Reviewer 5:

The reviewer found this project to be relevant to DOE's goal in improving the efficiency of transportation systems.

Reviewer 6:

The reviewer commented that it is really critical to help industry best apply these various solutions. Consumers are not going back to stores. E-commerce is set into our behavior. The reviewer stated that how we best deliver given money, environmental impact, etc., is critical to help all of us figure this out. The reviewer found the project to be very relevant, even though it seems somewhat disjointed. It is a good place for DOE.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The financial resources appeared to be sufficient to complete the work as described, and the team leveraged other data resources effectively to address gaps.

Reviewer 2:

The reviewer remarked that the project team made good use of resources, especially the number of presentations, which makes the dollars go further with respect to the funding.

Reviewer 3:

The reviewer commented that this project appears to be adequately funded with its multiple team members.

Reviewer 4:

According to the reviewer, funding is sufficient given the investigatory nature of this project.

Reviewer 5:

The reviewer said that Chicago tour data are needed.

Reviewer 6:

The reviewer said this project team has sufficient funding and one of the best research facilities available, so it should be able to complete this project on time because most of the work is numerical simulation.

**Presentation Number: eems035
Presentation Title: Coupling Land-Use
Models and Network-Flow Models
Principal Investigator: Paul Waddell
(University of California at Berkeley)**

Presenter
Paul Waddell, University of California
at Berkeley

Reviewer Sample Size
A total of four reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer said that the vision for this
project is to create a foundation for
broad integration and software
modularity across SMART models that
enable rapid innovation and advance the
research program. As part of the overall
EEMS end-to-end modeling workflow,
the overall objective of this project is to
develop an integrated modeling pipeline
that encompasses land use, travel
demand, traffic assignment, and energy
consumption, with the focus to model
combined and cumulative impacts of
transportation infrastructure and land
use. The reviewer found that this project
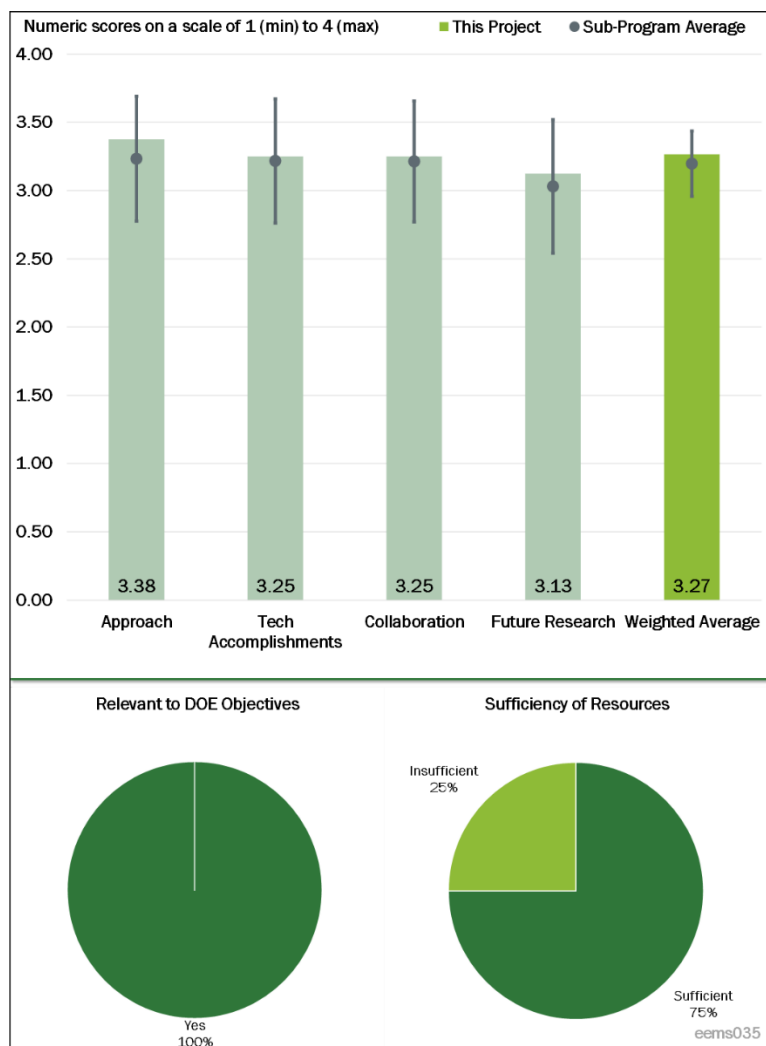is employing a modular approach that

Figure 3-20 – Presentation Number: eems035 Presentation Title: Coupling
Land-Use Models and Network-Flow Models Principal Investigator: Paul
Waddell (University of California at Berkeley)

integrates the land-use model (UrbanSim, which microsimulates choices of households, businesses, and
developers) and multiple personal-level activity modules as part of ActivitySynth with the BEAM model and
overall network models. These integration activities are coupled with aggressive testing and validation
elements for each modeling component, with the ultimate aim to achieve scale-up up to larger and more
diverse regions. This is a very strong project approach and one that could achieve large benefits, according to
the reviewer.

The reviewer noted that the development of large network models integrating urban planning and mobility is
complicated and poses many challenges, not the least of which is getting the ultimate end-users (MPOs, cities)
to accept and use the models to support their planning activities. The project PI indicated that the plan was to
modularize and present the models in piecemeal fashion to encourage ultimate acceptance by the end-users.
The reviewer found this to be a good approach and one that will be buttressed by the project's strong emphasis
upon validation. The reviewer encouraged the project team to continue to put considerable effort into
developing a robust end-user acceptance strategy and making models transferrable to practice.

The reviewer commented that a number of key barriers have been identified including run-time challenges, computational limitations of network modeling, and scalability. The need has been identified for deep software engineering, modularization, and performance improvement in network modeling components. This project is extensively leveraging collaboration with other modeling entities to develop options to accelerate computing performance and improve modeling accuracy.

Reviewer 2:
The reviewer stated that this project is focused on predicting vehicle ownership, impact of land-use change, and analysis of advanced accessibility. UrbanSim is the only land-use model in the SMART Mobility workflow and is thus on a critical path for most core models. The reviewer said that it is synonymous with the linkage between land-use and agent-based travel models.

Reviewer 3:
The reviewer commented that the integration of UrbanSim with BEAM makes sense. BEAM certainly needs inputs from UrbanSim. And, the reviewer noted, the feedback loop from BEAM to UrbanSim is as important, especially for evaluating how new mobility technologies may impact future land use and urban form.

Reviewer 4:
The reviewer understood what is being done here but it was not clear to the reviewer as to how the products of this project could be used effectively after project completion. The excessive run times seem to be limiting the number of potential users who can actually create real-world analyses. According to the reviewer, this is a serious shortcoming and, if not corrected, could make this work unusable.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
According to the reviewer, this project has presented a significant amount of data and demonstrated an impressive list of technical accomplishments including: The UrbanSim application from the Metropolitan Transportation Commission (MTC) and ActivitySynth have been updated to interface and integrate with BEAM. As part of ActivitySynth, a new set of models (workplace choice, auto ownership, work arrival time, work duration, and primary mode to work) have been developed and are being validated with several showing strong correlation to real-world observed values. Additional models (school choice, school arrival time, school duration, and primary mode to school) are being developed. The reviewer observed that the project is working extensively with other entities to address the run time, performance, and modularization challenges of network modeling components. Some road network models have been created as well as a simplified BEAM network to accelerate performance.

The reviewer reported that results from the combination of UrbanSim and BEAM are presented for the number of trips and energy consumption (as a function of trip mode) for each of the three principal EEMS scenarios (Sharing is Caring, Technology Takeover, and All about Me).

Overall, the reviewer indicated that is an impressive list of accomplishments.

Reviewer 2:
The reviewer remarked that the project has had several significant accomplishments that are important to achieving the overall objectives: the UrbanSim application has been updated to interface with BEAM and initial models to create person-level activity plans have been created as inputs to BEAM. Model run times have been identified as a challenge and there is a need for deep software engineering to improve performance.

Reviewer 3:
The reviewer commented that the preliminary results from the integrated model (UrbanSim plus BEAM) runs look interesting. The work dwell time model currently has a low goodness-of-fit. The reviewer asked why the

leveraging of UrbanSim Template, Pandana, and UrbanAccess is left for future research and why these tools are not already part of the UrbanSim package.

Reviewer 4:

The reviewer said that sub-model outputs were shown on specific technical accomplishments as results of the model work. That indicated to the reviewer that the work has been difficult and has created limited fully integrated model output. The reviewer asked if this were due to the excessive run time problems that limit the number of iterations that have been run. Progress has been made but a fully usable tool at project end is not a likely scenario.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

According to the reviewer, this project exhibits outstanding collaboration and coordination as exhibited by extensive connections with other National Laboratories (NREL, ORNL, INL, ANL), industry (Google), universities (University of Texas at Austin and Purdue), and the MTC. These collaborations include BEAM and MEP integration, network modeling, urban data science toolkit, and the Bay Area UrbanSim.

Reviewer 2:

The reviewer stated that all five SMART Mobility Consortium National Laboratories are participating as well as two universities (Purdue and University of Texas at Austin). Google and MTC are also collaborators.

Reviewer 3:

The integration with BEAM has been completed, but it looked to the reviewer like the integrated model, run-time issue would require further coordination within the project team. There is collaboration also with partners outside of the SMART Mobility Consortium, especially on network modeling.

Reviewer 4:

The reviewer commented that all collaborations were with academic or internal groups and very little was included from real-world transportation agencies. The reviewer found this to be a shortcoming.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

In short, the reviewer said, the effects of emerging mobility options on longer term household choices are not well understood and there are little data to inform it. However, the reviewer asserted that the project team has done an excellent job identifying the remaining challenges and barriers to addressing this challenge, including network model run times; the need to further refine and validate ActivitySynth and UrbanSim models; the need for the combined modeling system for additional testing, sensitivity analysis, and scenario development; and the challenges for scaling the model system to other metropolitan areas and for making the system practically useful and deployable for MPOs, DOTs, etc. One issue that was not clear to the reviewer was how to validate in totality complex, highly integrated network models to the satisfaction of potential end-users The proposed future research as presented addresses most of these challenges, with a strong focus on deep software engineering to increase model modularity, flexibility, computational performance, refinement of specs, and validation. It was clear to the reviewer that the project team has a good handle on the remaining challenges and is oriented to address them.

Proposed future research seemed appropriate to the reviewer and includes software engineering for increased model performance, refined specifications, calibration and validation, testing and evaluation with BEAM, and planning for scaling up.

Reviewer 3:

The reviewer said that the proposed future research seems logical, some of which could perhaps be attempted in the remaining time of the current project.

Reviewer 4:

The reviewer stated that the project is very much model-build based and did show how some sub-model elements were validated. The rest of the project will continue to do this and work on run time, which the reviewer said is good. But, it will not create a likely usable model set by project end.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer stated that this project is highly relevant and clearly supports overall EEMS and DOE objectives. Specifically, the project addresses the need to quantify the impact of urban development on mobility patterns and energy use, to quantify the impacts of SMART technologies on long-term urban development, and to evaluate combined policy impacts of land use and transportation to avoid bias. Integrating land use with transportation models enables better assessment of impacts of transportation innovations on energy consumption, travel, and urban development patterns. The reviewer noted that this project supports the EEMS and VTO goal of linking long-term modality styles with short- and medium-term mode choice in a multimodal transportation system and the ability to simulate emerging mobility services. The project also supports DOE goals to diversify and reduce transportation energy use by better understanding the relationships between land use and transportation mobility modes and use.

Reviewer 2:

The reviewer remarked that UrbanSim is the only land-use model in the SMART Mobility workflow and thus is critical to EEMS modeling efforts to increase mobility without increasing energy use. It also supports municipal transportation planning efforts for a more realistic assessment of cumulative impacts of transportation innovations on energy consumption, travel, and urban development patterns.

Reviewer 3:

The reviewer stated that land use and transportation are interconnected. Understanding their long-term relationships and impacts is important for projecting transportation energy demands.

Reviewer 4:

According to the reviewer, more information was given on results that can be achieved with these models during the questioning than was presented in the presentation. Many parts of study are using only California-centric scenarios and data. Working with other jurisdictions to help expand applicability must happen.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

This is an excellent project with a proven history of technical accomplishments, which has achieved a lot of bang for the buck. Future aspirations are extensive and well detailed but it may be questionable if current funding levels are sufficient to achieve them. Additional funding for this project should be considered.

Reviewer 2:

The project funding ($690,000) seems appropriate for the 2-year effort with a number of National Laboratories, universities, and industry.

Reviewer 3:

The project received increased funding last fiscal year, and it seems to be sufficient now.

Reviewer 4:

The reviewer said that the project ends soon so sufficient to complete what was shown as remaining work. Not sufficient to build a usable analysis system from the models.

Presentation Number: eems036
Presentation Title: Reinforcement Learning-Based Traffic Control to Optimize Energy Usage and Throughput
Principal Investigator: Tom Karnowski (Oak Ridge National Laboratory)

Presenter
Tom Karnowski, Oak Ridge National Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer stated that the project is focused on identifying vehicle types using a camera with a fish-eye lens and classifying them according to estimated fuel efficiency. Because of the high distortion in the lens, classification did not go much beyond light-duty and heavy-duty vehicles.

Reviewer 2:
The reviewer said that historical data and images were used to create methods to estimate vehicle fuel use at intersections. This information is being used in simulations, aided by high performance computing, to develop energy efficient traffic control.
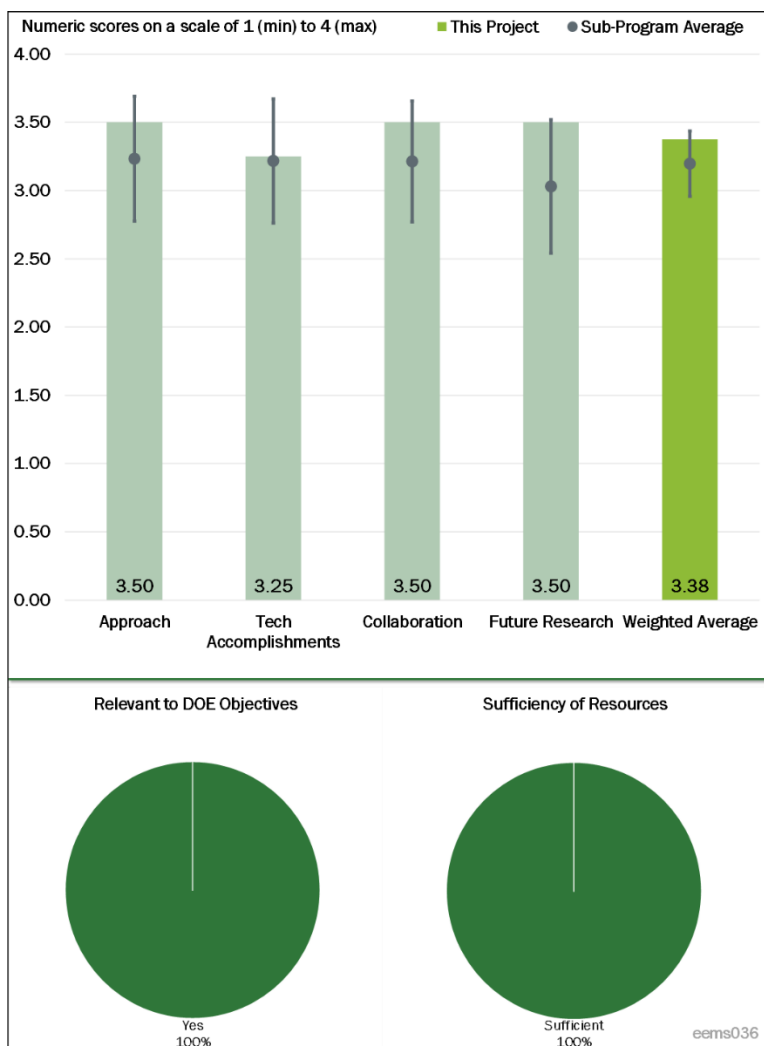

Figure 3-21 – Presentation Number: eems036 Presentation Title: Reinforcement Learning-Based Traffic Control to Optimize Energy Usage and Throughput Principal Investigator: Tom Karnowski (Oak Ridge National Laboratory)

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer indicated that classification was shown to be effective using undistorted images. The images available from the GRIDSMART camera are distorted and not as easy to classify. The work was able to distinguish cars from trucks and buses and to set signals to largely avoid the energy penalties of stopping and starting a large vehicle.

Reviewer 2:
The reviewer remarked that a large data set of vehicle images from GRIDSMART camera for a variety of vehicle classes can be used to illustrate the utility of bounding boxes to detect fuel consumption visually. This

data set will be made publicly available upon partner approvals. Preliminary HPC simulation results show that distinguishing large vehicles from conventional vehicles is effective for control methods.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer commented that collaboration was with GRIDSMART in Knoxville, Tennessee. The partner contributed part of the funding, which may motivate them to incorporate the work into a product feature.

Reviewer 2:
According to the reviewer, GRIDSMART is a cooperative research and development agreement (CRADA) partner supplying intersection data and providing technical expertise.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said that the CRADA ended in April 2019. Improved data sets, larger simulations and integration into other projects leveraging GRIDSMART technology seem appropriate future research possibilities.

Reviewer 2:
The reviewer stated that the project has ended.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer found this project to be relevant to DOE goals as it is a technology solution to increase mobility energy productivity, which is an EEMS goal within a broader VTO goal of reducing petroleum consumption.

Reviewer 2:
According to the reviewer, a traffic signal that is able to give heavy trucks and buses priority can save energy.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer indicated that this project was funded with $260,000 from DOE and $60,000 from GRIDSMART, which seem to be appropriate resources for a single-year effort.

Reviewer 2:
According to the reviewer, the project has achieved its most important milestones.

Presentation Number: eems037
Presentation Title: High-Performance Computing (HPC) and Big Data Solutions for Mobility Design and Planning
Principal Investigator: Jane MacFarlane (Lawrence Berkeley National Laboratory)

Presenter
Jane MacFarlane, Lawrence Berkeley National Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer indicated that the barriers are thoughtfully identified and the approaches to address them draw upon the advanced tools recently developed in machine learning and high performance computing. There seems to be a nice correspondence between the barriers and solution approaches.

Reviewer 2:
The reviewer remarked that node-to-node transportation networks are very complex to model and require high performance computing to design and optimize. The project seeks to develop such models for such networks and optimize energy use and travel time through optimal network design and route planning.
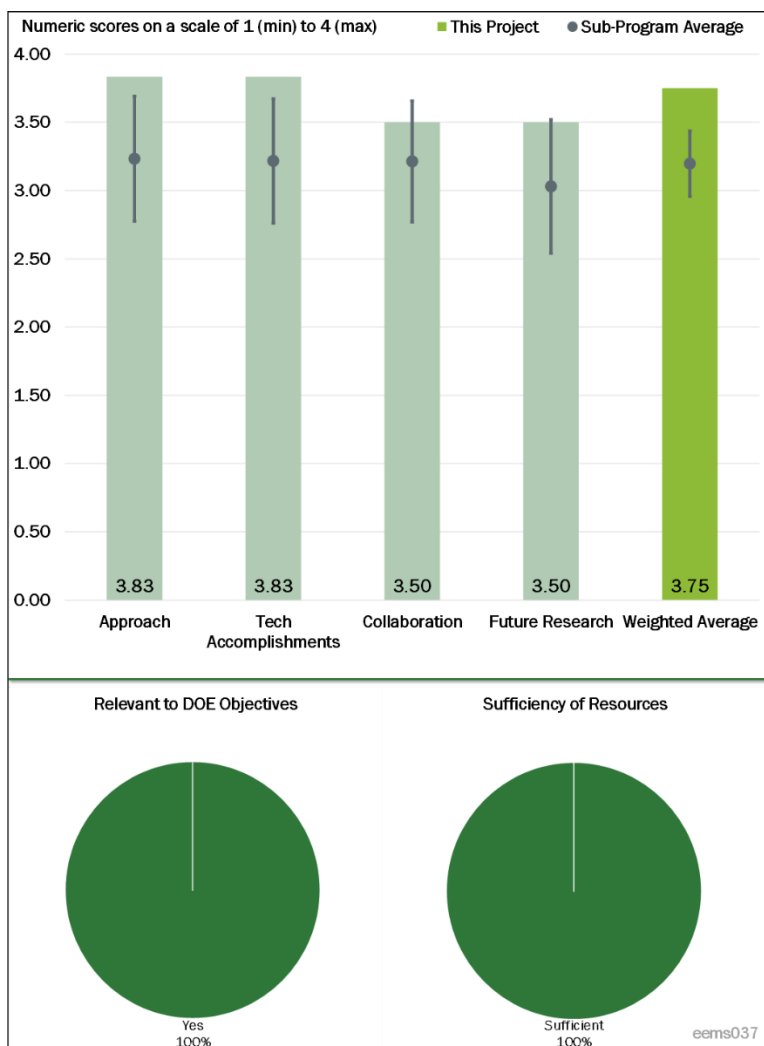

Figure 3-22 – Presentation Number: eems037 Presentation Title: High-Performance Computing (HPC) and Big Data Solutions for Mobility Design and Planning Principal Investigator: Jane MacFarlane (Lawrence Berkeley National Laboratory)

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer stated that the project team has already successfully run simulations for energy, rideshare, mobile device integration, and routing. This shows that the team is using several inputs to try to account for all scenarios. This will allow them to anticipate outcomes.

Reviewer 2:
The reviewer said that several tasks have been completed and the project is on schedule.

Reviewer 3:

The reviewer commented that the progress toward the goal of full metropolitan-scale modeling was clearly shown. The integration of ML models in mobility and validation results was demonstrated. It still was not clear to the reviewer whether it can make a meaningful difference on active control of fleets of connected vehicles.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

It appeared to the reviewer that the project team has tried to bring groups in to support the information inputs that the team desired to run scenarios. The team used government, rideshare, National Laboratories, and academia for their input information.

Reviewer 2:

The reviewer found that there were collaborations with CalTrans, HERE Technologies, and other DOE National Laboratories. Data for the project were from a number of sources, including the Connected Corridors Program, Uber, and HERE.

Reviewer 3:

Depending on the needs, the reviewer said that sufficient collaborative efforts were planned.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that the proposed future work includes validation and integration. These are a natural extension of the current accomplishments.

Reviewer 2:

At the end of the presentation, this reviewer reported that the project team mentioned making it open source. This can be useful others are allowed to add to the data that were not originally considered. Also, if other areas are allowed to access and use this, the reviewer stated that it will build a larger database with more answers to other traffic issues not restrained by one region's limited information that only pertains to that region.

Reviewer 3:

Among the activities planned for future, it was not clear to the reviewer whether an effective active control algorithm can be thoroughly studied, even though it is going to be the major use of the developed platform.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer remarked that accurate energy and mobility impact for large cities can only be reliably quantified when the simplifying assumptions typically driven by the computational limitation are kept at a minimum. This study is an interesting attempt at overcoming the computational burdens imposed by the large size of big metropolitan areas.

Reviewer 2:

The reviewer noted that this is very relevant as sitting in traffic and idling, otherwise known as congestion, is a major contributor to greenhouse gas emissions. If this project can anticipate and adjust traffic patterns to save energy and time with a byproduct of lower emissions, it is successful.

Improving transportation planning and mobility to save energy and reduce fuel consumption supports the overall DOE objectives, according to the reviewer.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that this is a well-funded project.

Reviewer 2:

The reviewer stated that the project team is allowing other to contribute to the information, which increases the data to run scenarios for different areas.

**Presentation Number: eems039
Presentation Title: Fueling
Infrastructure for Future Shared and
Shared-Automated Vehicles
Principal Investigator: John Smart
(Idaho National Laboratory)**

Presenter
John Smart, Idaho National Laboratory

Reviewer Sample Size
A total of six reviewers evaluated this project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer said the early recognition that there is no single infrastructure design appropriate to all situations was a key initial understanding. This understanding has enabled the project to deal with technical barriers in a flexible manner, avoiding schedule problems while meeting objectives.

Reviewer 2:
The reviewer remarked the approach to performing the work seems to have well-defined project boundaries.

Reviewer 3:
The reviewer found that this approach seems appropriate, particularly, as two projects were combined into a single one.
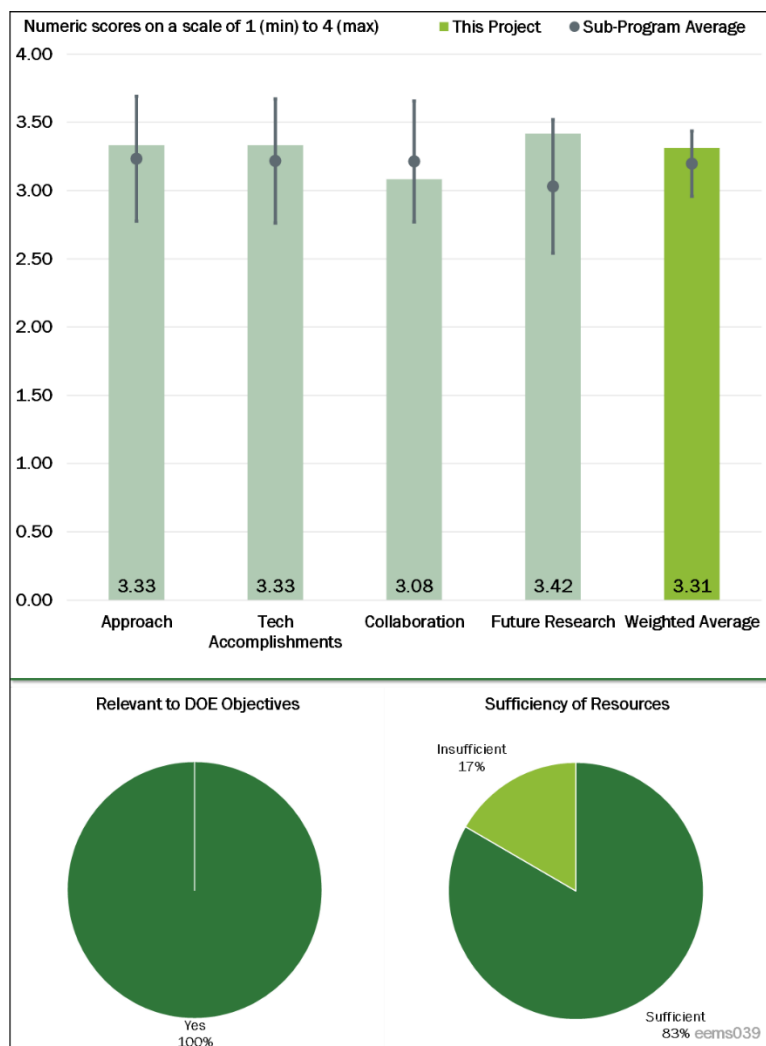

Figure 3-23 – Presentation Number: eems039 Presentation Title: Fueling Infrastructure for Future Shared and Shared-Automated Vehicles Principal Investigator: John Smart (Idaho National Laboratory)

Reviewer 4:
The reviewer commented that the project should have taken into consideration people who have electric vehicles (EVs), to get an idea of the total picture. There are charging stations installed in public venues to allow the public to charge EVs outside of their homes. The reviewer was unclear whether these were included in the availability for ride-share vehicles.

Reviewer 5:
The reviewer does not think that idealized cases were the best way to handle the approach of infrastructure. More variables should have been allowed, especially with respect to infrastructure coverage. In addition, the reviewer did not see a clear relationship between the infrastructure analysis and cost, versus the total system cost of the vehicle. There appear to be some non-connected issues that are complicating the project; e.g., automated versus human driven.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer said that the recognition that charging infrastructure is "horses for courses" has allowed the project to assimilate potential technical barriers. Then to continue moving forward, by incorporating these as trade-offs between charging infrastructure coverage, utilization, and mobility.

Reviewer 2:

The reviewer stated that this project is on schedule at 85% effective to plan. The project team has met their goals of projecting the costs of different types of vehicles over a 5-year period. The reviewer is not sure if the price of the EVs is shown as part of the total cost of ownership. The chart shows depreciation as the cost of the vehicle, but it is unclear if that is the cost of a vehicle with or without any incentives. It seems to be low and the cost of an EV is higher than the projection.

Reviewer 3:

The reviewer remarked as battery costs decrease, consider the battery electric vehicle (BEV) costs decreasing also. Consider expanding cost variation evaluation and analysis to include future battery cost reduction targets set by the U.S. Department of Energy (DOE).

Reviewer 4:

A cost model is nicely presented, but the reviewer would have appreciated more details regarding the assumptions what went into it. The project is still early on and the biggest results are yet to be shown.

Reviewer 5:

The reviewer was unclear how the future work, which supports project objectives, can be completed by the end date.

Reviewer 6:

The reviewer said it was difficult to understand exactly what was accomplished during the past year. The reviewer would have liked to see a more detailed list of clear accomplishments than was presented.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The project is utilizing tools developed across the laboratory team. These tools (Behavior Energy Autonomy Mobility [BEAM] and Electric Vehicle Infrastructure Projection Tool [EVI-Pro] for example) provide core analytics for the project. The project has also used the three Smart Mobility common scenarios as use cases.

Reviewer 2:

The reviewer commented that there was good follow-up with stakeholders and interviews.

Reviewer 3:

The information used to put together this project was good. There seemed to be a lack of information and lack of solutions offered. There are organizations currently working on charging stations in different segments trying to figure out how many to install at apartments, on the highway, and at convenience stores. The reviewer suggests that if there are a high number of ride shares at the airport, why not install chargers there, and the rideshare owners pay a fee to charge their vehicle. It seems as though there could have been more thought-provoking questions with the amount of people on the team.

Reviewer 4:

It was not clear from the presentation what are the collaboration activities, handover points, and mutual advantage.

Reviewer 5:

The presenter showed the team members but made few solid references to which team member did what. Slide 25 was very general, and the reviewer suggested mentioning what each of the four labs did.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

In an area of research that could take many different paths, the project has chosen to engage in work that this reviewer feels will provide the greatest value to industry and municipalities in their efforts to design an optimized infrastructure system.

Reviewer 2:

There are real world scenarios already taking place as charging models, and ideas such a company like charge point who already has a charging distribution strategy. Suncor has a charging strategy that they have implemented. There already is information or data to be had that is available instead of starting from the beginning or reinventing the wheel. It probably would be better served to look at what is already out there and look at improving or upgrading the model.

Reviewer 3:

The reviewer stated that there should be more justification phrased, such as, "we really need this, because...".

Reviewer 4:

The reviewer is looking forward to the complete simulations, but seems some of this should have been completed 6 months ago.

Reviewer 5:

Entering the last few months, there is a definitive amount of work to be completed. The reviewer commented that it was shared sufficiently.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer stated that it is well known that there must be infrastructure to support EVs in all scenarios. This project provides a unique insight into the possible infrastructure scenarios as connected and autonomous vehicles (CAVs) increase in use.

Reviewer 2:

When speaking about electric charging, it supports the vehicle technology with assisting that technology to advance or to be successful. The reviewer noted that as the electric technology gets better, the infrastructure needs to keep up with the vehicle advances not only in hardware to support it, but places to fuel it in the most efficient way like time to fuel and location to reduce time spent.

Reviewer 3:

The reviewer remarked the project nicely analyzes the total cost of ownership (TCO) for future modes of transportation.

Reviewer 4:

The reviewer said yes, this project seems to support the overall DOE objectives. An analysis of shared mobility charging is a good first step.

The reviewer remarked that the project is in line with the DOE target to optimize charging infrastructure

Reviewer 6:
The reviewer commented that there remain many questions concerning the energy use of autonomous vehicles (AVs), limit rather than gain "out of route" miles. Analyzing charging in-line with automation is a good approach to predicting the impact of these technologies.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The project seems to be moving on schedule. Much work beyond the original authorized scope has been identified as beneficial. The reviewer stated that this work should be quantified and proposed as part of phase 2 work.

Reviewer 2:
The reviewer commented that the information may have already been available to complete the project on charging infrastructure and possible network distribution models. Most charging companies, at this point, have strategy plans or are already deploying their chargers.

Reviewer 3:
The reviewer said that it appears that another 6 months or another $150,000 would have aided the project.

Reviewer 4:
Not much shown or stated around the resources to accomplish the goals in the past or going forward. The reviewer is assuming that it is sufficient.

Reviewer 5:
The reviewer said no evidence for missing or excessive resources.

Reviewer 6:
This reviewer stated that the budget was not reviewed.

Presentation Number: eems040
Presentation Title: Dynamic Wireless Power Transfer Feasibility
Principal Investigator: Omer Onar (Oak Ridge National Laboratory)

Presenter
Omer Onar, Oak Ridge National Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The idea of evaluating energy consumption level for AVs and developing an optimization framework to locate the placement of the dynamic wireless power transfer (DWPT) system looks appealing. The reviewer offers some ideas here; please refer to comments in Relevance as well. If the project team is looking at vehicles that operate on a fixed route to study the feasibility, it seemed to the reviewer that the best return on investment (ROI) may be in places like theme parks and certain busy national parks. Unfortunately, funding for national parks leaves much to be desired already. So, perhaps national parks are not a likely deployment site. The reviewer asked in theme parks with large numbers of visitors, when shuttles have to run continuously, rather than continually, would the investment in DWPT make sense compared to acquiring a significantly higher number of shuttles to handle the load.

Reviewer 2:
The reviewer said that not enough time was devoted to discussion of approach on Slide 5.

Reviewer 3:
The reviewer suggested that this project approach can provide only limited useful knowledge. Also stating that the project is narrow in scope and lacks inclusion of real-world use cases. Collaborations with potential users of DWPT would be needed to make this work pertinent to any potential real-world application development.
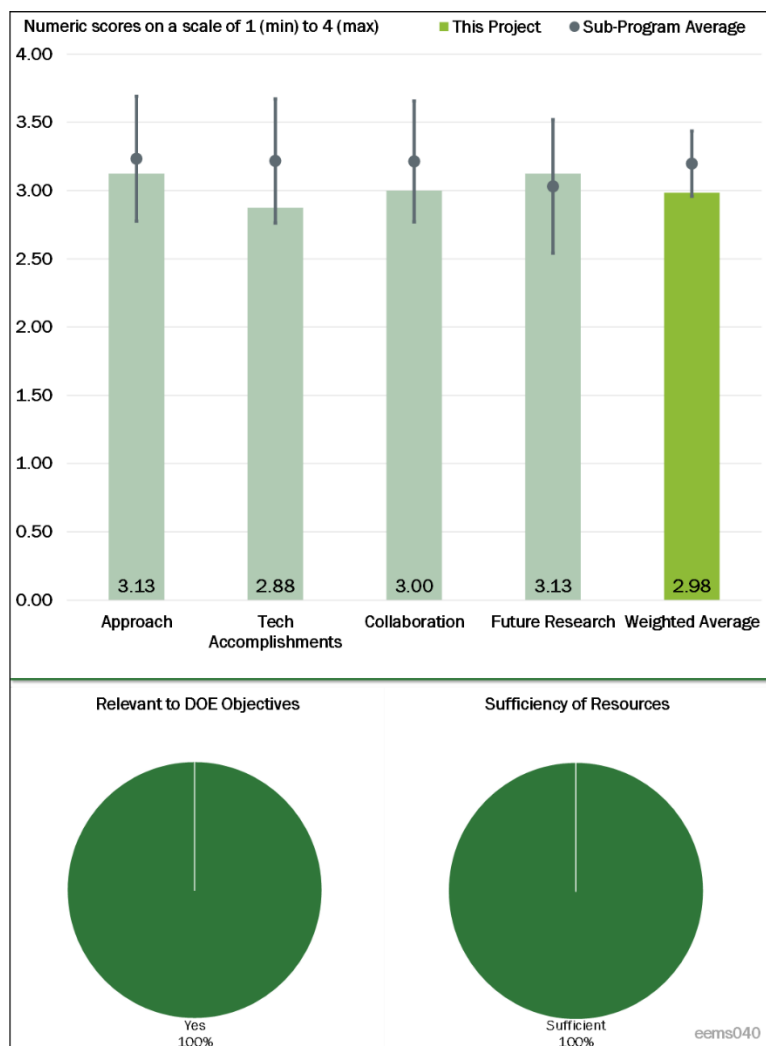

Figure 3-24 – Presentation Number: eems040 Presentation Title: Dynamic Wireless Power Transfer Feasibility Principal Investigator: Omer Onar (Oak Ridge National Laboratory)

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer stated that the project has good results and progress. Also, that explanation of how the scenarios were chosen would have been helpful.

Reviewer 2:
The reviewer suggested considering air-gap variation between loaded and unloaded vehicles.

Reviewer 3:
The reviewer is concerned that the project appears to be somewhat behind schedule. With 3 months to go, the project still has 35% that remains to be completed.

Reviewer 4:
The reviewer remarked the technical accomplishments are basic. The reviewer said that the project should have been designed to use some kind of simulated commercial drive cycle and measure how DWPT could be utilized to achieve functional, cost, and energy efficiency improvements on that cycle. Studying the feasibility of this technology must include all of these elements. This approach is quite academic at a time when the use of DWPT should be in the early stages of deployment. The reviewer remarked the narrow technical scope of the projects limits the knowledge gains that would make it useful to those who may want to build full-scale demonstrations.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
Inter-laboratory collaboration is good. The reviewer suggested reaching out to the University of Michigan to understand the energy consumption of the MCity shuttle, a driverless shuttle on the campus. The reviewer also recommended reaching out to other companies that have AVs on the road to understand their energy requirements and see whether a DWPT option makes economic sense.

Reviewer 2:
The reviewer suggested that the project team investigate possibility to analyze overall operation costs including infrastructure installation and maintenance.

Reviewer 3:
The reviewer stated that the project is good but not quite good enough. The reviewer questioned where the end user or vehicle provider collaboration is that may explore how to gain from this technology either in operational efficiency of an EV or in marketing EVs to new users. This project could be the EV system element that could enable greater adoption. It appears the potential first users not been identified, analyzed, and contacted to gain new collaborations.

Reviewer 4:
The reviewer is unclear whether proper collaborations have occurred.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer suggested that perhaps the proposed long-term potential research should take precedence over the near-term research. Especially, the comparison of the "business case" for direct current fast charging (DCFC) versus stationary wireless power transfer (SWPT) versus DWPT.

Reviewer 2:
The reviewer observed a good list of future challenges and hopes the DOE can fund a follow-on project.

Reviewer 3:
The project appears satisfactory to complete what has been planned. However, the reviewer has concern that what has been planned is too narrow to support real adoption.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer remarked that an approach that increases the likelihood of EV adoption is a good thing. This project lists one of the points in the "Relevance" slide that the reviewer finds most appealing; utilizing vehicles without any down-time and providing a high utilization factor. However, the reviewer would like to see some number crunching that supports the claim that higher utilization factor will sufficiently offset the investment costs. For instance, comparing the numbers for the MCity shuttle and see how they stack up.

Reviewer 2:
The reviewer observed that the project is in line with DOE targets to improve the energy efficiency and productivity of future integrated mobility systems.

Reviewer 3:
The reviewer remarked that this is an important technology that will aid in increasing market share of electrified vehicles. Also, the reviewer encourages that the DOE continues research in this area.

Reviewer 4:
Yes, in a narrow sense, the reviewer affirmed this project supports the overall DOE objectives.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer noted that the project is near completion.

Reviewer 2:
The reviewer remarked that there is no evidence for missing or excessive resources.

Reviewer 3:
The resources appear sufficient for the work defined. However, the reviewer commented that the work needed to be expanded to achieve real project success.

Reviewer 4:
The resources appear sufficient, but the reviewer said that it may be difficult to finish the work on time.

Presentation Number: eems041
Presentation Title: ANL Core Tools -
Hardware
Principal Investigator: Kevin
Stutenberg (Argonne National
Laboratory)

Presenter
Kevin Stutenberg, Argonne National
Laboratory

Reviewer Sample Size
A total of five reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer noted that, given the
limitations of what information is at
hand, this is a nice plan of attack.

Reviewer 2:
The build of vehicle baseline
performance datasets and comparing to
modeled results is a high value exercise.
The reviewer affirms that it validates the
models and provides extensive access to
the results for multiple projects. These
tasks are, and will be, pertinent for years
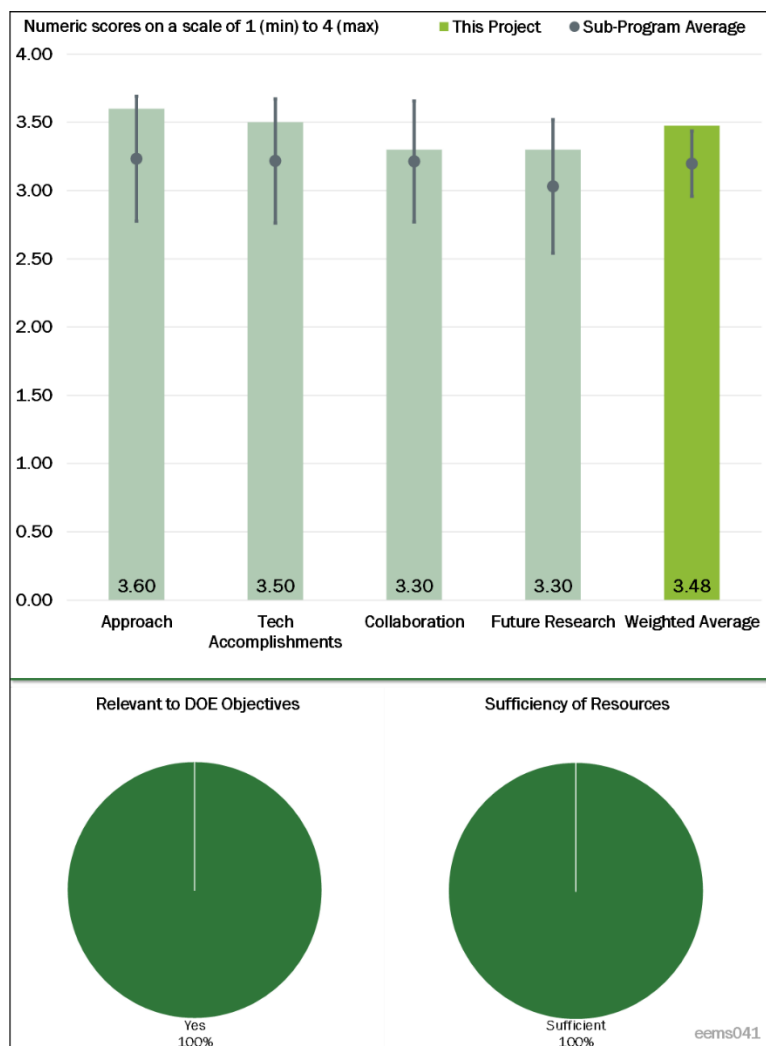to come.

Figure 3-25 – Presentation Number: eems041 Presentation Title: ANL Core
Tools – Hardware Principal Investigator: Kevin Stutenberg (Argonne
National Laboratory)

Reviewer 3:
The approach of hardware-in-the-loop
(HIL) dynamometer test for CAV can provide a convenient way to experimentally evaluate the energy
consumption. The quantification of road-load impact of vehicle platooning by test-track tests is promising. The
reviewer expressed that, to further enhance the impact, an adoption of an aerodynamic model and validation of
the model by multiple vehicle test data will make the results more general and more useful to others.

Reviewer 4:
The reviewer remarked that a very good approach has been developed.

Reviewer 5:
This work is very well designed. The reviewer suggested the research project moves further; however, it would
be helpful to fine-tune the approach tailored towards certain end-users. Currently, it is not clear what specific
use cases this project can address. Although, that is understandable because the project is still in its early
stages.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer remarked impressive progress in getting the vehicle-in-the-loop (VIL) up and running. This has very interesting results for vehicle platooning and the method for emulating on the dyno is innovative.

Reviewer 2:
The reviewer commented testing across different versions of new technology powertrains and understanding how these systems operate and perform on various drive cycles is key to understanding technology changes along the technology maturity cycle. These tests are appropriate to gaining significant knowledge. The reviewer expressed that the VIL work is quite well done.

Reviewer 3:
The reviewer said the project team has given many results since the project started. Instrumentation and overrides of vehicle, track test for road load measurement, and fuel/energy consumption for different types of vehicles in dyno-based hardware-in-the-loop experiments have all given promising results. The reviewer affirmed the project is making good progress and the plan is on schedule.

A model of aerodynamics based on test data is expected based on the track test results and a deeper analysis of fuel/energy consumption differences for hybrid-EV and EV is expected.

Reviewer 4:
The reviewer stated the accomplishments are quite good for this early stage and seem ahead of schedule.

Reviewer 5:
The reviewer remarked that it appears that the project is making satisfactory progress.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer commented that there is a good mix of organizations for collaboration among the modeling and hardware teams at Argonne National Laboratory, U.S. Department of Transportation, and universities.

Reviewer 2:
The project team has leveraged multiple collaborations including partnerships within the National Laboratory, Department of Transportation—National Highway Traffic Safety Administration, Innovative Vehicle Institute, and two universities. The reviewer affirmed the vehicle data to publish will benefit society.

Reviewer 3:
The project has some good collaboration partners but the project team said that there is plenty of room for more to join the effort to improve the outcomes. The reviewer agrees that this would be beneficial.

Reviewer 4:
The reviewer remarked that the project has good partners, which are utilized well.

Reviewer 5:
The reviewer commented the project team is small, which helps with effective collaboration.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer expressed the future activities that were indicated are appropriate follow-on to the progress so far.

Reviewer 2:
The continuation of the planned tasks, as presented, is quite valuable and will provide long-term benefit.

Reviewer 3:
The reviewer stated the list of proposed future research is great.

Reviewer 4:
The proposed research work is planned in a logical manner. The reviewer suggested the migration of risks in vehicle override in different vehicles and vehicle platooning track test should be planned.

Reviewer 5:
The future research appears reasonable, but the reviewer expressed that it will need to be refined according to sponsor and market needs.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The project provides some real-world validation for the simulation activities undertaken by DOE in the Energy Efficient Mobility Systems (EEMS) technology area.

Reviewer 2:
Test data and test programs provide performance data to validate models and provide some data to other programs. The reviewer affirmed this work is a necessary part to support many other activities.

Reviewer 3:
The reviewer said yes, the project supports the DOE objectives by developing facility to evaluate energy consumption by CAVs.

Reviewer 4:
The reviewer commented yes, this project supports the DOE mission because testing is a key step before the technology can go to market.

Reviewer 5:
The reviewer commented these tools are required to support smart mobility modelling.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The resources are sufficient to complete the work outlined. The reviewer commented that additional work could be done, and should be funded, for better asset utilization and increased benefits to many other programs.

Reviewer 2:
The reviewer stated that funding appears adequate based on progress to date.

Reviewer 3:
The resources look sufficient to achieve the stated milestones.

Reviewer 4:
The reviewer expressed that it is still early in project.

Reviewer 5:
The resources appear sufficient to the reviewer.

Presentation Number: eems042
Presentation Title: High-Performance Computing (HPC) Enabled Computation of Demand Models at Scale to Predict the Energy Impacts of Emerging Mobility Solutions Principal Investigator: Jane McFarlane (Lawrence Berkeley National Laboratory)

Presenter
Jane McFarlane, Lawrence Berkeley National Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
Node-to-node transportation networks in an urban area are very complex and require intensive computation to model such networks. The project team use high performance computing (HPC) and efficient assignment algorithms to develop models to predict traffic time and fuel consumption in an urban transportation network. The reviewer remarked that the project seems to be well conceived and planned.

Reviewer 2:
The reviewer affirmed that this project has a very good approach to traffic assignment methodologies.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer remarked the project is completed and the team has a transferable model to utilize anywhere.

Reviewer 2:
The project team has produced interesting results during this 1-year project. However, the reviewer is unclear what performance metrics were proposed. Therefore, it is challenging to evaluate if the project has delivered according to the proposed milestones.
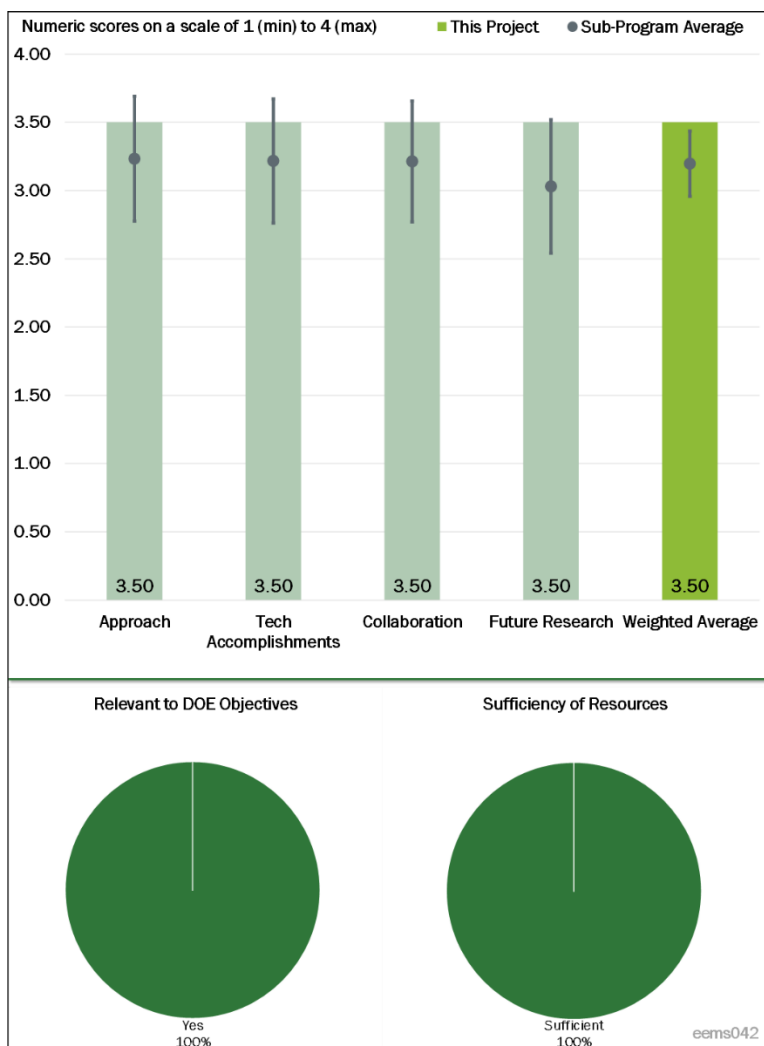

Figure 3-26 – Presentation Number: eems042 Presentation Title: High-Performance Computing (HPC) Enabled Computation of Demand Models at Scale to Predict the Energy Impacts of Emerging Mobility Solutions Principal Investigator: Jane McFarlane (Lawrence Berkeley National Laboratory)

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer affirmed the project has a very good team.

Reviewer 2:
Collaborations with California Department of Transportation (CalTrans), California Department of Transportation, Los Angeles County Metropolitan Transportation Authority (LA Metro), University of California at Berkeley (UCB), etc. were essential for the project.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer remarked that the 10-minute block goal is very important to make this tool much more effective.

Reviewer 2:
Dynamic traffic assignment is a very interesting area for future work leveraging the demand model already developed. Of course, the challenge lies in the reduction of computation in creating near real-time assignment solutions. The reviewer remarked that therefore, advancement in advanced computing is also necessary.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer expressed that the project will help reduce emissions and traffic congestion.

Reviewer 2:
The reviewer said that understanding traffic flow patterns is essential to cities and metro areas for both traffic management and infrastructure planning. Of course, efficient transportation in complex metro areas leads to improved mobility and reduced fuel consumption. Therefore, per this reviewer, the project is relevant to the DOE objectives.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer stated that there are sufficient resources for the project to achieve the milestones.

Reviewer 2:
The reviewer pointed out that this is a small-scale project. To create a useable algorithm and apply it to traffic planning and route assignment would require significant resources in a larger scale project with multiple collaborators.

Presentation Number: eems043
Presentation Title: Mobility Behavioral Responses to Transportation Network Company Services
Principal Investigator: Alejandro Henao (National Renewable Energy Laboratory)

Presenter

Alejandro Henao, National Renewable Energy Laboratory

Reviewer Sample Size

A total of six reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:

The reviewer remarked that the approach is generally acceptable. Several times during the presentation, there were comments about data availability being an issue/concern. However, it appears that the approach moved on from the data availability issue and still created a framework (albeit with definite merit). It seemed wise to the reviewer to explicitly identify the various data gaps, whether quality or availability. Then, prioritize the data gaps and perhaps even divert some of the funding to gathering or enhancing those data streams.
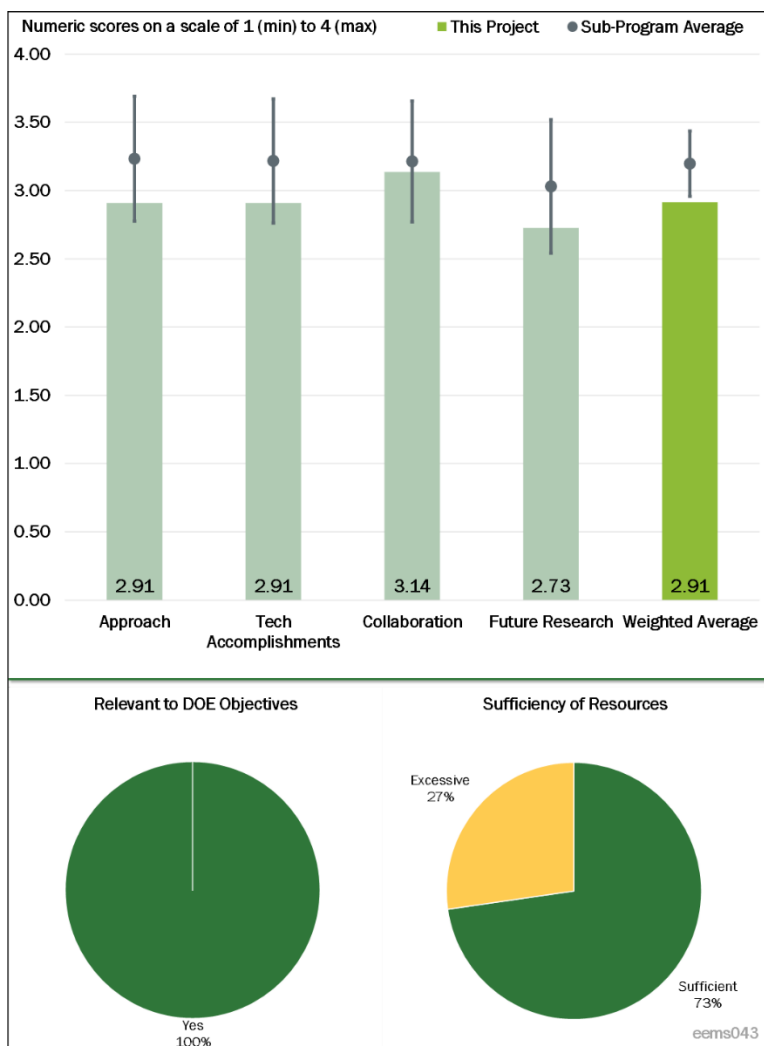

Figure 3-27 – Presentation Number: eems043 Presentation Title: Mobility Behavioral Responses to Transportation Network Company Services Principal Investigator: Alejandro Henao (National Renewable Energy Laboratory)

Reviewer 2:

The limited availability of transportation network company (TNC) data is acknowledged. The reviewer observed that there is minimal discussion of the confounding factors that make it difficult to draw conclusions from the limited data.

Reviewer 3:

The reviewer commented the stated barrier is limited data on TNCs. This project made good use of Ride Austin data, but the results of that analysis continue to reflect data limitations.

Reviewer 4:

The reviewer noted that the objective of this project is to determine the impacts and scale of TNC services on mobility behavior and energy use. In short, the approach is to identify and investigate mobility and energy impacts of TNCs and understand data needs, including availability. Specific research questions are to be answered. Regarding the approach, the reviewer commented that the details are somewhat limited and overall

somewhat generic. However, the project, as presented, is clearly feasible and is geared to addressing some of the identified barriers including limited data availability.

Reviewer 5:

The reviewer said the approach, unlike some other projects, included only analysis of available data sets and did not include any serious effort to seek input from a broad number of users. Regarding behavior, taking human surveys and reducing those results to confirm or validate trends shown in the travel data was required. The reviewer suggested bringing in a marketing partner to perform these surveys if that is not a core competency. The data analysis is not the only and complete answer.

Reviewer 6:

The reviewer is unclear why question three, "What is the national impact of TNC availability on vehicle ownership?" is chosen to investigate impact to mobility and energy impact of TNCs. The reviewer suggested that a more relevant question may be, "What is the national impact of TNC availability on total vehicle-miles traveled (VMT) and energy use?"

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer affirmed the project objective is to determine energy impacts. However, in the crucial area of sharing and mode shift, the analysis apparently on the literature rather than the RideAustin data. A broader concern is that conclusions about TNC implications at this early stage should not be taken as direct indicators of longer-term outcomes, e.g., deadhead miles may be a function of a relatively sparse network of vehicles. Regarding the relationship between vehicle registrations and TNC entry, it was observed that the analysis should have normalized the result by population. The project is on schedule, based on the milestones listed.

Reviewer 2:

The reviewer commented that the technical accomplishments of this project are adequate. Research question one appears to be the least answered of the three research questions, although there is a nominal answer/framework that provides insight. Using RideAustin and other data, question two appears to have some robust initial insights. The data attempting to answer question two also has some interesting trends, including the significant increase in energy use compared to the prior mode. Question three also appeared to be fairly well covered from this reviewer's perspective. There was some legitimate concern about normalization of data, i.e., whether it was properly scaled to population growth and other factors to enable properly drawn conclusions. There was a lack of information to know whether this is an issue, but this reviewer found the answer—that it was not a problem—to be unsatisfying. Therefore, the reviewer suggested ensuring these types of factors are accounted for.

Reviewer 3:

The reviewer remarked that the results are somewhat surprising and lead to new questions. It is difficult to deduce a causative relationship between the correlations of increased TNC use with other factors. In one particular case, increased TNC use was correlated with increased vehicle ownership. It cannot be assumed that the effect generalizes. It cannot be assumed that TNC use caused increased vehicle ownership, though the purchase of vehicles for TNC use is a hypothesis. Project work does indicate that the "natural" assumption that TNC use drives down vehicle ownership is false or at least questionable.

Reviewer 4:

The project has demonstrated some technical accomplishments especially concerning answering the three research questions. This includes identifying the main TNC factors impacting energy use, the estimated energy impact of TNCs, and the national impact of TNC availability on vehicle ownership. An extensive look has been undertaken on the travel and energy implications of a TNC in Austin, Texas, including commute deadheading, between-ride deadheading, vehicle efficiency, and modal shift and sharing rides. A close look at

the RideAustin fleet versus the baseline Austin Department of Motor Vehicles fleet was conducted with regards to vehicle type and powertrain, with some notable observations being made and quantified including the Ride Austin fleet is 3.2 miles per gallon (MPG) more efficient than the average vehicle in Austin. Despite more efficient vehicles, overall energy use increases by 41%-90% due to deadheading and modal shifts. Regarding TNCs and vehicle ownership, analysis indicates that on average the entry of a TNC into a particular area is associated with a net increase in vehicle registrations. The reviewer pointed out that in regards to comparison with US 2.1.1: ground transportation at airports, analysis from the project shows that the introduction of TNCs reduces use of all other modes of transportation including taxis, car rental, transit, and associated parking.

Overall, a reasonable level of technical accomplishments.

Reviewer 5:
The reviewer commented that the answer to question one is satisfactory. Question 2 results require further work to explore the impact of ride sharing and modal shifts, and question 3 appears not to indicate a causal relationship between vehicle registration and TNCs.

Reviewer 6:
The reviewer stated that the data analysis, though not validated with real world inputs, was done as well as expected. The outputs shown are significant but in need of a real-world smell test.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer remarked that the team and resulting collaboration seem to be high quality and robust. Given these research questions, and then combining two highly competent National Laboratories with a world-class data science university (Carnegie Mellon University) with data provided from the top two TNCs (Uber and Lyft), the project should be on excellent footing in terms of a project team.

Reviewer 2:
The reviewer acknowledged that getting data from Uber and Lyft is challenging. The project team is making an effort, but available data are limited. Collaboration with National Laboratories experienced with TNC data is good.

Reviewer 3:
The reviewer affirmed extensive collaboration was apparent, at least between the National Renewable Energy Laboratory and Lawrence Berkeley National Laboratory.

Reviewer 4:
Project collaborations and coordination is sufficient, if not extensive, being undertaken with another National Laboratory (Berkeley), university (Carnegie Mellon), and TNCs (Uber and Lyft). The reviewer was not entirely clear though about the extent of the roles of the other entities, and no mention is made as to specific coordination mechanisms.

Reviewer 5:
The reviewer expressed that including a market survey collaborator, the score would have been higher.

Reviewer 6:
The reviewer is unclear about the level of collaboration and co-ordination across the project team. The reviewer recommended adding more description on the roles and responsibilities from each of the partners.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

Overall, future research proposal is good. The reviewer agrees with the suggestion that data collection is critical and that it is important to identify additional TNC data gaps. At the same time, the reviewer was hoping to see a bit more on innovative ways of acquiring or generating that data (e.g., enhanced partnership with Uber and Lyft, novel data gathering techniques with new sensors, etc.).

Reviewer 2:

The project needs to address that some of the most important parameters in the Ride Austin analysis (ride sharing rate and mode shift) are from the literature, not the TNC data and that some findings from that analysis may relate to the current early stage of TNC development. For example, with more rides, density of vehicles will increase and deadheading should go down.

Reviewer 3:

The reviewer said a reasonable list of remaining challenges and barriers have been identified including data availability/sharing, difficulties in separating out opposing effects, and the causal inference constrained by the application and underlying assumptions of appropriate models. As presented though, the proposed future research provides only marginal insights into future activities, and is largely an extension of research into the previously identified research questions one through three. The reviewer remarked it would be beneficial to identify additional salient research questions to be pursued and/or insights into how to potentially mitigate the negative energy impacts of TNCs.

Reviewer 4:

The reviewer pointed out only 4 months remain in the project. The basic goals have been accomplished, but the reviewer expressed that there are still unknowable factors. Effective future research will depend on release of additional data.

Reviewer 5:

The reviewer remarked one of the significant remaining barriers identified is driver and rider behavior, likely requiring a survey of riders/drivers. The proposed research does not seem to address this barrier.

Reviewer 6:

The plan for future research is good regarding the intent to complete the project as originally defined. The reviewer suggested that the original definition that should have been different to make the project much more useful.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

This work, once complete, will certainly support the overall DOE objectives of understanding these complex relationships between TNC use, mode shifts, and energy usage changes over time. These topics cut to the heart of understanding EEMS.

Reviewer 2:

The reviewer noted that the behavior of TNCs is a good predictor for the behavior of fully automated vehicles. The reviewer questioned whether Uber or Lyft can achieve profitability without removing drivers from their vehicles. The energy effect of Level 4-5 automation is unknown. TNCs can provide clues to future transportation energy needs.

Reviewer 3:

The reviewer said that regarding the EEMS vision of "an affordable, efficient, safe, and accessible transportation future in which mobility is decoupled from energy consumption," this project would plausibly provide information supporting that vision.

Reviewer 4:

The reviewer suggested this project is relevant to overall DOE objectives because it is developing research insights that help identify and understand the energy productivity of emerging mobility systems such as TNCs. TNCs are playing an increasingly important role in mobility and clearly identifying their energy impacts (negative and positive) supports EEMS, VTO, and DOE objectives to reduce transportation energy consumption.

Reviewer 5:

The reviewer remarked the introduction of TNCs and consumer behavioral changes are a large driver to overall transportation system energy use. Identification and quantification of main drivers to inefficiencies is essential in prioritizing future opportunities for mitigation.

Reviewer 6:

The reviewer commented it is relevant to add some understanding of the effects of new mobility elements on the transportation system.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

Monetary and time resources for this project are sufficient, although the reviewer is concerned that much of the relevant data is proprietary and unavailable. The reviewer expressed that the data resources appear insufficient.

Reviewer 2:

The resources are sufficient to complete the approach as originally defined. However, the reviewer observed that the project did not complete the development of a fully usable toolset.

Reviewer 3:

The reviewer stated that there is no evidence of insufficient funds.

Reviewer 4:

The reviewer commented that the resources appear to be sufficient to complete the project.

Reviewer 5:

This effort appears to have been well funded over the last 3 years. However, given the current overall project scope and technical accomplishments, it seems that funding for this project may be somewhat excessive.

Reviewer 6:

With funding for this project over $800,000, the reviewer would have expected more robust, interesting results and possibly the introduction of new data streams or methods. The reviewer would not suggest the resources are significantly misaligned with the results, but the results seem a bit light for that level of funding. The reviewer said that perhaps some of the results were not presented or not presented in such a way to highlight the various challenges that were overcome.

**Presentation Number: eems044
Presentation Title: Quantify National
Energy Impact of Electrified Shared
Mobility with Infrastructure Support
Principal Investigator: Joann Zhou
(Argonne National Laboratory)**

Presenter
Joann Zhou, Argonne National
Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer said the project is doing
the best it can with limited data and an
inability to aggregate regional data and
results to national results and
conclusions. Building on the available
data leaves many potential errors that
cannot be quantified. For example,
determining charging availability (0.25-
mile x 0.25-mile grid cells) using data,
which includes Level 2 chargers, does
not seem appropriate to determine
charging availability for ride hailing
scenarios. The reviewer said it is not
credible that ride hailing would be taken
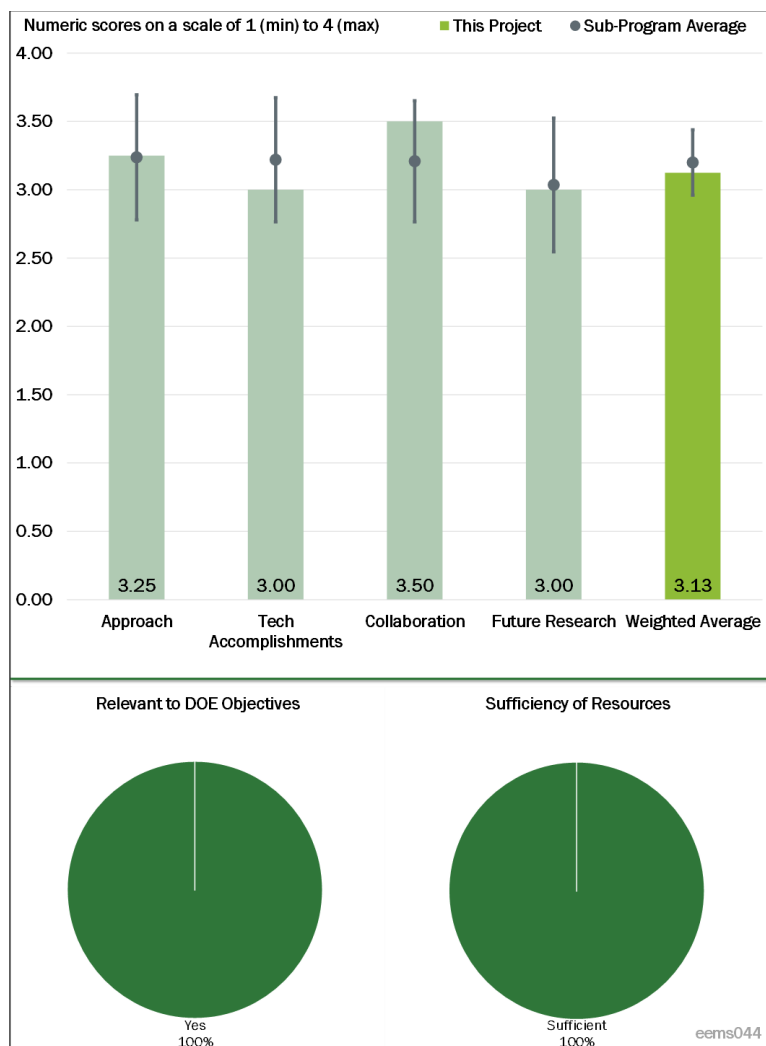out of service long enough to charge at
Level 2.

Figure 3-28 – Presentation Number: eems044 Presentation Title: Quantify
National Energy Impact of Electrified Shared Mobility with Infrastructure
Support Principal Investigator: Joann Zhou (Argonne National Laboratory)

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The project has progressed, in spite of the difficulty in aggregating results to the national level. Results have
been generated, and the sensitivity of results to changes in input assumptions, has been evaluated in selected
scenarios. The reviewer suggested more sensitivity work should be a priority in light of the sparsity of actual
data supporting developing analyses at the national level.

Reviewer 2:
The reviewer suggested considering the impact of cost of charging analysis public versus home/private and its
sensitivity bearing on charge availability.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer remarked laboratory partners appear to have been used very effectively. Models developed by other labs have been incorporated into the project (e.g. EVI-Pro). The reviewer suggested that care should be taken to recognize the limitations and uncertainties associated with these models, and the potential for the effects of these uncertainties to propagate to the national level.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The "bottoms up" approach to future work will continue to develop results (varying RTP from 0% to 100%), but will not evaluate the voracity of these results by testing assumptions and determining sensitivities. The reviewer said that for any future work the project team should consider determining the uncertainties of existing results as important as generating additional results.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer said that this is clearly a determination of the energy reduction benefits (or lack thereof) of ride hailing, in the context of varying charging infrastructure support, provides overall guidance to the direction of the Systems and Modeling for Accelerated Research in Transportation (SMART) mobility effort.

Reviewer 2:
The reviewer commented this project is in line of DOE target to quantify energy consumption.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer remarked progress appears to be moving on schedule and the proper expertise appears to be available to conduct the work. Unfortunately, data are lacking, so many assumptions must be made to move the work forward.

Reviewer 2:
The reviewer stated there is no evidence for missing or excessive resources.

**Presentation Number: eems045
Presentation Title: Focused Validation
and Data Collection to Support
Systems and Modeling for
Accelerated Research in
Transportation (SMART) Activities
Principal Investigator: Eric Rask
(Argonne National Laboratory)**

Presenter
Eric Rask, Argonne National
Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer said very good attempt to
work around the barriers of relatively
few Level 2 and 3 and no available
Level 4 production autonomous
vehicles, general sensitivity of original
equipment manufacturers (OEMs) to
revealing competitive info.

Reviewer 2:
The reviewer reported that the identified
project barriers were difficulty in data
collection, changing AV technologies,
and variation in AV assumptions. The
project addresses these barriers, but this
reviewer indicated that the question is whether these barriers are related by the DOE objectives.

Reviewer 3:
The reviewer said this project samples automated vehicle operation data, which will provide accurate input to
numerical model and research community. Collaborating with industry and other government agencies,
demonstrating and deploying automated vehicles, is a good approach.

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer said this team has made significant progress of the work promised. The preparation work for the
data collection needed is complete. The reviewer is confident this team will have the work done on time.
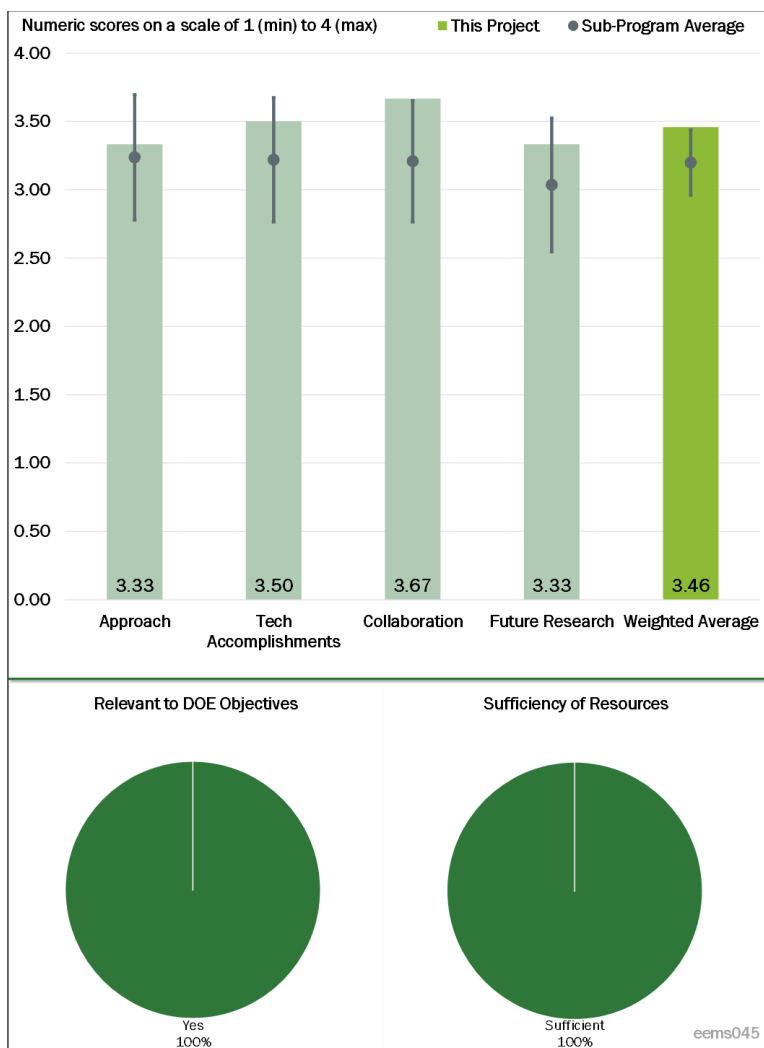

Figure 3-29 – Presentation Number: eems045 Presentation Title: Focused
Validation and Data Collection to Support Systems and Modeling for
Accelerated Research in Transportation (SMART) Activities
Principal Investigator: Eric Rask (Argonne National Laboratory)

Reviewer 2:

The reviewer remarked very good progress so far, and the road-load emulation for platooning vehicles is excellent.

Reviewer 3:

The reviewer pointed out that this is a one-year project and the project progress is on target.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer remarked this project team has done an excellent job in collaboration, especially the collaboration with industry.

Reviewer 2:

The reviewer commented the project team has done as good a job as can be done. The FEV collaboration is an excellent automotive industry partnership.

Reviewer 3:

The reviewer observed that the project team includes government agency, industry, and university partners.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer remarked the project plan is a reasonable progression from the current state. It would be quite a coup if the project team could get cooperation from a non-traditional OEM like Waymo. The reviewer does not expect the traditional OEMs to cooperate because they are more vehicle-centric.

Reviewer 2:

The reviewer said the proposed work is to continue data collection with respect to electrical loads in highly automated vehicles and data in autonomous vehicles. The reviewer would have liked to see highlights of the intended use of the data and how such data use contributes to overall DOE objectives.

Reviewer 3:

The reviewer remarked the proposed research is clear and logically makes sense.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said this project provides real-world data that can be fed back into other SMART studies.

Reviewer 2:

The reviewer remarked the authors should make it more explicit how the data collection work contributes to the overall DOE objectives. The reviewer believes that it is the analysis of the data, and insights from such analysis, that will lead to better understanding of fuel consumptions and use patterns of highly- and fully-automated vehicles.

Reviewer 3:

The reviewer remarked the research conducted in this project will provide input to research community for inquiry associated with automated vehicles. The application of the data collected will help to improve fuel economy of transportation systems, which is aligned with DOE's objective in improving transportation system efficiency.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said the resources available for this team are sufficient for the team to complete the research work proposed in this program.

Reviewer 2:

The reviewer remarked no indication that work planned was not completed due to lack of resources.

Reviewer 3:

The reviewer said resources are sufficient for the scope of the project.

Presentation Number: eems048
Presentation Title: An Analysis of the Spatial Distribution and Impacts of One-Way Car-Sharing Programs on Transit Ridership and Energy Use Principal Investigator: Tom Wenzel (Lawrence Berkeley National Laboratory)

Presenter
Tom Wenzel, Lawrence Berkeley National Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer said that this project team identified and performed surveys with several key groups within this space. A concern in the regression model results for vehicle shedding; Slide 15 did not contain any demographic information regarding age. It was based primarily on income and education.

Reviewer 2:
The reviewer remarked the project team has very good use of an existing survey (9,500 responses) and a vehicle trip dataset (five North American cities) from car2go project conducted by the Federal Highway Administration (FHWA). Leveraging a significant previous investment by car2go and FHWA for a relatively small ($375,000 over 3 years) DOE funding amount.

Reviewer 3:
The reviewer detailed that this project aims to conduct early-stage research and development at the traveler level. With a goal to better understand behavior of drivers, barriers to increased mobility, and energy productivity of future integrated mobility systems. The project seeks to understand the energy implications from shifts in personal travel, including in public transit, to emerging transportation modes, and to estimate the relationships between transit accessibility, urban form, and impacts from one-way car sharing. The reviewer remarked that it builds on an existing survey of users on VMT and mode shift impacts to understand spatial factors of survey responses at very low cost to DOE. This survey includes a unique existing data set with detailed user survey responses linked to their trip origins-destinations (O-Ds). Additionally, the data set for the car2go program in San Diego is for a unique all-EV fleet, which is the future model for automated TNC services.
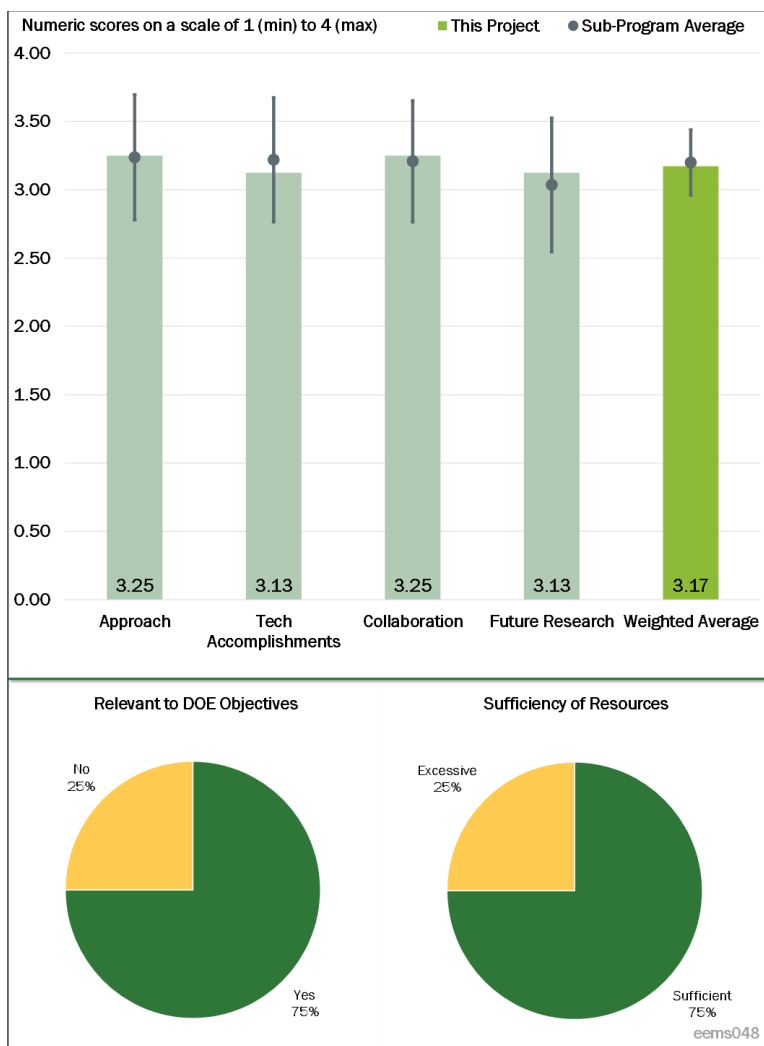

Figure 3-30 – Presentation Number: eems048 Presentation Title: An Analysis of the Spatial Distribution and Impacts of One-Way Car-Sharing Programs on Transit Ridership and Energy Use Principal Investigator: Tom Wenzel (Lawrence Berkeley National Laboratory)

The reviewer summarized that the project is analyzing the spatial distribution of 9,500 car2go survey respondents in five cities: San Diego, Seattle, Washington, DC, Calgary, and Vancouver. These University of California Berkeley survey responses provide information on home/work location, mode shift, vehicle shedding, vehicle suppression, change in VMT, and vehicle activity. The reviewer noted that individual trip data (over1 million trips across five cities) has been collected by Lawrence Berkeley National Laboratory. The survey identifies O-Ds, measured distance for each trip, and trips taken by respondents.

The reviewer noted that subsequently a database of characteristics in each city has been developed by Idaho National Laboratory, which includes census tract demographics, public transit system infrastructure, transit ridership data, transit schedule data/general transit feed specification (GTFS), and urban land use and form. Data visualization and regression is used to estimate relationships between census tract characteristics and car2go use and impacts in each city (Lawrence Berkeley National Laboratory).

Overall, the reviewer liked the approach especially because it builds upon an existing survey with broad geographic sampling, large and unique data sets, and detailed survey participant responses. Additionally, it is coupled with specific city characteristics to estimate relationships between census tract characteristics and car2go use and impacts. Overall, this seems like a sound, well-designed, and feasible project approach.

One notable deficiency the reviewer pointed out is that the project does not sufficiently identify barriers, with the exception of a generic one upfront "limited understanding of car sharing and transportation network company services on net energy use and relationship with transit".

Reviewer 4:

The reviewer said the approach does not quantitatively address the barrier framed as "net energy use impacts attributable to car sharing and network company services." The approach does provide insights into relationships between car sharing and other transportation modes.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer said technical accomplishments include five logistical regression models, each with different dependent variable including walking, vehicle shedding, vehicle suppression, bus use, and transit use. Models have been developed for three U.S. cities (Washington, DC, Seattle, and San Diego).

Reviewer 2:

The reviewer said the project developed five logistic regression models, each with a different dependent variable: vehicle shedding, vehicle suppression, increased/decreased use of public buses, increased/decreased use of public light rail, and increased/decreased amount of walking. More than 30 independent variables were tested or applied, depending upon the model. An iterative Lasso technique was applied to minimize re-prediction error using training and testing data sets. The reviewer noted that the project has successfully developed spatial representations looking at these five dependent variables as a result of one-way car sharing in the five cities. Mapping impacts allow analysis of how urban form influences the impacts of shared mobility. Results are mixed but in general, it seems that on the positive side one-way car sharing increases vehicle shedding and vehicle suppression, but on the negative side, it decreases bus and rail use. There are differences though between cities; for example, San Diego exhibits an increase in walking as a result of one-way car sharing while Washington, DC exhibits a decrease in walking.

The reviewer said a reasonable number of results were presented from the regression analysis from the vehicle-shedding model. This included insights about individuals with different household incomes, number of personal vehicles, varying parameters within census tracts, different travel tendencies, employment levels, and commute times, and how this impacts their likelihood to shed vehicles. This reviewer's major concern is that the results are very scattered and disparate and the reviewer is unsure how they can be assimilated into overall

coherent, impactful inferences that would be useful for program policy and planning. Additionally, no results regarding energy impacts have been presented.

Reviewer 3:

The reviewer noted that the project has produced maps that address car-sharing phenomenology for five cities and performed regression/least squares analysis that provides useful insights into what independent variables are important to transportation mode decisions where car sharing is used.

Reviewer 4:

The reviewer considers that good progress has been made. This project is indicated as early stage per the information on Slide 3. The project looked at three larger municipalities; a smaller or mid-sized dynamic would be of interest.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted collaboration with Idaho National Laboratory and various UC Berkeley institutes; Institute of Transportation Studies (ITS) and Transportation Sustainability Research Center (TSRC). FHWA project with car2go survey and trip data is used for this effort but unclear if any direct collaboration beyond the use of their data took place as part of this effort. The reviewer said the sharing of analysis results was not directly addressed in the presentation but given the relatively small project budget, the final report and journal publication will likely be the extent of it.

Reviewer 2:

The reviewer said the project's products indicate dual use of data sources and complementary analyses by the project partners. The project appears to leverage funding from a previous research and development project.

Reviewer 3:

The reviewer said that the project team has good partners.

Reviewer 4:

The reviewer summarized that this is a 3-year, modestly funded ($375,000), no cost share project which ends in September 2019. There are three team members: Lawrence Berkeley National Laboratory, UC Berkeley, and Idaho National Laboratory, as well as car2go providing data under a previous contract with the U.S. Department of Transportation (DOT) FHWA and other sources of data on the five cities. The roles of the team members have been presented, but the active collaboration and coordination mechanisms are not really discussed. The reviewer said that given the project size and scope, the overall team structure and collaboration is reasonable.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.ar

Reviewer 1:

The reviewer said this project is in its third and last year; end date is September 30, 2019. The remaining work includes developing similar models for Calgary and Vancouver as well as applying observed relationships to another city to estimate the impact of one-way car sharing. The reviewer pointed out that beyond this project, several suggested analyses were mentioned including assessing the net energy implications of micro mobility systems.

Reviewer 2:

The reviewer said that it is encouraging to see more focus on energy use in two of the proposed research tasks. The reviewer would have liked to see more details of the proposed approaches for these tasks to ensure that it is not just "lip service" to analyzing energy use.

Reviewer 3:

The reviewer pointed out that the proposed future research is quite expansive in scope. Specifically, regarding beyond fiscal year 2019, this includes applying similar analysis to other shared mobility modes, analyzing the deeper relationship between public transit energy use and ridership (including developing planning tools for evaluating the efficiency of different shared mobility interventions and their interface with public transit), and analyzing the net energy implications of micro mobility systems (shared bikes, e-bikes, e-scooters). As an alternative to the proposed broader scope, the reviewer suggested considering a narrower and deeper effort, which emphasizes a deep dive into the results already obtained concerning car sharing (plus a hard look to hopefully tease out energy implications). Hopefully, means could be developed to draw more impactful inferences out of the existing data and allow it to be packaged in a way to permit high value for program planning. At this point moving forward, the reviewer said that more definitive/impactful synthesis and packaging of results from the existing project scope (augmented as necessary with additional research) would be more beneficial than a broad expansion into additional areas such as other shared mobility modes and micro-mobility systems. Additionally, somewhat unsettling is that no specific future challenges and barriers have been presented which may suggest that future project pathways have not yet been thoroughly thought out.

Reviewer 4:

The reviewer questioned whether the rental car industry entered into this discussion. Some carshare use cases could be provided by a rental agency for various individuals.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said this project supports the overall DOE objectives as it contributes travel behavior understanding to the EEMS overall workflow of smart mobility, which in turn supports increasing mobility without increasing energy consumption. Hence, directly supporting the VTO goal of reducing petroleum use.

Reviewer 2:

The reviewer said that this project is relevant because DOE wants to increase the knowledge base regarding what drives decisions related to "smart mobility" modes of transportation, including car sharing.

Reviewer 3:

The reviewer noted that this project aims to better understand traveler behavioral patterns and energy implications from shifts in personal travel, including public transit, to emerging transportation modes such as one-way carsharing. One-way carsharing may be complementary to other shared modes (e.g., public transit, TNCs, bikesharing, etc.). A strong understanding of the relationships, implications, and impacts of emerging transportation modes and public transportation is needed to identify appropriate future research and development and implementation of strategies to enhance mobility and minimize energy consumption. As such, knowledge gained through this project does support VTO and DOE goals by supporting transitions to higher transportation mobility with lower energy consumption.

Reviewer 4:

The reviewer has not previously seen much from this segment of society. The reviewer hears frequently about bikeshare and other applications.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer found that allocated resources ($375,000) are sufficient to achieve the project objectives and milestones (five city linear regression models) in a timely fashion (over a 3-year period).

Reviewer 2:

The reviewer remarked the resources provided have resulted in significant progress being made to achieve the project objectives.

Reviewer 3:

The reviewer noted that this is a $375,000, no cost share project. Based on the project scope, utilization of existing survey information (funded by other entities), and no mention of funding constraints, it can be assumed the project is sufficiently resourced and positioned to complete the remaining milestones and requirements.

Reviewer 4:

The reviewer questioned whether this segment represents a significant enough space in transportation modes.

**Presentation Number: eems057
Presentation Title: Urban Traveler –
Changes and Impacts: Mobility
Energy Productivity (MEP) Metric
Principal Investigator: Venu
Garikapali (National Renewable
Energy Laboratory)**

Presenter
Venu Garikapali, National Renewable
Energy Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer noted that mobility energy
productivity (MEP) is a very well
thought out metric that provides a
unified framework for quantifying
mobility and energy impacts of
transportation investments and
technologies. There may be
opportunities for the team to further
enhance the methodology based on the
experience from early applications of
the metric.

Reviewer 2:
The reviewer suggested working with
other external organizations such as the
National Association of City Transportation Officials (NACTO) and the Institute of Transportation Engineers
(ITE) on quantifying metrics and for the tools for evaluation of new mobility technologies.

Reviewer 3:
The reviewer said more information on the quantification of energy and costs, including scope, is required. For
example, the reviewer questioned whether costs include infrastructure and end-user factors, whether they are
based on an entire life cycle, and how are capital investments with finite lives (and various states of remaining
life) considered.

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer said the MEP maps are quite intuitive. Mode choice and activity-based maps are both included.
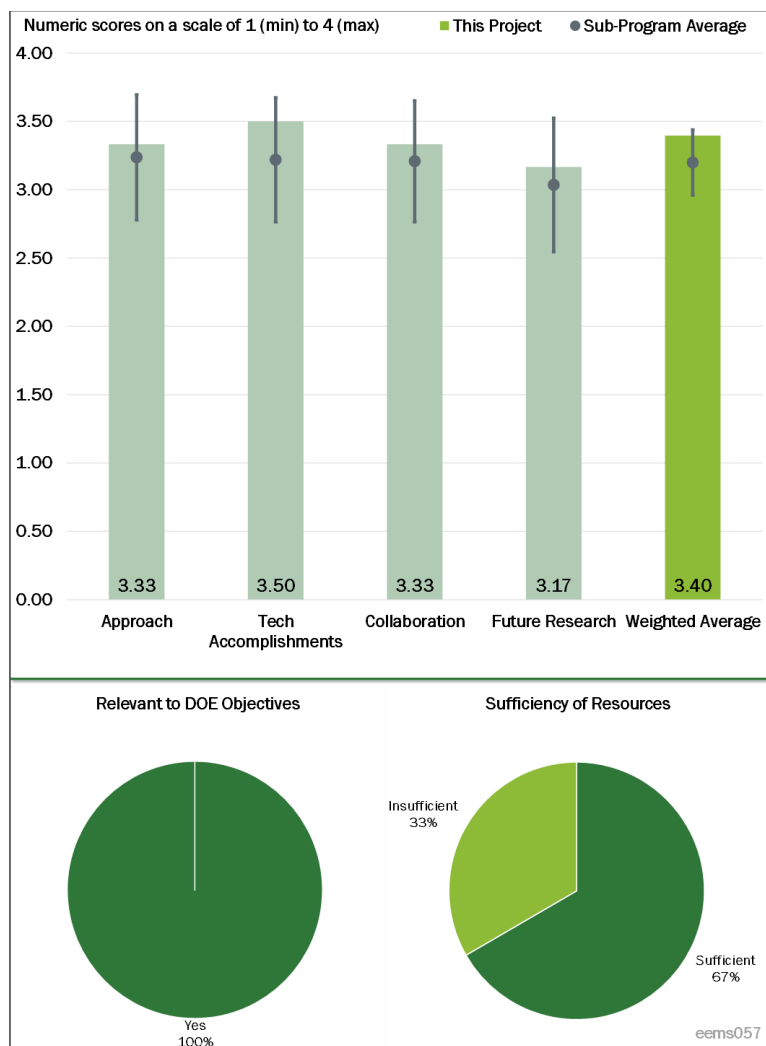Kudos on that!

Figure 3-31 – Presentation Number: eems057 Presentation Title: Urban
Traveler – Changes and Impacts: Mobility Energy Productivity (MEP) Metric
Principal Investigator: Venu Garikapali (National Renewable Energy
Laboratory)

Reviewer 2:

The reviewer noted that the current ability to generate MEP for a variety of scenarios is very valuable. Sensitivity analysis to main factors would be helpful in understanding opportunities to improve MEP. In addition, multi-mode transportation does appear to be currently comprehended. Implementation of this capability is vital to understanding how MEP will change with adoption of TNCs and other disruptive technologies.

Reviewer 3:

The reviewer said all milestones have been met, and the project seems on track to be completed by the end date. The results shown on the slides are interesting. The reviewer suggested showing a case study to illustrate how MEP would change under different transportation investment or technology adoption scenarios.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted that MEP being integrated into modeling tools such as BEAM and the Planning and Operations Language for Agent-based Regional Integrated Simulation (POLARIS) is an evidence of coordination across multiple project teams. The collaboration efforts also go beyond the SMART Consortium. The reviewer appreciates the effort to have MEP become a SMART City metric.

Reviewer 2:

The reviewer said the collaboration was good among the Project Team. The engagement of Metropolitan/Transportation Planning Organizations (MPO/TPO) would have provided better opportunities across the MEP metric discussion.

Reviewer 3:

The reviewer remarked collaboration with transportation partners seems vital to ensure the results and metrics generated are valuable to future customers—transportation providers, city planners, etc. Partnering with Colorado DOT is a good start but it would be valuable to know what learnings and feedback they have provided.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

Some follow-on research has already been initiated. The reviewer commented that enhancing the metric to be able to represent multi-modal travel is critical.

Reviewer 2:

The reviewer noted that Slide 23 explains perfectly a path forward from here.

Reviewer 3:

The reviewer noted that several future research topics were proposed by the presenter. However, it is not clear which are most important, and overall impact of implementing the improvements.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said that the ability to quantify and compare mobility and energy impacts of transportation investments and technologies is critical to DOE in assessing those investments and options.

Reviewer 2:

The reviewer remarked this project appears to have accomplished the task of creating a benchmark to move forward from POLARIS and BEAM. The reviewer suggested considering engaging the NACTO and the ITE. Both organizations are working in this space and can provide insights into steps forward.

Reviewer 3:

The reviewer said yes, the creation of a MEP is a valuable metric for evaluation and development of transportation systems.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said the level of project funding is reasonable. It looks like the project team was able to leverage other resources in the project as well.

Reviewer 2:

The reviewer remarked there appears to be sufficient resources to complete the project.

Reviewer 3:

The reviewer commented that there is no mention of budget moving forward.

Presentation Number: eems058
Presentation Title: Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium Tools and Process Development
Principal Investigator: Aymeric Rousseau (Argonne National Laboratory)

Presenter
Aymeric Rousseau, Argonne National Laboratory

Reviewer Sample Size
A total of five reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:

The reviewer remarked the approach looks good overall, putting the emphasis mainly on integration of existing tools into the SMART workflow framework. There is a good focus on the targeted analysis use cases and aligning tool integration accordingly. Overall, it is very logical and seems well thought out.

Reviewer 2:

The reviewer remarked the team has established a well-thought technical approach aiming at providing answers to key questions. The team might want to clearly state their assumptions made along with the potential limitations.

Reviewer 3:

The reviewer commented the approach of the team seems robust and already appears to be producing interesting, useful results. The inclusion of MEP seems certainly useful. A minor suggestion on the presentation of MEP, it might be helpful to introduce and define MEP with some slides for a hypothetical "extreme" city to illustrate what MEP is showing. As an example, showing MEP overlaid on a city with zero transit above Main Street and massive transit below Main Street would be helpful. Then, building on top of that with other scenarios like massive TNCs in the first quadrant, and only roads with long distances between workplace and homes in the second quadrant. The reviewer suggested familiarizing people on how to interpret MEP and why they even should care in the first place.
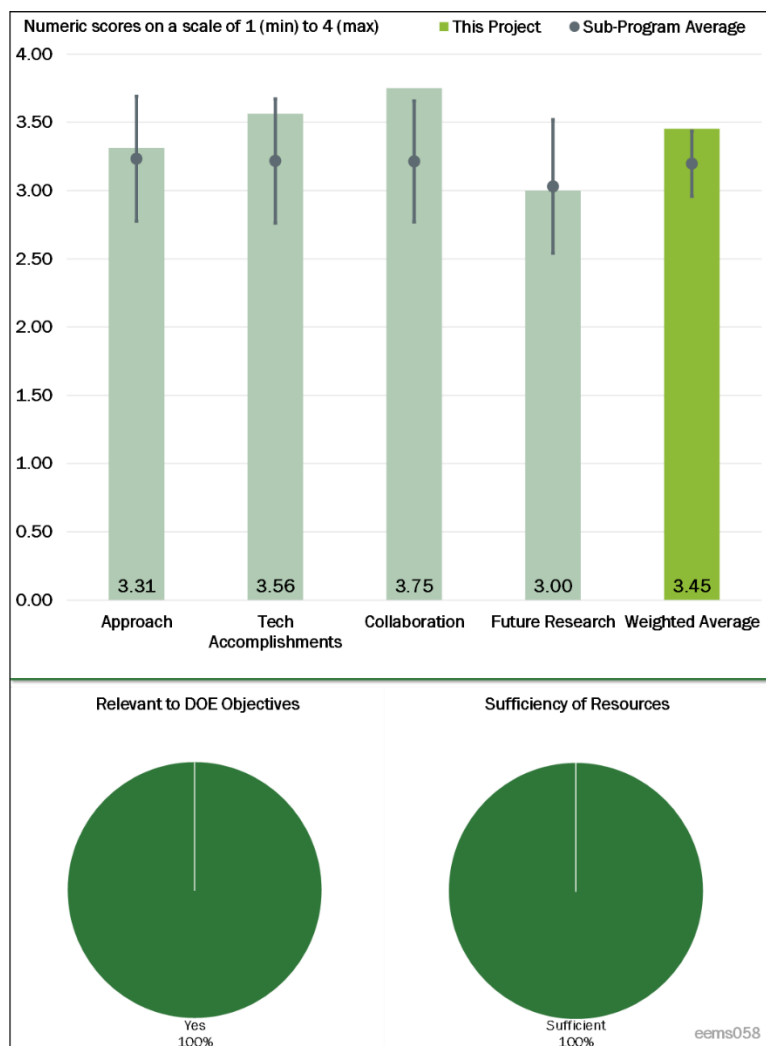

Figure 3-32 – Presentation Number: eems058 Presentation Title: Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium Tools and Process Development Principal Investigator: Aymeric Rousseau (Argonne National Laboratory)

Reviewer 4:

The reviewer said the layout of the approach is understandable. However, specific details of each product covered by the project should be explained. In addition, the reasons why these products are chosen for development should be explained.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer appreciates the focus and attention on model validation that appears to have become embedded in the day-to-day work in POLARIS and the other models. The project team also is to be applauded for having a very modest runtime of 3-4 hours on a laptop and much quicker on HPC/parallel cloud processing. This time is short enough to produce a big data level of scenarios and post-analysis with machine learning techniques to tease out other relationships/outcomes that may not be obvious with only a small number of scenarios. The reviewer pointed out that AMBER also does seem like a necessary addition to the project.

Reviewer 2:

The reviewer said that technical accomplishments are very good, especially the ability to link transportation system level simulation capability with detailed powertrain system simulation capability. That is something that is unique and requires a team with a broad range of skills.

Reviewer 3:

The reviewer said there has been significant progress and results up to this date leveraging capabilities and expertise from different National Laboratories. The team has produced very interesting results and done a comprehensive analysis.

Reviewer 4:

The reviewer noted that the project has been very successful in its accomplishments because it is used by so many EEMS related projects. More clarification on the ease to run simulations standalone or without expert configuration would be helpful. It is not clear if the tools have a corresponding level of documentation and usability to match their capability. In addition, high-level data flows and interfaces between tools should be reported.

Reviewer 5:

The reviewer remarked detailed analysis of VMT due to charging trip needs is not very clear.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted that Slide 38 shows many partners, all with different model or technical contributions. This is probably not an easy project to coordinate, but the outcome looks promising, which might indicate that the collaboration is working well.

The reviewer suggested a matrix of inputs/outputs/features for POLARIS and BEAM that show common attributes, attributes assigned to only one of the two models, and attributes that might not be in either model (but should be).

The reviewer also strongly endorsed the suggestion to model the same city with both POLARIS and BEAM to compare results with the primary goal of comparing and improving each model.

Reviewer 2:

The reviewer said that partnerships and collaborations seem broadly dispersed across laboratories and universities. It looks like the leadership of the team has worked hard to make this happen. There seems to be

overlap with the goals of the BEAM work (EEMS011). It seems that integration of that work to leverage a common platform to assess selected modeling approaches would be helpful.

It appears that there is a productive collaboration across the National Laboratories in this project.

The reviewer noted that the very large number of partners, projects and studies demonstrates a high level of collaboration across the project team.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

The reviewer suggested considering validation of simulation model in the different environments

The reviewer said overall good, but some suggestions. As mentioned earlier, suggest a same-city comparison with BEAM. Also, suggest enhancing the visualization output beyond what look like Excel charts manually created. Perhaps linking outputs to Tableau or other types of visualizations would be very effective for dynamic data shows. The reviewer said the geographic information systems (GIS) side looks good. However, there is opportunity visualizing the non-GIS data. Finally, the characterization that safety modeling is simpler than energy analysis is simply not true. The reviewer said it was mentioned that safety analysis only cares if the child is hit or not in a binary fashion. There is so much more to it than that. In fact, the reviewer would argue safety analysis is more complicated than energy analysis with consideration of severity of injuries, demographic exposure concerns, vulnerable road user considerations, safety equipment on vehicles and within the infrastructure varying road segment by road segment, etc. Therefore, the reviewer suggested that future research start thinking about how to incorporate (or perhaps using POLARIS in concert with a DOT model) some level of safety analysis as well, because that is clearly also affected in these future scenarios.

The reviewer said there was not a lot of detail covered regarding further work. This may be because the project ends later this year. The next steps outlined seem to make sense.

The reviewer remarked the team should elaborate a bit more on the next research steps and coordinate with DOE to make sure that the future research is well-aligned with EEMS goals.

The reviewer commented directionally, the proposed research topics make sense. However, a more specific rollout of features and capabilities or analysis plans should be included. The specific details of the integration of the tools into AMBER could be explained better.

Question 5: Relevance—Does this project support the overall DOE objectives?

The reviewer remarked this project absolutely supports DOE objectives by incorporating MEP modeling and overall modeling of future mobility scenarios.

Reviewer 2:

The reviewer said the tools and processes are well aligned with the goals of implementing the SMART workflow and establishing important analytical capability for assessing energy impacts of alternative mobility scenarios.

Reviewer 3:

The reviewer commented the project provides an excellent set of modeling tools that will be very useful to the community.

Reviewer 4:

The reviewer said the simulation tools and process are an integral part of all EEMS projects.

Reviewer 5:

The reviewer commented that the project is in line with DOE target to increase transportation efficiency through vehicle controls.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer found that the project resources appear sufficient due to the completion of milestones to-date. However, this is such an important project that additional resources should be allocated if justified by the project team.

Reviewer 2:

The reviewer remarked significant progress from significant funding seems evident. It does not seem excessive nor insufficient.

Reviewer 3:

The reviewer commented the budget allocated looks reasonable for the scope of the work. The project looks to be on target to finish this year as planned, which is another indication that project resources are well aligned to plans.

Reviewer 4:

The reviewer said it seems that the team has the resources they need to complete the project.

Reviewer 5:

The reviewer remarked there is no evidence for missing or excessive resources.

Presentation Number: eems059
Presentation Title: Experimental Evaluation of Cooperative Automated Cruise Control (ACC) for Passenger Cars
Principal Investigator: Eric Rask (Argonne National Laboratory)

Presenter
Eric Rask, Argonne National Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer said this project seems to be well focused on making a system of vehicles that can allow for testing of cooperative adaptive cruise control (CACC) control strategy development, which will lead to realistic fuel economy estimations from this technology. The fact that the team is focusing on vehicles with multiple powertrain technologies also sets this work apart and makes it much more relevant than most of the current work in this area. The reviewer does not see any significant changes that are needed in approach. What the team is trying to do is difficult, and the reviewer would expect it to take a lot more funding than they are receiving. The reviewer stated that this clearly shows that the team is leveraging their existing work and partnerships very well. Great job!
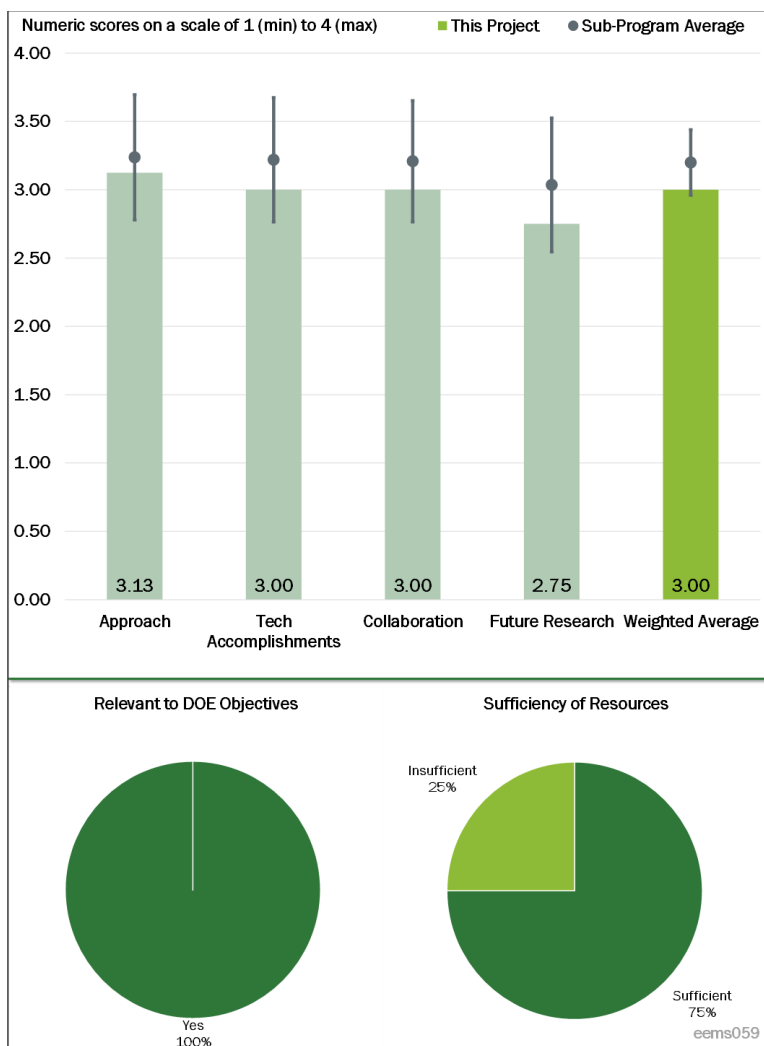

Figure 3-33 – Presentation Number: eems059 Presentation Title: Experimental Evaluation of Cooperative Automated Cruise Control (ACC) for Passenger Cars Principal Investigator: Eric Rask (Argonne National Laboratory)

Reviewer 2:
The reviewer commented the approach overall is fine if the goal is to essentially "hack" vehicles so that they can be part of a CACC test track data gathering initiative. (The reviewer uses the word hack in the positive sense of the word as that really is what this is about since OEMs are not involved). The project team did state that they are, on some level, purposely not working with OEMs so that they learn enough to apply this to a variety of OEMs somewhat generically as well as to a variety of vehicle types. The reviewer suggested that this creates a lot of extra work and may not even yield robust results (but it is possible).

Reviewer 3:

The reviewer said that adopting four vehicles with different types of powertrains can help find out the control strategy differences in automating vehicles with different powertrains. On-tracking testing of four-vehicle CACC can provide experimental data and evaluations of energy consumption by CAVs.

The vehicle automation for CACC needs a more refined modelling and control approach to achieve better accuracy in control and better evaluation in energy consumption. In addition, accurate measurement of power consumption for different types of powertrains needs to be designed.

Reviewer 4:

The reviewer said that the project should yield very valuable data to support the SMART simulation framework. While the desire to understand the differences in operation and behavior between different vehicles and propulsion systems is admirable, it does add an extra layer of complexity to the project. Because much of the effort will be in interfacing with the vehicles for control, focusing on one platform would enable more time to work on CACC controls.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer pointed out that a lot of progress has clearly been made getting inside these vehicles to enable torque control (both propulsion and braking) as well as intercepting ACC and other vehicle systems in the process.

Reviewer 2:

The reviewer remarked the team has given results of speed tracking for one vehicle. Compared to the milestones and timeline, it looks that the project has lagged behind a lot. Automation of other three cars, communication setup, CACC development, and test track evaluation all need significant efforts to accomplish.

Reviewer 3:

The reviewer said the accomplished low-level interface work to control the subject vehicles appears to be successful enough to take the next step in CACC controls. The project team is encouraged to partner with OEMs to more readily obtain this capability, so work can be focused on CACC development.

Reviewer 4:

The reviewer pointed out that the project seems focused on integrating control override systems into a wide variety of vehicles. This is a difficult challenge, so progress is expected to be slow. It would not be a surprise if this work was lagging behind significantly because overriding vehicle control systems always generates surprises that are difficult or impossible to anticipate without in-depth knowledge of the system from the OEM.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer remarked that the collaboration between Argonne National Laboratory and Lawrence Berkeley National Laboratory seems close. The collaboration with Idaho National Laboratory is limited. Data dissemination will benefit other researchers in the field.

Reviewer 2:

The reviewer remarked the project team seems to be working quite well together. The progress achieved at the low project cost shows that partnerships and previous expertise are being well utilized. In this reviewer's opinion, the most time consuming part of this project occurs at Argonne National Laboratory, with vehicle prep, and the bulk of the budget is there, so the project seems to be well structured.

Reviewer 3:

The reviewer said the level of collaboration and work split looks appropriate.

Reviewer 4:

The reviewer noted that the project team seems to have made a conscious choice to not partner with any automotive OEMs. The reviewer said that this is a mistake. OEMs would have the ability to significantly reduce the work and cost given the goals of the project by providing interfacing information and important algorithm and calibration considerations. Adding OEMs with various vehicle classes would also make sense, and should be more important than proving whether one can hack a production vehicle to make it have CACC functionality.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer remarked the proposed work of vehicle lateral controls is very important for evaluating energy consumption in more complex CAV tasks. The migration of safety risks in multi-vehicle track tests in complex tasks should be planned.

Reviewer 2:

Future directions seem strong, but the reviewer would focus the most effort on getting a multi-vehicle CACC test capability in place. Once the test bed (multiple vehicles on track and communicating) is in place then tremendous amounts of new data/knowledge will be generated. Getting a working test setup should clearly be the top priority because the reviewer assumes that most of the modeling and simulation work in this area is over-simplified significantly, so adding real data from real vehicles will be eye opening. Having this test-bed in place will then allow for follow on projects related to control for fuel economy improvement, safety, etc. The reviewer would also not dwell too much on some of the speed tracking errors that have been observed. These errors are probably inevitable, and the reviewer expects they will help lead to the development of stochastic optimal control strategies, which are needed in this case anyway. They will also force simulation-based projects to consider that vehicles and vehicle control are not perfect, and that there is always the possibility unexpected behavior (from vehicles or drivers) that need to be taken seriously. Great job overall with this project, it is filling a large gap in this area.

Reviewer 3:

The reviewer said the proposed research scope seems very aggressive. The reviewer recommended focusing on areas that will help understand energy opportunities. Perception activities should be leveraged from other teams that have already developed this capability. Lane changing should only be explored as it pertains to a potential increase in efficiency. The reviewer said that coordination with mainline vehicles also seems to be a stretch objective. Simulation should be first used to determine if this capability has a large impact on total energy.

Reviewer 4:

The reviewer expected to see information from OEMs and/or form partnerships with OEMs. The proposed research is mostly around advanced vehicle hacking. There are a few other areas of future research the reviewer suggested for future consideration. Based on the project team's hacking success, consider writing a paper addressing cyber physical security concerns that many people with the right skills could also hack their cars to add functionality like this. Perhaps there are some lessons here to ensure road safety is maintained by exploring whether it is true that anyone with a certain set of skills could hack their own vehicle. (As a reference, GM just came out with an engine control unit that will not allow itself to be reflashed or altered except by GM, and has protections built in that will brick itself if it detects hacking).

The reviewer remarked safety assessment incorporated to qualitatively or quantitatively assess safety of various scenarios ultimately modeled. For example, given some CACC scenario for vehicle mix, following distances, reaction times, percentage penetration, etc., the reviewer questioned the relative safety of that scenario along with the already-planned energy implications. Safety assessment of the hacks themselves. OEMs spend millions or billions of dollars on safety research and development to ensure CACC-like systems have adequately addressed failure modes, fault tolerance, hazard mitigation, etc. (see ISO26262, ASIL, etc.). These hacks, updated without OEM input and therefore lacking full knowledge of the hardware and software, may not be safe in and of themselves unless a similar design and analysis effort has been conducted.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer said this project definitely supports the overall DOE objectives of generating real CACC data for inclusion into models/simulations to calculate energy implications of CACC systems.

Reviewer 2:
The reviewer remarked yes, the project supports the DOE objectives by evaluating energy consumption of CAVs and different types of powertrains in CAVs.

Reviewer 3:
The reviewer said yes, this project works in the direction of developing coordinated vehicle control strategies for vehicles with multiple powertrain types and vehicle dynamics behavior. This is an area that can probably be exploited to greatly improve fuel economy, but is not likely to be studied too closely by vehicle manufacturers. The reviewer would expect OEMs to take an "optimize for my vehicle first" approach, which is not a system optimum, so the current research could one day lead to a list of CACC behavior standards (basically, everyone might give a little for a larger benefit to society).

Reviewer 4:
The reviewer commented that CACC enabled vehicles present an opportunity for energy improvements before vehicle to infrastructure (V2I) technology is rolled out at scale.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said resources do seem sufficient at this point, not excessive nor insufficient.

Reviewer 2:
The reviewer remarked sufficient, but the reviewer would expect this to take more funding than the team has received. The team is clearly leveraging years of expertise into overriding vehicle control systems.

Reviewer 3:
The reviewer noted that the proposed project deliverables and future work are large in scope. It is likely the resources allocated are insufficient to fully explore the energy opportunities in this project.

Reviewer 4:
The reviewer said the resources look sufficient, but the lag in development is a big concern.

**Presentation Number: eems060
Presentation Title: Agent-Based
Model and Data Collection for
Inter/Intra-city Freight Movement
Principal Investigator: Monique
Stinson (Argonne National
Laboratory)**

Presenter
Monique Stinson, Argonne National
Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer was unclear whether top-
down data for truck trips will provide
needed detail. The approach was not
explained clearly, especially Slide 9.

Reviewer 2:
The reviewer remarked the approach is
solid, but benefited from a very short
timeline of 1 year.

Reviewer 3:
The reviewer remarked the top-down
approach taken by this project is
essential for the scope it is attempting to
understand, addressing intercity well as
intra-regional truck/weight movements in response to changing e-commerce. The study design manages spatial
disaggregation utilizing POLARIS data, although freight analysis framework (FAF) seems only to be used as a
scaler.

Figure 3-34 – Presentation Number: eems060 Presentation Title: Agent-
Based Model and Data Collection for Inter/Intra-city Freight Movement
Principal Investigator: Monique Stinson (Argonne National Laboratory)

The reviewer noted that the focus of this study on heavy-duty vehicle (HDV) and medium-duty vehicle (MDV)
movement through intra-regional (urban) areas seems problematic for study modeling the effect of e-
commerce on intra-regional freight energy use. LDV, even passenger cars, have space-efficiency value in
congested areas or where lanes are narrow and curb access is limited; the context of how MDV and LDV fare
as technologies, prices, and overall levels of congestion change seem missing.

The reviewer remarked an agent-based model requires a representation of the agent's objective functions.
While this may be implicit in data on driver behavior, supplier/freight companies seeking to maximize profits
would presumably be relatively price-sensitive in how they position themselves to compete for market share.
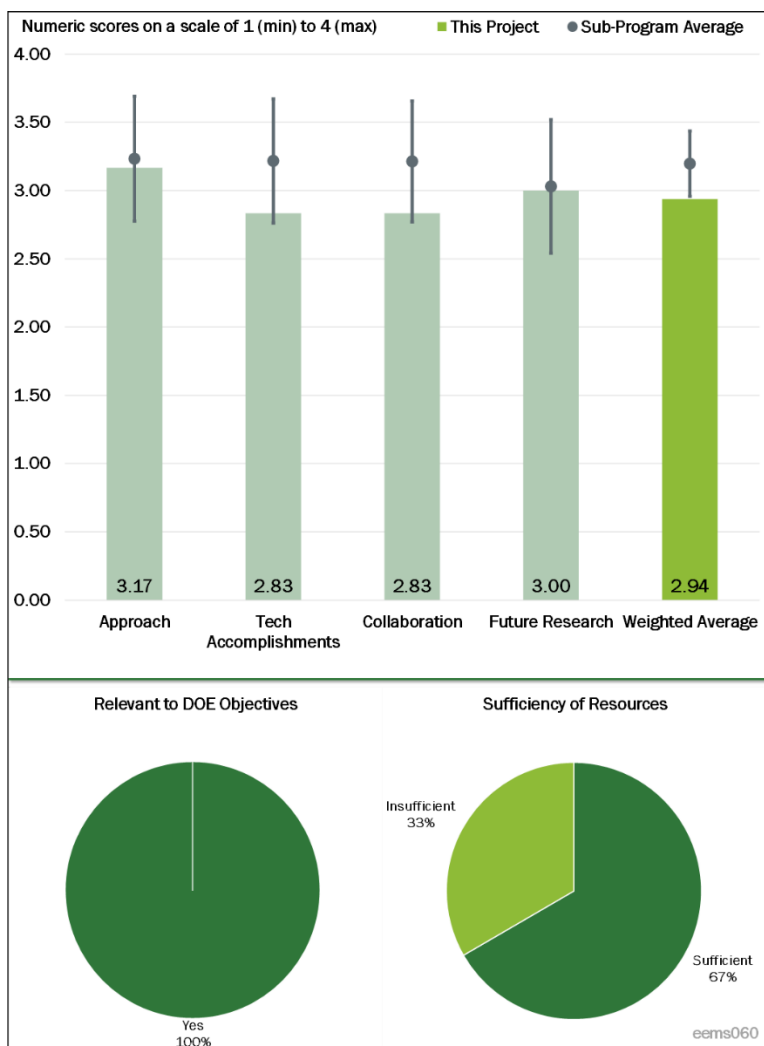
Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer commented that not enough details on scenarios are being studied. Emphasis on parcel delivery is important, but should not be sole method of verifying the model. Slide 15 indicates that heavy-duty trucks are quite important for energy analysis, yet nothing was presented to support work in this area.

Reviewer 2:

The reviewer remarked the project is delivering accomplishments against objectives. It is a difficult and challenging problem, and the team is approaching it with thought and details.

Reviewer 3:

The reviewer was unclear why parcel/commercial vehicle trips (trips or VMT) are assigned uniform start times, including during rush hour. The reviewer questioned how firms' time costs are factored in. It is not clear why e-commerce deliveries would be concentrated in daytime. The concept of a "potential solution" being off-hour delivery suggests that the market pressures that would shift deliveries out of high-cost time periods are not being reflected, as one would expect in an agent-based (incentive-based) model.

The reviewer said the model on Slide 13 appears to significantly underestimate HDT travel on high-capacity roads and overestimate local road travel. While this may not net out to a significant difference in VMT or fuel share, it warrants investigation, especially over the representation in the model of time and price elasticities across freight and shipping agents.

The reviewer was unclear what behavioral assumptions are reflected in the VMT results for the e-commerce scenarios. The reviewer questioned how often e-shopping returns are picked up, and whether there is a "take-back" effect with some newfound household time spent driving somewhere else. The reviewer also questioned whether there are lower brick-and-mortar retail rents.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted a good list of collaborators. The reviewer suggested that the project may need some private industry assistance.

Reviewer 2:

The reviewer said more collaboration opportunities will emerge as sub-projects take shape next fiscal year.

Reviewer 3:

The reviewer remarked the project appears to have partners with logistic capabilities, which of course is critical for this study. The project seems to be lacking from contributions associated with the economic and behavior sciences to inform assumptions about the factors that motivate firm and household behavior.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said that a good list of challenges and future research was presented.

Reviewer 2:

The reviewer said that the project team knows where to head next with analysis, tool development, and stakeholder engagement.

The reviewer said the proposed research questions are certainly relevant in themselves, but the meaningfulness of the results would depend entirely on how well the project is modeling the different incentives and behavioral responses of the freight and household agents. This means understanding how they respond to external factors, such as new technology or changing market conditions, such as prices or market share.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer said vital to the goal of smart mobility.

Reviewer 2:
The reviewer said continue exploring truck-to-truck intermodal. It is not only about the equipment and about the trips, but how the freight can be quickly moved to different types of trucks, i.e., smaller as the route gets more urban and dense.

Reviewer 3:
The reviewer noted that understanding the interplay between retail shopping VMT and commercial parcel delivery VMT is critical both to understand the net effect on energy use, but also to understanding changes in the performance of the transportation system.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
Sufficient, but the reviewer stated that this subject could get more funding and resources given its potential.

Reviewer 2:
The reviewer said that a lack of resources does not seem to be the limiting factor for the project.

Reviewer 3:
The reviewer said it does not appear the project will finish on time.

Presentation Number: eems061
Presentation Title: Regional Mobility – Chattanooga
Principal Investigator: Jibonananda Sanyal (Oak Ridge National Laboratory)

Presenter
Jibonananda Sanyal, Oak Ridge National Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer remarked this project proposes to develop of digital "twin" of city transportation system, which can be used for agencies to best control of city transportation system, infrastructure and customers to be aware of the coming traffic information. The reviewer said the work proposed is very challenging. If the project succeeds, this research will provide a very useful tool in optimizing the operation of the transportation system.
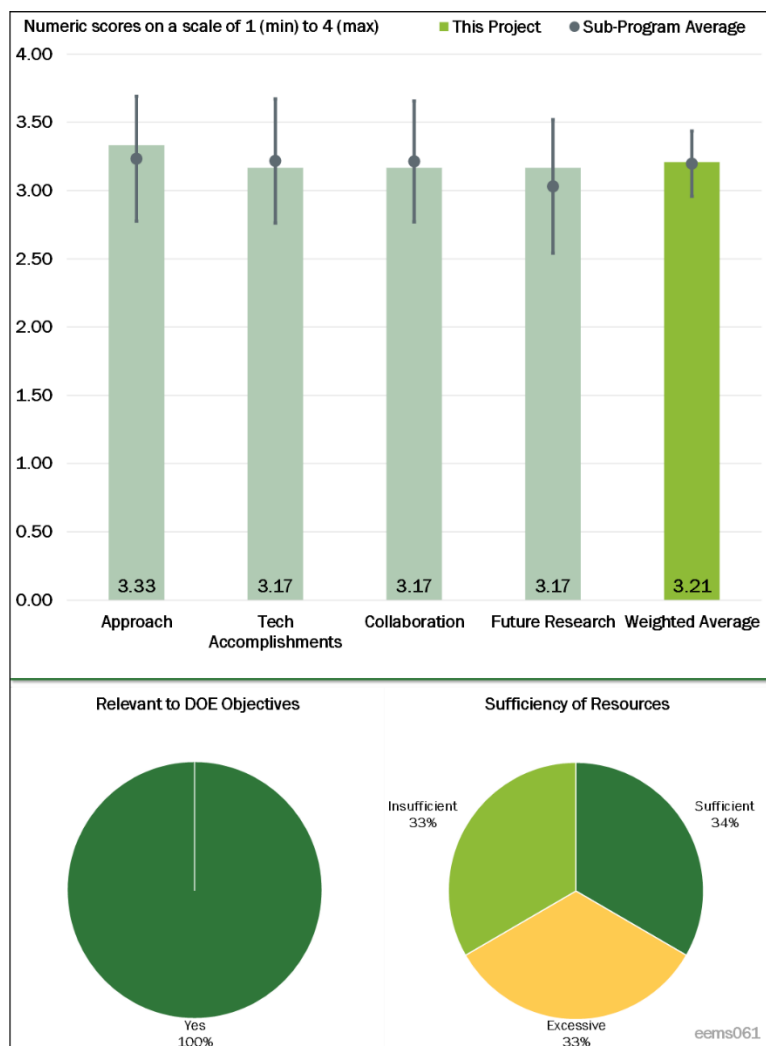

Figure 3-35 – Presentation Number: eems061 Presentation Title: Regional Mobility – Chattanooga Principal Investigator: Jibonananda Sanyal (Oak Ridge National Laboratory)

Reviewer 2:
The reviewer said the approach to performing the work is good, given the large regional challenge that the project is undertaking. If the project is successful through this approach, the base barrier of lack of observability about the region's transportation energy system could be addressed. It should be noted that the project could benefit from setting a more realistic goal. As stated, the project team noted that the goal of 20% is not realistic, and perhaps 2% would have been a better target given all of the unknowns of the project.

Reviewer 3:
The reviewer commented the project team has an idea of how to use computing, but have not yet put all the pieces together on where they are going to get information to feed into the computer for it to run scenarios. About the input information mentioned, the team admitted it has not yet been completely acquired.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer remarked this team is making progress following the schedule.

Reviewer 2:

The reviewer said the project team has identified sources for their input information from Chattanooga traffic resources, but have not gotten into the project far enough to analyze the data.

Reviewer 3:

The reviewer said the project is still in early stages, but it is clear that foundational progress has been made in establishing a data exchange plan among project partners and completing a baseline measure of energy usage. The project still has only requested data from many key sources, indicating that final ability to obtain data is still in flux for important data points to complete project.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer said this project team is working with its partners in having the work done. However, the exact contribution between National Renewable Energy Laboratory and Oak Ridge National Laboratory is not clear.

Reviewer 2:

The reviewer said the team appears to have the right partners involved in obtaining accurate information. It also appears all entities are supplying the information, but at the time of the presentation, the team had not met with the high-power computer folks to figure out the scenarios.

Reviewer 3:

The reviewer commented the project foundation of establishing data exchange plan and all non-disclosure agreements (NDAs) and other associated legal and technical requirements shows solid collaboration and coordination among partners. The presenter noted that obtaining real time data feeds from the city partner has been very challenging, so this is something that should be addressed to continue good collaboration.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said this project is on track to complete future work successfully.

Reviewer 2:

The reviewer said this team proposed the future research work. However, the reviewer did not find a research plan necessary for mitigating/overcoming the remaining challenges and barriers presented in Slide 19.

Reviewer 3:

The reviewer remarked it is hard to tell right now, but there may be difficulty securing information from freight fleets on their movements ahead of time. Real time adjustments to traffic may be an issue with the age of signals equipment. In addition, it seems to duplicate the Google directions, which already adjust route options in real time.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said the work proposed is relevant to DOE's objective in reducing energy consumption of transportation systems.

Reviewer 2:

The reviewer remarked this technology supports the VTO if the future project also encompasses ideas of how to make this technology vehicle to infrastructure and possibly take the human factor out of the decision making.

Reviewer 3:

The reviewer commented this project supports overall DOE objectives to conduct research to support the improvement of energy efficient mobility at a regional level.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer remarked that resources seem sufficient. However, it was unclear if data sources are already paid for out of the existing budget or if the project team has secured agreements that data would be provided in-kind. If there are portions of data that have not yet been obtained but require funding to secure, in particular INRIX or Tom-Tom which are still in discussion, the team may not have adequate resources to obtain.

Reviewer 2:

The reviewer remarked this team has appropriate funding in completing the research work needed. The research team and partners have sufficient facility for this team to get the data and platform needed for the completion of this project.

Reviewer 3:

The reviewer remarked until the team incorporates the HPC, none of this can be verified as a viable option. Even when the computer is involved, a good simulation must be produced and the lack of signal control needs to be addressed.

Presentation Number: eems062
Presentation Title: Deep-Learning for Automated Vehicle (AV) Development Principal Investigator: Robert Patton (Oak Ridge National Laboratory)

Presenter
Robert Patton, Oak Ridge National Laboratory

Reviewer Sample Size
A total of five reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer remarked the overall approach of leveraging modeling and simulation, HPC, and artificial computing to enable rapid development of perception, control and communications algorithms for CAV is inspiring. Tasks and milestones are also clearly planned for the first year. Some details need to be further refined.

The reviewer said the detailed approaches to address energy issues are unclear. The proposed MENNDL approach is a highly application-/scenario-dependent approach, which means its scalability to new
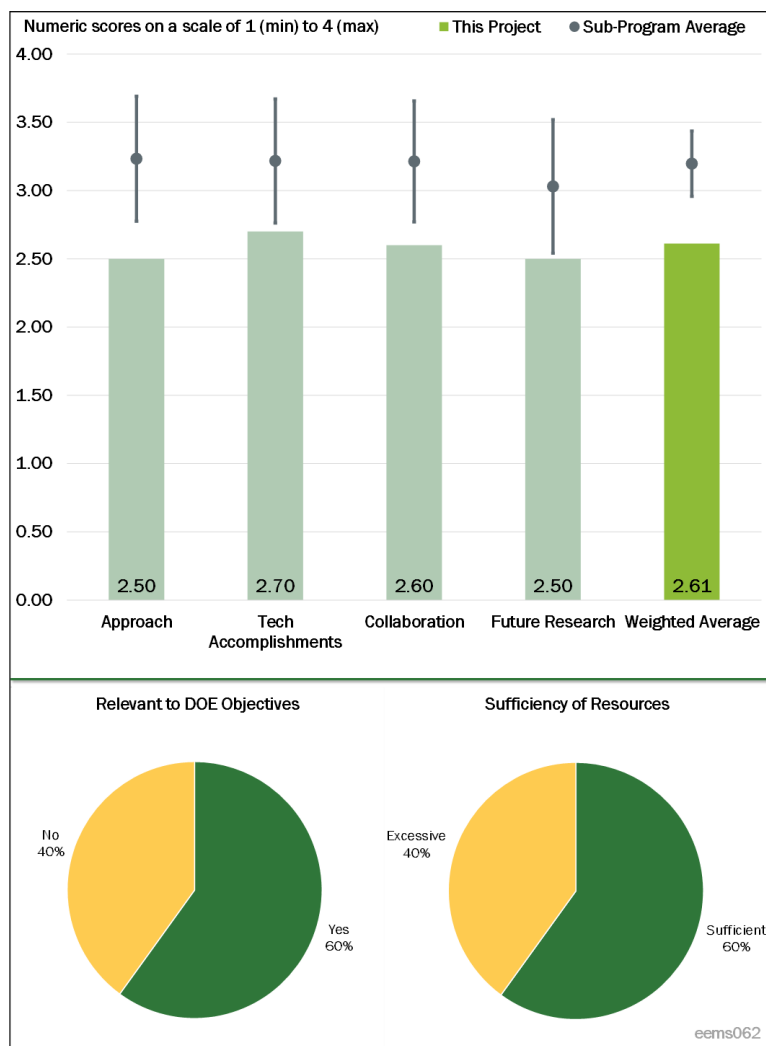

Figure 3-36 – Presentation Number: eems062 Presentation Title: Deep-Learning for Automated Vehicle (AV) Development Principal Investigator: Robert Patton (Oak Ridge National Laboratory)

applications/scenarios could be even than general machine learning approaches seeing the fact that the scalability of general machine learning approaches are already limited. There are many existing annotated vehicle driving data sets in both realistic and simulated environments for machine learning usage. The reviewer said the approach should leverage these existing data in addition to their own data collection in CARLA simulation.

Reviewer 2:
The reviewer said the technical work that is being performed seems strong for this project, but the focus of the project seems disconnected from DOE goals. The project seems to have minimal to no focus on energy savings, at least how it is framed currently. This project should probably have much more focus on powertrain control of AVs. There is a lot of published research available on powertrain fuel economy gains associated with having a preview horizon (e.g., dynamic programming, optimal control, etc.). This is also dependent upon powertrain layout. The reviewer said this work, while great, does not seem to be adding to that knowledge.

It should also be made clear why there is a significant advantage to combining machine-learning algorithms from the different steps into one. This may make it difficult to develop solutions in parallel (something

important to vehicle development teams), and can generate large problems if an issue is found at one point and the entire system needs to be retrained. The reviewer said that clear and justified reasoning for why this work is being done and how much energy could be saved from it was not provided.

Reviewer 3:

The reviewer remarked, generally, the deep learning approach seems to be prevailing. Almost everyone is deploying this model agnostic method for AVs. It is understandable the project is still at the early stage, although the reviewer did not vision a clear path or more technical details to overcome the potential challenges. In addition, there are two major questions from the reviewer: whether the framework would be to fuse different sources of sensor data, and what the goal is. A couple additional questions are whether the project plans to achieve Level 4 or Level 5 autonomy, and how to distinguish this research from other on-going research (especially those by industry).

Reviewer 4:

The reviewer commented the barriers identified are related to machine learning. From this perspective, the project was designed to address these barriers. The question is whether these barriers are true barriers toward achieving the DOE objectives, or a sub-set of objectives. The machine learning models are developed based on a simulated driving environment, CARLA. It is not clear whether CARLA can create and simulate unexpected scenarios that we frequently see in real-world traffic. In addition, the team needs to assess the state-of-the-art with industry. The reviewer questioned whether industry already built models using simulated environments.

Reviewer 5:

The reviewer stated that the project seems unfocused. Some broad research questions have been posed with no structured plan for attacking them. It is not clear what the metrics for success are for the work. It looks like researchers are trying out different ideas they have and seeing what happens.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer said the project is within the first 6 months of the project start. It has generated results that are consistent with the milestones.

Reviewer 2:

The reviewer remarked the project has just recently started so there are no technical accomplishments to report yet. It is hard to judge progress given the open-ended nature of the questions the project team are trying to address. The reviewer said the team seems to be trying to define a better approach to machine learning for AV's. If that is the case, then the project should include some level of comparison with existing approaches and some way to measure improvements.

Reviewer 3:

The reviewer commented the team has made some progress in setting up CARLA to try out existing YOLO deep learning package for object detection. However, not many significant contributions towards the proposed goal are found. It is understandable that the project is in its early stage, but it looks that the full implementations of machine learning for sensing, perception, and control in fiscal year 2019 would still be a long way to go.

Reviewer 4:

The reviewer remarked accomplishments are good, complex algorithms have been developed in a short period. This is a massive research area, with endless problems to solve. The reviewer suggested making it clear when this project is going to be finished.

There are some concerns that need to be addressed, although the reviewer understood it is still at the early stage of this project.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer said the project team should seek out to industry partners to get real world test data.

Reviewer 2:
The reviewer noted that the project looks to be between Oak Ridge National Laboratory and the National Renewable Energy Laboratory. It looks like it could benefit from broader collaboration with outside partners who are directly involved with automated driving systems design and development for AV's and who bring additional expertise in machine learning.

Reviewer 3:
The reviewer said collaboration and interaction between the Oak Ridge National Laboratory team and the National Renewable Energy Laboratory team are unclear. The project team should seek more collaborations to acquire annotated data sets for machine learning in vehicle driving to facilitate the proposed work.

Reviewer 4:
The reviewer remarked that current collaboration seems sufficient, but it is highly recommended to seek additional partners for this work. For example, Siemens PreScan is already on the market and contains a lot of sensor data, including noise and variable scene (poorly painted lines, etc.). Using an open source software that might be very far behind commercial packages may be slowing the project down. Also, with as active as this area is, the reviewer would expect that companies would be lining up to be part of this work.

Reviewer 5:
The MENNDL developed by the team is definitely a strength, but some concerns remain for the implementation of the algorithm in a real vehicle. More concerns are related to handling the corner cases in a complex real-world situation.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that the proposed future is focused on the machine learning algorithm, not directly related to AVs.

Reviewer 2:
The reviewer said the proposed work was a list of broad research questions and there was no plan proposed for how to address these.

Reviewer 3:
The reviewer remarked the proposed research scope is broad and many challenges are pointed out. However, detailed approaches to address these challenges are unclear. It looks to be very challenging to address these open questions. The reviewer said a realistic and achievable future research plan is needed.

Reviewer 4:
The reviewer noted that there are a large number of possible future tasks provided, all of which are major projects. The reviewer suggested narrowing the future work scope to clearly meet the original project

objectives. Make it clear what your chunk of the problem is and focus on that. It seems like the team's strengths are in making this process parallel and training models faster. The neural network "calibration" code seems to be something very useful for industry as well.

Reviewer 5:

The reviewer said the proposed future steps by the project team are definitely some challenges to overcome, but there are still more than what has been listed here. It is already not just pure simulation as it was more than a decade ago. More realistic scenario testing and consideration of complex constraints are required and a clearer path to achieve the final goal should be presented to gain the reviewer's confidence.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said yes, but the project needs to make the connection to energy savings significantly clearer. Generating "preview" information for a powertrain significantly improves powertrain efficiency (in combination with optimal control), so this project could have a clear benefit to energy usage reduction.

Reviewer 2:

The reviewer remarked the project, if successful, would definitely help leverage DOE's the state-of-the-practice in the AV or CAV related research. If such a great platform is developed, then more applied CAV research can be built upon it.

Reviewer 3:

The reviewer pointed out that the project is focused on machine learning. Specifically, machine learning models are built on simulated automated driving. The relationship to overall DOE objectives is only second order, not direct.

Reviewer 4:

The reviewer remarked relevance to the EEMS goals is hard to see. The focus seems to be on machine learning methodologies for designing automated driving systems. There was very little about energy usage and energy impacts.

Reviewer 5:

The reviewer said the proposed challenges and goal are relevant. However, the relevance between the presented approaches and energy issues is not very clear.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer remarked the CARLA simulation is sufficient to generate simulated driving data. The team should also leverage existing realistic data sets. In addition, resources for machine learning software for control and communications and hardware for HPC are unclear.

Reviewer 2:

The reviewer said resources seem sufficient, but the project team might want to try to team up with a commercial software company to keep the team from solving the same problems they may already have addressed.

Reviewer 3:

The reviewer remarked from the algorithm and computational power perspectives, the resources should be more than enough. However, the reviewer is a bit concerned about the implementation on a real vehicle.

Reviewer 4:

The reviewer said for $2.9 million, the project team needs to connect with industry. Building a machine-learning algorithm on simulated data does not need that much money.

Reviewer 5:

The reviewer said excessive amount of funding given issues highlighted in comments for previous questions.

**Presentation Number: eems063
Presentation Title: Ubiquitous Traffic
Volume Estimation through Machine
Learning Procedure
Principal Investigator: Venu
Garikapati (National Renewable
Energy Laboratory)**

Presenter

Stanley Young, National Renewable
Energy Laboratory

Reviewer Sample Size

A total of two reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:

The reviewer remarked this project
applies machine learning algorithms in
estimating traffic volume using as
inputs probe traffic data, road
characteristics, weather information, etc.
Counting stations are used for training
and validation using cross validation
algorithms. The overall methodology
seems to be well thought out.

Reviewer 2:

The reviewer remarked the project's
approach leverages real-time data
sources that are spatially diverse and the
project objectives will likely contribute
to advancing the state-of-the-art for affordable and practical traffic management systems. The approach also
has potential to develop tools that will be able to take inputs from CAVS and provide information that the
traffic management system can use to have CAVS increase the energy efficiency of the region's transportation
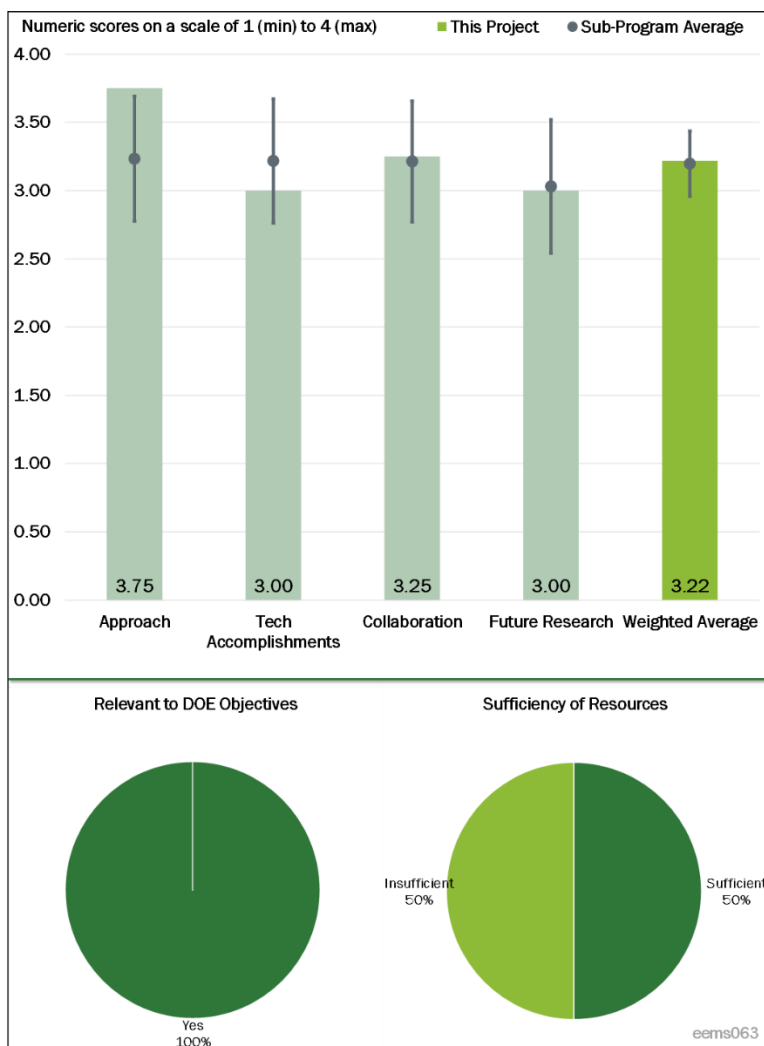network.

Figure 3-37 – Presentation Number: eems063 Presentation Title:
Ubiquitous Traffic Volume Estimation through Machine Learning Procedure
Principal Investigator: Venu Garikapati (National Renewable Energy
Laboratory)

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:

The reviewer noted that the project seems to have taken 6 months to execute the project agreement with
commercial partners. As such, the project started middle March 2019.

The reviewer said it is still early, but the project appears to have a clear work plan and is appropriately prioritizing the long pole in the tent. The initial comparison results from the three learning algorithms are a good indicator that this project will reach its objectives.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer said the project involves a large number of collaborators, state DOTs, universities, and a commercial company. Because the project is at its beginning, there is no evidence to evaluate collaboration across the project team.

Reviewer 2:
The reviewer said results to date have limited partner interactions but this project has excellent collaboration in its work plan.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that the team outlined a number of topics for future work. This reviewer suggested that the project team take into account of other possible forms data as input for volume prediction. Such data may include C2C and C2V communications in the traffic networks.

Reviewer 2:
The reviewer said the project presentation includes a logical progression of future research but is lacking in discussion regarding mitigating risk by providing alternate development pathways.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer remarked this project is relevant to DOE's objective to develop technologies that have potential to improve the energy efficiency of CAVS. Tools that reduce the cost of gathering data regarding transportation network states and loading are useful for modeling of CAVs transportation with potential to benefit operational traffic network management systems.

Reviewer 2:
The reviewer commented accurate traffic volume estimation supports planning of transportation infrastructure and traffic management, which leads to improved mobility and reduced fuel consumption.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said this project could likely use more funding to accomplish the validation of the algorithms across all the state DOT partners/locations that the team has targeted and to develop vehicle classification capabilities that work off traffic camera images/video.

Reviewer 2:
The reviewer noted that the match to the DOE support is 1 to 1.

**Presentation Number: eems064
Presentation Title: Modeling
Connected and Automated Vehicles
(CAVs) Transitions Dynamics and
Identifying Tipping Points
Principal Investigator: Jeff Gonder
(National Renewable Energy
Laboratory)**

Presenter
Jeff Gonder, National Renewable
Energy Laboratory

Reviewer Sample Size
A total of one reviewer evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer pointed out that the
objective of this project is to determine
how the transition and end state for
CAV adoption and energy outcomes
depend upon cost, technology, and
behavior in the interactions between
numerous stakeholders. The project will
develop a semi-quantitative "CAV
scenario generation" model to identify
behavioral, cost, and technical
influences. Specifically, this model will
simulate the circumstances and
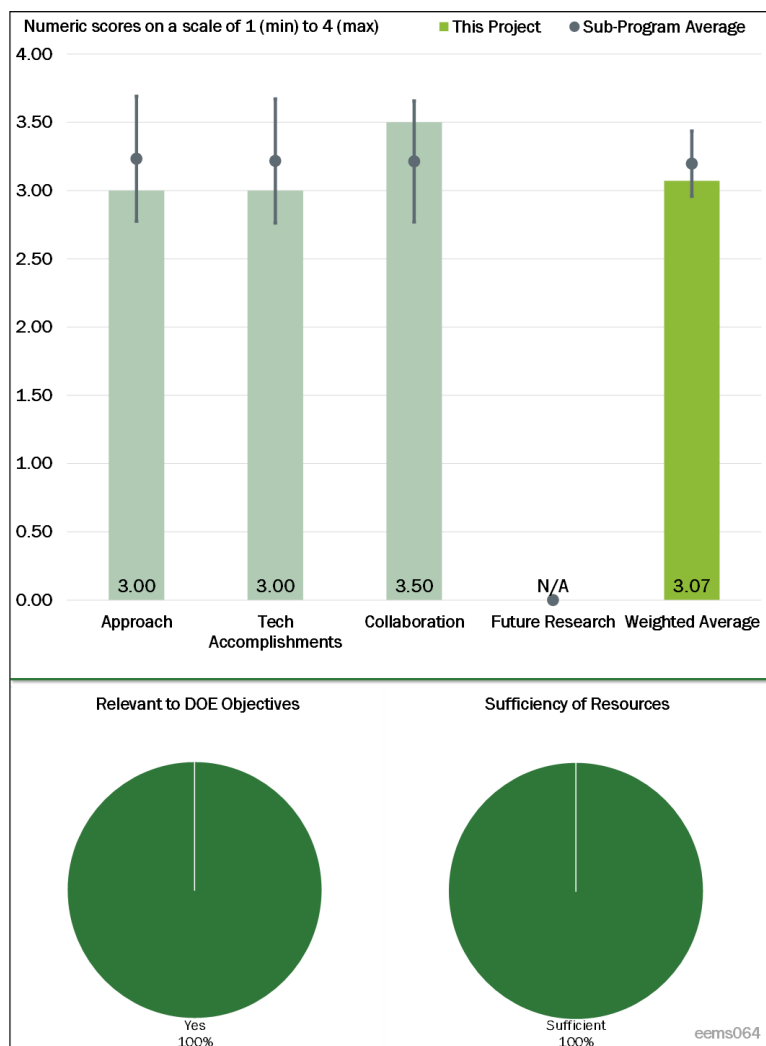dynamics of transitions from
predominantly individual ownership of

Figure 3-38 – Presentation Number: eems064 Presentation Title: Modeling
Connected and Automated Vehicles (CAVs) Transitions Dynamics and
Identifying Tipping Points Principal Investigator: Jeff Gonder (National
Renewable Energy Laboratory)

non-CAVs to various future scenarios of high connectivity / automation. The reviewer noted that the approach
will identify/quantify tipping-point hypotheses, evaluate known and hypothetical situations with possibly
adverse effects, and analyze sensitivities for CAV scenarios. This model incorporates the importance and
influences of a number of stakeholders including travelers, vehicle owners, manufacturers, regulators, insurers,
infrastructure providers, and energy. It also captures many primary differentiators such as population cohorts,
CAV/travel concepts, and activity purposes. Ultimately, the approach is to conduct scenario-screening analyses
to identify the influential factors for CAVs adoption and energy consumption. The reviewer noted that this
project aims to estimate the potential energy and mobility impacts of CAVs at both the national and in 50+
metropolitan regions.

The reviewer noted that barriers have been identified including the need for new tools, techniques, and
capabilities to understand the most important levers for improving energy productivity of future mobility
systems, potential rapid and uncertain evolution of vehicle and mobility technologies, and difficulty accurately
modelling large-scale interrelated transportation systems. In many ways, this project is working to address
these technical barriers.

Overall, according to the reviewer, the project seemed pretty well designed and feasible; however, it is very ambitious in scope attempting to model, quantify, and understand the myriad influences that potentially impact CAV adoption scenarios and ultimately energy consumption characteristics. The reviewer appreciated this aggressive approach, but felt its expansive scope and overall complexity is potentially detrimental to ultimate project effectiveness and success. Additionally, there is a lack of discussion regarding robust validation processes and mechanisms in which to apply them to the CAV-adoption model.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer detailed that the project has demonstrated progress and produced a number of technical accomplishments and insights including: a screening study was produced in fiscal year 2017, an energy study was produced in fiscal year 2018, and a comprehensive study will be completed in fiscal year 2019; identified that relatively small changes in combinations of assumptions may rapidly separate end states of CAVs adoption; varying assumptions regarding CAV usage may result in either very high or very low system-wide energy usage; consumer preference, time valuation, and technology cost most greatly influence low fuel consumption. This energy study demonstrates that disjoint combinations of model input parameters may lead to very similar outcomes (e.g., low energy consumption); the project successfully computed cohorts (or groupings based on preferences) of CAV travelers via analysis of Lawrence Berkeley National Laboratory's Whole Traveler Survey results. The reviewer said the CAV adoption model was calibrated to WholeTraveler and National Household Traveler Survey (NHTS) traveler cohorts, trip mixes, local deliveries, and mode splits in 50+ metropolitan regions; outcomes with higher "traveler satisfaction" (system-wide utility) tend to require more fuel consumption unless CAV Level 4 concepts predominate. The reviewer said that overall, the project has identified stakeholder-related bottlenecks and points of leverage for rapid CAV adoption, ranked and quantified factors impacting system wide energy use in CAVs adoption scenarios, and mapped key influences on CAV scenarios; and finally, a substantial list of additional key insights has been provided.

Overall, strong progress and technical accomplishments. However, the reviewer does have concerns about the ultimate validation of the results, whether they are sufficiently able to align with other SMART modeling activities, and if they are truly actionable (programmatically), especially in a more immediate sense.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer pointed out that this is a modest size task, which appears to have done a good job collaborating and coordinating with other labs including Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, and Los Alamos National Laboratory, and the overall SMART Lab Consortium. The project commented on, and is the first external user of, the Whole Traveler Survey (WTS), discussed melding WTS and NHTS and clustering traveler behavior in WTS, and has used WTS to calibrate the CAVs adoption model. With MA3T (ORNL), the project has held discussions on data sources, representing choice, mode split, etc. The reviewer said the project has collaborated with LANL on statistics and identifying extremes of CAV adoption and energy use, design of computer experiments, and sequential sensitivity analyses. With the SMART Lab Consortium and SMART Workflow Task Force (WTF), a detailed data dictionary for inputs and outputs of this CAV adoption model has been provided to support overall workflow. The reviewer said that overall, the project has made a strong effort to collaborate and coordinate with partner labs of the SMART lab consortium to discuss and exchange insights, leverage and utilize each other's project results, and enhance the overall effectiveness of several research projects.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that this project concludes in June 2019. However, the researchers have done a good job identifying future challenges and barriers including data gaps, the uncertainty of future CAV scenarios, challenges to stakeholder outreach, and difficulties for future coordination with other elements of SMART, especially with regards to comprehensive, synchronous alignment. Additionally, some insights are provided into how the CAV-adoption model and technical manual could help explore future questions such as effects of transportation strategies on energy use changes with CAV deployment, effective strategies to leverage CAV deployment to decrease energy use, and how effective strategies might vary among different metropolitan regions.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said that as first identified in the 2016 CAVs bounding study and subsequently reaffirmed through this modeling study, CAVs have a wide variability in energy consumption (-60% to +200%) depending upon assumptions and scenarios. This project provides an analytic tool for generating numerous scenarios for CAVs adoption under a variety of conditions and supports efforts to estimate potential energy and mobility impacts of CAVs both at the national level and in 50+ metropolitan regions. The reviewer said this tool better enables stakeholders to understand the range of effects of CAVs and the circumstances likely to lead to particular CAV outcomes. As such, this project supports EEMS/VTO and DOE objectives to reduce transportation energy consumption while potentially increasing mobility.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer remarked this project is on track and is scheduled to end in June 2019 with final documentation of analysis results for journal publication and CAV- adoption model preparation for open-source release. Resources for this project are sufficient.

**Presentation Number: eems065
Presentation Title: Analysis of
Platooning Trucks to Better
Understand Dynamic Air Flow
Principal Investigator: Michael
Lammert (National Renewable
Energy Laboratory)**

Presenter
Michael Lammert, National Renewable
Energy Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer said the approach of using
experimental data to analyze dynamic
airflow in platooning trucks can help
address the lack of understanding of the
aerodynamics effect in platooning.
Noise processing looks necessary before
the analysis in order to give clean and
trustable data. In addition, an
aerodynamic model considering the
vehicle parameters such as dimensions
and weight will make the results more
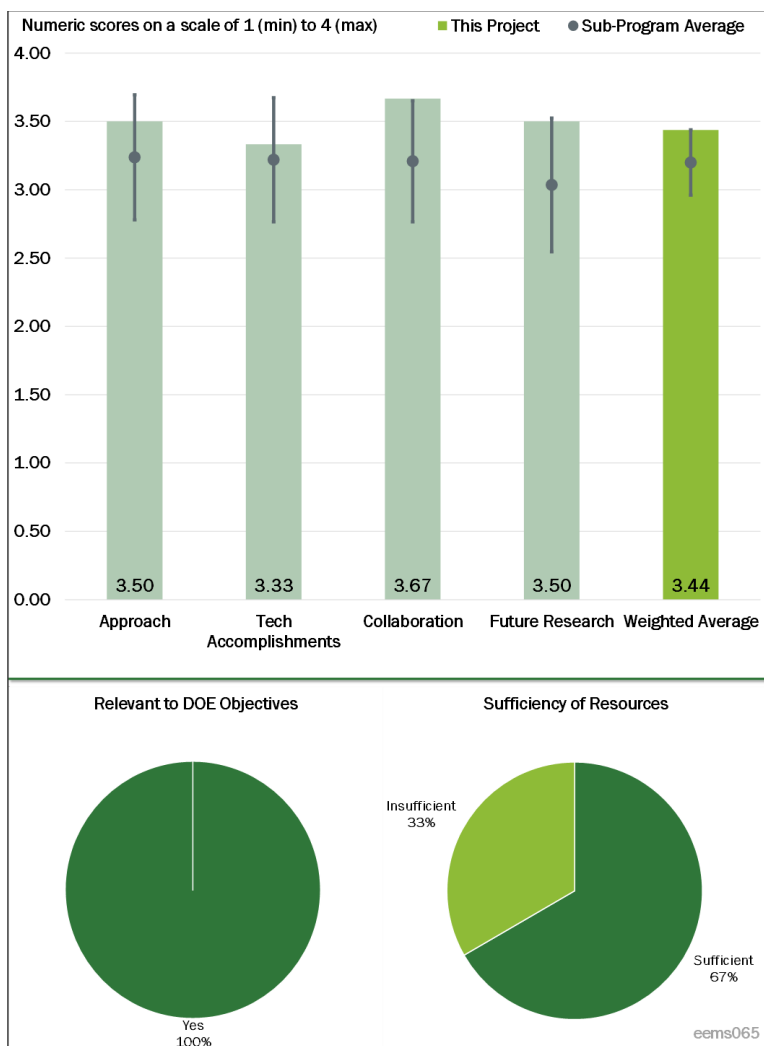scalable to other vehicles.

Figure 3-39 – Presentation Number: eems065 Presentation Title: Analysis
of Platooning Trucks to Better Understand Dynamic Air Flow Principal
Investigator: Michael Lammert (National Renewable Energy Laboratory)

Reviewer 2:
The reviewer noted that the project approach is using detailed data-capture techniques to gain insight on
platoon trailing distances and positions. The project also anticipates data correlation efforts with Lawrence
Livermore National Laboratory wind tunnel data for additional resolution and possible simulation
enhancement of wind turbulence impacts on platooning.

Reviewer 3:
The reviewer remarked well-designed approach with all areas of concern covered.

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer said the team did a great job with the wind speeds, angles, and temperature findings for future
projects.

Reviewer 2:

The reviewer remarked the results of using three vehicles are very inspiring to observe the differences in aerodynamics and cooling effects of different platooning gaps and vehicle positions. An aerodynamic model based on these experimental results is expected and more vehicles in the platooning are expected as well to provide better understanding of the effects.

Reviewer 3:

The reviewer said progress has been good to-date and looks to achieve majority of milestones by fiscal year end. Technical accomplishments include comprehensive data set and analysis for more clarity on air temperature, wind speed, and wind angle on platoon positions.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer said very good truck OEM, labs, and government collaboration.

Reviewer 2:
The reviewer said the collaboration is effective with different partners, especially in truck platooning data collection and analysis.

Reviewer 3:
The reviewer noted project collaboration with both domestic and international organizations. Collaborating with other National Laboratories and using their expertise. Anticipating collaboration with Lawrence Livermore National Laboratory this year and potentially looking at National Renewable Energy Laboratory tools for future analyses. The reviewer noted that the project team is collaborating with both industry and government stakeholders.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said the breadth, depth, and diversity of this high-resolution data lend itself to analysis utilizing current and future learning techniques.

Reviewer 2:
The reviewer remarked the proposed aerodynamic modeling work is necessary. The HPC work needs further justification. In addition, platooning data collection with more vehicles should be included for aerodynamic modeling.

Reviewer 3:
The reviewer said the project is developing a dense and broad data set for platooning which could be further analyzed and/or directed at simulation efforts and tools. Project investigators potentially looking to collaborate with the National Renewable Energy Laboratory's high computing power tools, including their Exascale Computing Project, which has been used for wind farm analysis. The reviewer said the investigators may also develop computational fluid dynamic model for simulating turbulent flow within the platoon convoy.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer noted that this project is highly relevant to DOE VTO given the potential for truck platooning and automation technologies, and potential benefits to heavy trucking and the freight industry.

The reviewer remarked the project does provide vital data to improve MPG in platooning vehicles.

Reviewer 3:
The reviewer said yes, the project supports DOE objectives by analyzing the aerodynamics effect in platooning to potentially save energy in platooning.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said the project team should get more resources to continue work.

Reviewer 2:
The reviewer remarked the project seems to be doing well and making good progress with the resources it has.

Reviewer 3:
The reviewer said yes, the resources look sufficient to achieve the stated milestones.

Presentation Number: eems066
Presentation Title: Livewire Data Platform – A Solution for EEMS Data Sharing
Principal Investigator: Johanna Levene (National Renewable Energy Laboratory)

Presenter
Kay Kelly, National Renewable Energy Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer said that the focus of the Livewire Data Platform is to allow easy and secure data sharing and discovery using both human website and computer-accessible application programming interface (API) formats. Livewire will leverage two existing successful data platforms (a2e.energy.gov and api.data.gov) to be efficiently built and will utilize a Pacific Northwest National Laboratory data hub, National Renewable Energy Laboratory API system, and data sets. The reviewer noted that data will be protected behind an authentication process, usage of data will be gathered for both API, and data downloads. Researchers and partners will be involved in the development process to aid in the reduction of human barriers to data sharing, with the aim of building a community of partnerships and collaboration rather than competition.
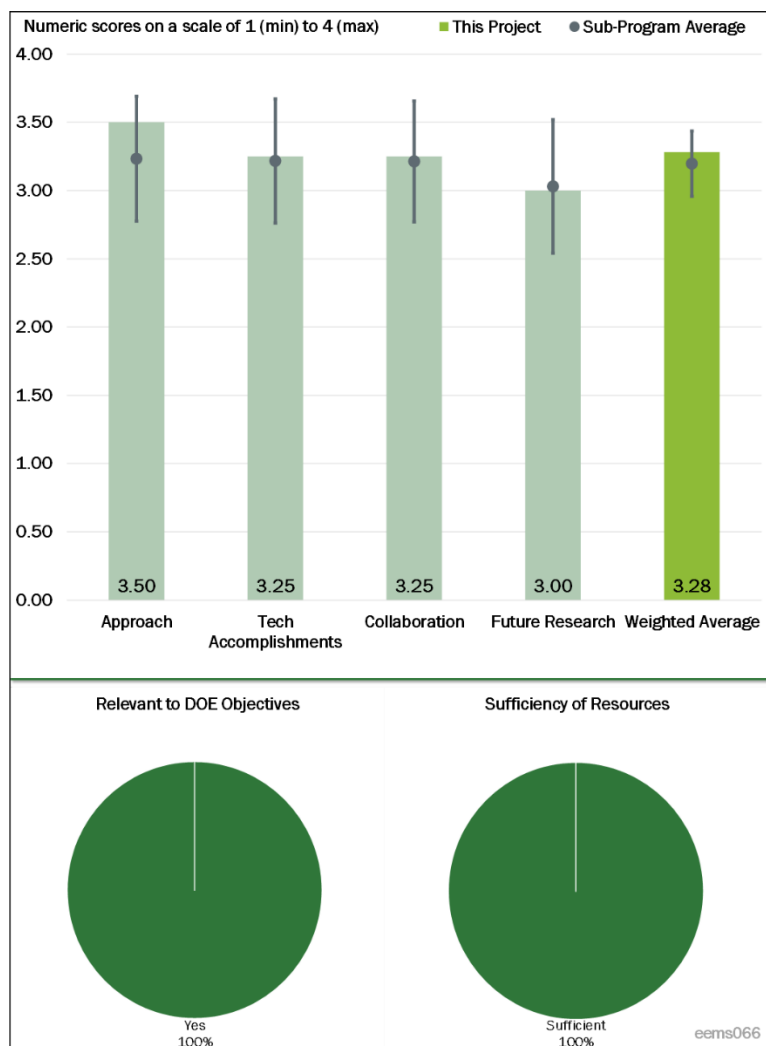

Figure 3-40 – Presentation Number: eems066 Presentation Title: Livewire Data Platform – A Solution for EEMS Data Sharing Principal Investigator: Johanna Levene (National Renewable Energy Laboratory)

The reviewer said the Livewire data platform is to provide a single location for EEMS researchers to catalog datasets that have existing sharing capability, share file-based catalogs, or create APIs to share real-time data. Data and big data providers will be able to create projects, upload data, set up APIs, and link to data repositories including the transportation secure data center (TSDC) and FleetDNA. In addition, it will provide a way to share licensed and limited-use data in a secure, audited fashion. The reviewer said the system will be designed to allow shared data to grow in size and complexity as EEMS evolves. The project has laid out three key tasks including creating a data management platform and exposing data sets, building complex-data management capabilities, and addressing human factors limiting data sharing and facilitating a working group.

The reviewer detailed that barriers identified by the project team include the expansive community of relevant stakeholders; difficulty in sourcing empirical real-world data applicable to new mobility technologies; many

researchers have never built an API and are unfamiliar with web technologies and need coaching and a simple platform to share data; large complex data sets require expansion of the platform to effectively share data; and legal challenges around non-disclosure agreements make sharing data difficult. This scope of this project appears to address barriers 1, 3, 4, and 5 above.

The reviewer found that overall, the approach to the project seems reasonably well designed and feasible. The reviewer especially appreciated the intent to build upon and leverage the existing a2e.energy and api.data platforms. If fully successful, it would aid in the ability to locate, access, and share data to the great benefit of EEMS research and development. The reviewer expressed concern that projects similar to this have been undertaken in the past with limited success. This project is not so much a technical challenge as a human factors challenge. While the project identifies Task 3 to address human factors limiting data sharing, the reviewer is not sure this will solve the historical human problems with data sharing. The reviewer would suggest that a very comprehensive study have been done upfront on the human factors hindering data sharing (including using new information such as extensive interviews and researching old information on the subject) to truly ascertain if the human factors are surmountable and how this new proposed system will be better than others before. In short, the reviewer suggested that Task 3 becomes Task 1 and the first go/no-go milestone be a comprehensive human factors study. In addition, it would help to provide reassurance if firm commitments from numerous researchers upfront were obtained to contribute to and utilize the Livewire Data Platform prior to development. Nonetheless, the reviewer does appreciate the project's approach to initially catalyze data sharing through use of first data sets, which are: highly requested by many research teams, clearly able to be shared successfully, and data sets where Livewire data platform labs (National Renewable Energy Laboratory and Idaho National Laboratory) are involved, displaying that the creators of the platform are willing to share data.

Reviewer 2:
The reviewer said that project goals are highly commendable and would have significant impact. The project is still in its early phase and it remains to be seen whether the substantial barriers to data sharing can be overcome.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer noted that this is a social-technical problem. Success will depend on both building a user-friendly technical system and transforming institutional cultures to make use of the tool. Cultural transformation is hard to measure. The technical portion is on-track.

Reviewer 2:
The reviewer detailed that several key milestones have been identified including: developing the beta version of the Livewire platform and implementing the API platform exposing at least three APIs (6/30/2019); implementing the first iteration of the data catalog through the DataHub including 10 data sets (6/30/2019); and exposing at least 9 APIs and cataloging 20 data sets in total (9/30/2020). The first two milestones are ostensibly on track for completion. However, nowhere in the list is a specific human factors milestone, which is potentially a major omission.

The reviewer said the project has shown progress and achieved some technical successes: plan development including cataloging and prioritization of data needs, development of use cases, software development, DOE web governance team approval, and sharing of data via the Livewire platform; cataloged user needs including conducting over 14 interviews and compiling a catalog of over 43 potential data sets that people either have or would like to have; first API has been completed and shared first data set (National Renewable Energy Laboratory MEP metric); and shared additional data. Identified initial data sets for June release including MEP, Whole Traveler Survey, and Idaho National Laboratory/Univ of Michigan CAV project. Currently

developing use cases for data sets that will be either hosted or linked to in Livewire. Explored researcher development stack options and decided upon Amazon Web Service (AWS) Lambda/Chalice/ Python for initial API development; and established an EEMS Data Working Group hopefully to lead a cultural shift toward data sharing among labs, prioritize data needs/asks across tasks, ensure data availability via Livewire platform, and tackle legal barriers to data sharing.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted that the project leads consist of National Renewable Energy Laboratory, Pacific Northwest National Laboratory, and Idaho National Laboratory with ostensible interactions/collaborations (primarily as data providers and the reviewer would suspect as part of the EEMS data working group) with Argonne National Laboratory, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Globus, and the VTO Technology Integration Living Laboratories. Given the overall scope and type of project, an acceptable level of collaboration and coordination amongst team members. However, the specific coordination and collaboration mechanisms, amongst the project leads and others, are not formally discussed.

Reviewer 2:

The reviewer said several key players are involved in the early phase of the project, with more expressing interest in joining.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said the project has a go/no-go milestone of producing 3 APIs and 10 data sets by the end of September 2019. It will be key to see whether the project lives up to its expectations and the degree to which it is accepted. Social acceptance may lag technical implementation, and it would be a mistake to cancel the project for the wrong reasons. Correct reasons to terminate the project would be that providing convenient access to diverse data turns out to not be feasible. The reviewer said the project has good plans to expand beyond the initial milestone.

Reviewer 2:

The reviewer remarked the proposed research is somewhat high level and generic. It proposes to build complex data management capabilities (incorporating Fleet DNA, TSDC and other large data sets), tackle difficult legal challenges that hinder sharing, expand researcher data suppliers and users, and share more data with the target to achieve the fiscal year 2020 milestone of 9 APIs and 20 data sets. It would have been beneficial to have discussed in more detail several of the key human and technical barriers for the Livewire platform moving forward and how they will be specifically addressed and what mitigation options exist.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said that if successful, this project will highly increase the ability of DOE to reach multiple objectives.

Reviewer 2:

The reviewer remarked this project is relevant as the need for data is critical to the EEMS program and others. As things stand, now there are significant barriers to data and information sharing and to bring about fundamental changes in our transportation system, data sharing must become ubiquitous. Many barriers exist to data sharing including that it stored in home institutions, is vulnerable to loss, the inability to share certain

data, difficulty in finding data, lack of standardized access, hoarding to maintain a competitive advantage, and an overall disinterest in sharing. If this project is able to overcome many of these barriers and greatly increase the level of data availability and sharing, it will have gone a long way to supporting advances for the EEMS program in bringing fundamental changes to our transportation system. These fundamental changes could lead to significant reductions in energy consumption and increases in mobility, which both support overall VTO and DOE objectives.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that resources appear to be sufficient at the present time. If the future shows the need for more resources, they should be provided.

Reviewer 2:

It is difficult for the reviewer to gauge the sufficiency of funding resources for this project. However, from a distance, the sense is that the project is sufficiently resourced or even over-resourced to an extent.

**Presentation Number: eems067
Presentation Title: ORNL Connected
and Automated Vehicle (CAV) Testbed
Principal Investigator: Dean Deter
(Oak Ridge National Laboratory)**

Presenter
Dean Deter, Oak Ridge National
Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer appreciates the idea of
having HIL and vehicle level testing
included to capture some aspects that
may be missed in the simulation. It
seemed to the reviewer that a not
insignificant amount of research has
been directed towards "string stability,"
"lane changing," and "lane merging"
(and a few other similar) scenarios.
While these are important aspects of
self-driving vehicle capabilities, the
reviewer questioned whether these
topics are of interest because of the ease
with which these can be simplified into
"toy" problems of control design. What
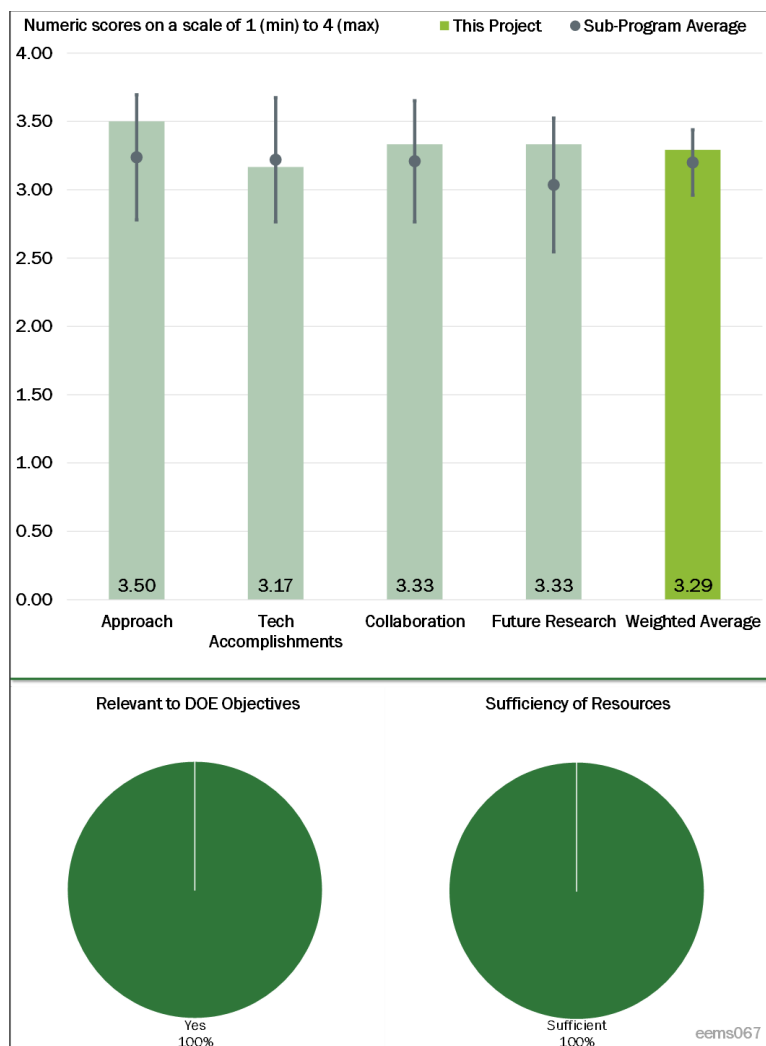would be good to see is a study that

Figure 3-41 – Presentation Number: eems067 Presentation Title: ORNL
Connected and Automated Vehicle (CAV) Testbed Principal Investigator:
Dean Deter (Oak Ridge National Laboratory)

incorporates the real world driving data that NREL has amassed at TSDC, along with the other work done at
Argonne National Laboratory, Idaho National Laboratory, and Oak Ridge National Laboratory, to understand
which aspects of driving around this country have the potential to impact the overall fleet fuel consumption the
most. The reviewer pointed out this could include a variety of driving maneuvers such as lane changing, lane
merging, city driving, highway driving, and platooning, etc.

Reviewer 2:
The reviewer remarked excellent approach, providing analytical and laboratory tools at various levels of
product development. Open source approach is also to be commended.

Reviewer 3:
From the reviewer's perspective, vehicle-in-the-loop rather than engine-in-the-loop may be more appropriate
for the purpose.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer said the project has only had a few months to bear fruit, and it appears that significant progress has been made.

Reviewer 2:

The reviewer commented work in the various simulation environments has progressed to the point that outside groups are beginning to utilize the resources. This is indeed the purpose of the simulations and should be encouraged to find bugs and determine potential improvements in the models.

Reviewer 3:

The reviewer said it is understandable the progress may be a bit sluggish at the beginning of the project, to coordinate all the partners and tool preparation for the entire project. Therefore, 10% seems to be appropriate for this 3-year project, but it is expected to see more results at future AMRs.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer said good collaboration with other National Laboratory partners. It may be worthwhile to explore what kind of progress has been made in similar areas outside of the United States.

Reviewer 2:

The reviewer remarked collaboration appears to have been sufficient to achieve excellent progress.

Reviewer 3:

The reviewer said the team looks strong and the project team explained well on the collaboration plan and the required skills or sources from different partners. The reviewer suggested it would be more suitable if a vehicle-in-the-loop can be set up.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said there is a clear plan for upgrades to the models.

Reviewer 2:

The reviewer was under the impression that Simulator of Urban Mobility (SUMO) originated from Europe and questioned whether there is a different SUMO whose development was funded by DOE. The reviewer said the proposed work for the immediate future, aerodynamic properties for platooning, looks good. However, it appears that several studies have already been published on the benefits of platooning; so, unless new simulations or measurements are to be performed, incorporating the available data should not present a huge task. Some of future tasks for fiscal year 2020 are rather vaguely defined, including integration of DOE developed tools into the "virtual-physical" proving ground. The reviewer was unclear what is expected to be achieved here.

Reviewer 3:

The reviewer said the project team explained the proposed future research well during the poster session. However, it is still not very clear to the reviewer which CAV application(s) will be deployed for the validation of this testbed.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer agreed that incorporating a HIL aspect to all of the research that is being done is valuable, adding to the body of knowledge generated by the various simulations. However, the reviewer does have some reservations.

Reviewer 2:

The reviewer said the project supports simulation testing of CAV operation, reducing costs, and potentially improving operation and safety.

Reviewer 3:

The reviewer said, this project, if successful, should be able to provide a good testbed of engine-in-the-loop for the evaluation of emerging transportation technologies such as CAVs and electric vehicles.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said the project resources appear adequate at this time.

Reviewer 2:

The reviewer remarked no resource constraints are apparent.

Reviewer 3:

The reviewer said based on the team's resources and qualifications, this should not be a problem.

Presentation Number: eems068
Presentation Title: Demonstrate
Mobility Energy Productivity (MEP)
Benefit of Intelligent Electric Vehicle
(EV) Infrastructure Design Using
Agent-Based Models (ABM)
Principal Investigator: Eric Wood
(National Renewable Energy
Laboratory)

Presenter
Eric Wood, National Renewable Energy
Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer remarked the approach of
this project seems excellent. It is
developing an important piece of
software that feeds into a larger overall
portfolio of products.

Reviewer 2:
The reviewer noted that the project
approach integrates the use of three
models (EVI-PRO, POLARIS, and
BEAM) in assessing EV charging
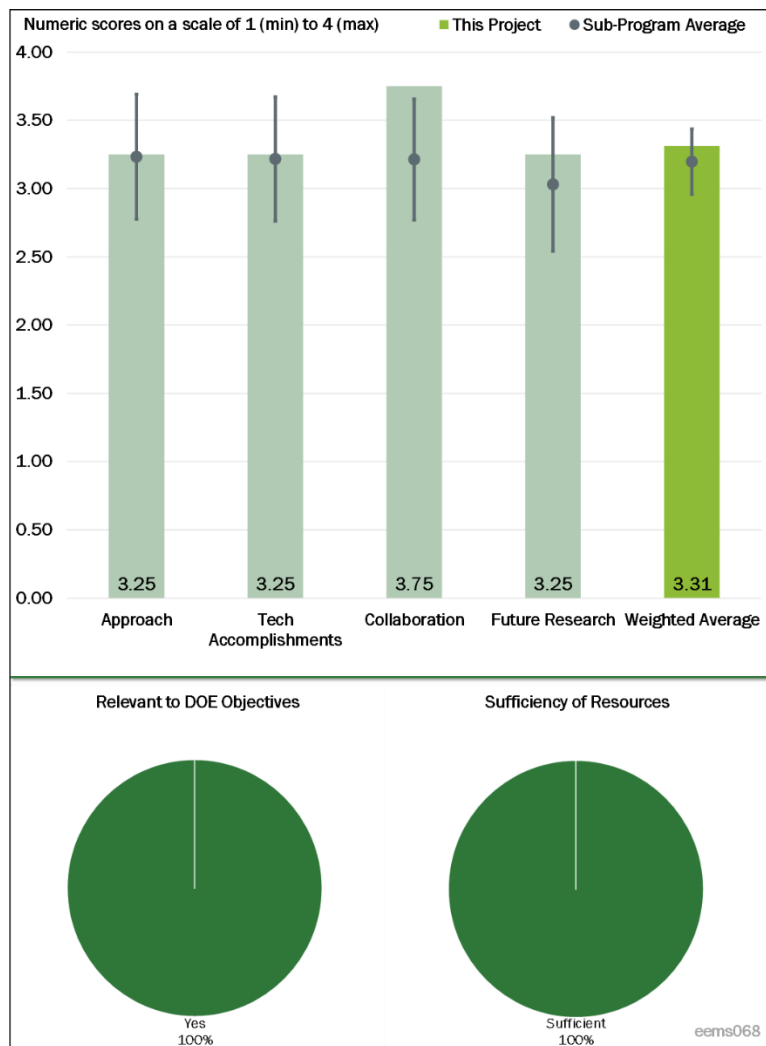spatial dynamics and charging behavior
and decision making.

Figure 3-42 – Presentation Number: eems068 Presentation Title:
Demonstrate Mobility Energy Productivity (MEP) Benefit of Intelligent
Electric Vehicle (EV) Infrastructure Design Using Agent-Based Models (ABM)
Principal Investigator: Eric Wood (National Renewable Energy Laboratory)

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer said the project team has made good progress to date in integrating and utilizing the synergistic
abilities of the three models to assess and validate EV charging behavior and spatial distribution.

Reviewer 2:
The reviewer remarked software integration targets seem to have been achieved, and scenarios are being
simulated. It would be good to better clarify what the model inputs are, and what the big picture goals of the
project are. Basically, show there is a great need for this work, ideally with data, and how this project fills that
need.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer remarked collaboration seems outstanding. This project took close communication with multiple labs to accomplish, and the results of the project show that this occurred.

Reviewer 2:

The reviewer said the researcher is working with multiple laboratories and collaborating extensively in the EEMS community on projects with complimentary workflows.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer commented this project appears to be shortened, so it should focus on outputting results and showing the benefit of the effort.

Reviewer 2:

The reviewer said the project team laid out near-term research plans, which extensively leverage off previous project results.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said yes, this project helps understand a large energy related problem for the automotive industry, how much electricity is needed where and when. Infrastructure is a big barrier to EV expansion, and it may be found that widespread EV adoption is not even be a viable path forward without understanding the results of this type of work.

Reviewer 2:

The reviewer remarked this project is relevant to DOE, VTO, and EEMS initiatives tying together mobility modeling, assessment of EV infrastructure, and quantifying new travel modes within an increasingly electrified transportation system.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said the project resources seem sufficient.

Reviewer 2:

The reviewer commented the project work appears to be sufficiently funded.

Presentation Number: eems069
Presentation Title: Next-Generation Intelligent Traffic Signal for Multimodal, Shared, and Automated Future
Principal Investigator: Andrew Powch (Xtelligent)

Presenter
Andrew Powch, Xtelligent

Reviewer Sample Size
A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer said that when developing new traffic systems timings, it is common practice to offer before and after analysis. Indicate what technology or type of traffic signal system/coordination plans were in place prior to this project. The average number of stops and the average delay are key metrics. These are the key performance indicators in a Transportation Management system.

Reviewer 2:
The reviewer remarked the objective of the project (not as presented, but as understood by this reviewer), is to improve traffic throughput at intersections by making traffic signals smart. The project team identified three barriers: real-world validation required of "proportionally fair" Adaptive Traffic Control System (ATCS) algorithm; connected and Automated Vehicle Future requires V2I capable ATCS algorithm design; and computational difficulty of modeling energy efficiency and greenhouse gas (GHG) improvements across cities. It is not clear if these are true barriers to achieving the project objectives.

The reviewer noted that the poster and PowerPoint file reference an ATCS modeled after IT network control theory. However, no details were provided on the algorithm. As such, it is difficult to evaluate if the project is well designed to address the technical barriers.

Reviewer 3:
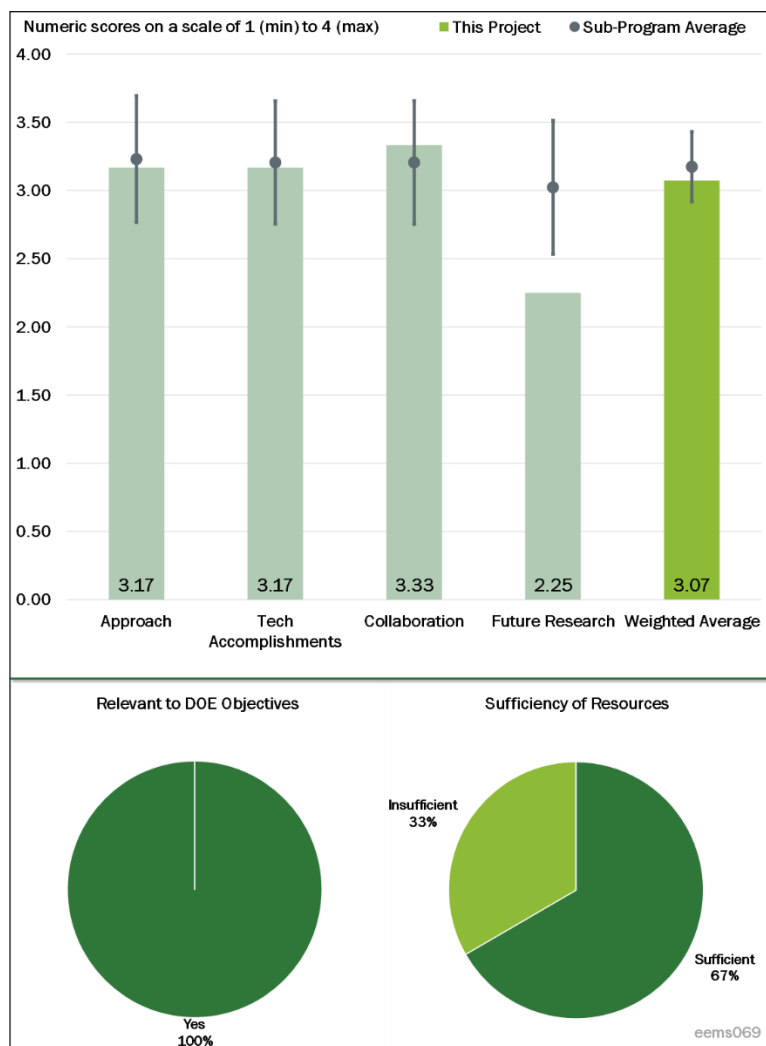The project contains all of the elements to address the goals of the study.

Figure 3-43 – Presentation Number: eems069 Presentation Title: Next-Generation Intelligent Traffic Signal for Multimodal, Shared, and Automated Future Principal Investigator: Andrew Powch (Xtelligent)

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:

The reviewer remarked this project has matured greatly within the past year.

Reviewer 2:

The reviewer said the poster and PowerPoint presentation summarized the accomplishments with respect to the defined milestones. However, no evidence was given in each task area or milestone.

Reviewer 3:

The reviewer remarked the work to-date is impressive. The most optimal setup is not currently planned for demonstration before the project end.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer suggested bringing in all of the appropriate partners, which can be difficult considering that municipalities are involved.

Reviewer 2:

The reviewer remarked it was presented that Xtelligent was the key agency in the milestones accomplished. Argonne National Laboratory's involvement was relegated to review of pre- and post-analysis in energy efficiency and GHGs. This should be coordinated against actual Traffic Systems performance metrics. As an example, there is no mention of the crash history pre- and post-analysis.

Reviewer 3:

The reviewer said the project requires coordination with city engineers, IT, and traffic planners, etc. Argonne National Laboratory is a subcontractor for final data analysis. The project is being piloted in two cities.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer's suggestions include closely working with the six advanced traffic control (ATC) manufacturers. Look at the system on both the Caltrans spec traffic controller and the National Electrical Manufacturers Association (NEMA) type one, two, and hybrid platforms. Invite independent review from transportation engineering consultants in this space.

Reviewer 2:

The reviewer said no additional research is proposed. Rather, the project team proposes additional large-scale deployment.

Reviewer 3:

The reviewer noted that the project is ending.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said V2I is very important technology being studied by DOE as means to reduce energy consumption. This project provides excellent demonstration of what can be achieved and provides real world data that can inform other SMART studies.

Reviewer 2:

The reviewer remarked improvement in traffic flow improves mobility, reduces congestion, and reduces fuel consumption.

Reviewer 3:

The reviewer said this work does support the DOE VTO program. There needs to be more evaluation and validation of the technology.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer remarked the project has made significant progress with the given resources.

Reviewer 2:

The reviewer said to perform the evaluation by licensed transportation professionals, the team appears to be short on funding and time.

Reviewer 3:

The reviewer remarked as it has been difficult to evaluate the outcome of the project, it is also challenging to evaluate whether resources are sufficient.

**Presentation Number: eems070
Presentation Title: Development of a
Connected and Automated Electric
Vehicle with 4-in. Wheel Motors
Principal Investigator: Jeffrey Wishart
(Arizona State University)**

Presenter
Jeffrey Wishart, Arizona State
University

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer remarked the project team
laid out a well-conceived approach for
the project.

Reviewer 2:
The reviewer commented it is
understandable to integrate high-level
and low-level control strategy for the
energy saving of EV, but the
intersection management seems to be a
bit loosely coupled with
vehicle/powertrain control from the
presentation (slide deck). A holistic co-
optimization should be much more
attractive and expected as the outcome
of this project. In addition, it is not clear
how to validate intersection management, as it is traffic management. A field test with a limited number of test
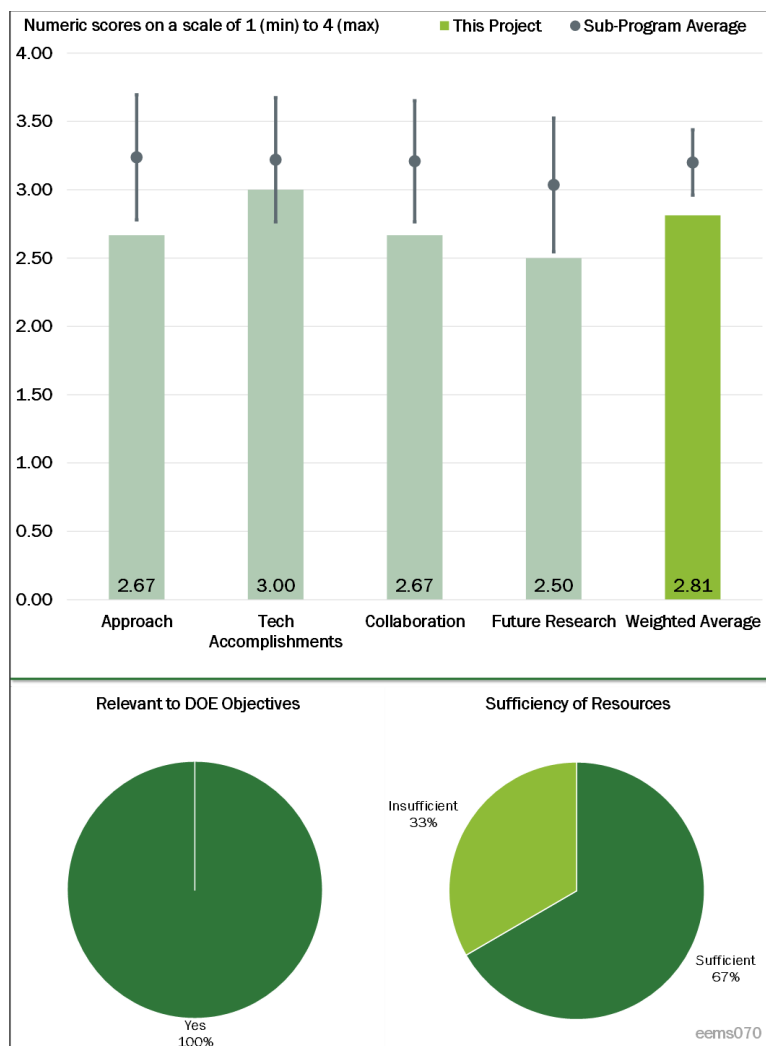vehicles seems to be not so convincing.

Figure 3-44 – Presentation Number: eems070 Presentation Title:
Development of a Connected and Automated Electric Vehicle with 4-in.
Wheel Motors Principal Investigator: Jeffrey Wishart (Arizona State
University)

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer said the project team achieved significant progress in Phase I of the project.

Reviewer 2:
The reviewer remarked that based on the information (slide deck) provided here, it is difficult to judge fully if
the project is on schedule or not. Overall progress is good, but if this is one-year project, the timeline seems to
be quite tight. Moreover, it is very difficult if the work is on budget, shown up to December 2018. If not, a no-
cost extension would be suggested.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer said collaboration on this type of research project seems reasonable.

Reviewer 2:
The reviewer commented collaboration between Arizona State University and Local Motors can be seen, but it is not clear to the reviewer why the team is still working on some other experimental vehicle than the Olli shuttle; possibly due to the budget, LM's confidentiality, or other concern.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer said the project team has laid out a detailed approach for the remainder of Phase I and for accomplishing Phase I objectives.

Reviewer 2:
The reviewer is unclear about a clear plan or path for the integration of intersection management and evaluation of this component. Intersection management is traffic management where the test of a very limited number of vehicles has no sense.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer said this project is relevant to DOE, VTO, and EEMS programs.

Reviewer 2:
The reviewer said yes, this project, if successful, should be able to support the overall DOE goal with 20% energy efficiency improvement. However, the range may vary with scenarios and how well the system/algorithm is developed. The optimization of high-level and low-level control as well as infrastructure operation should be the right components to achieve that goal for the future electrified and automated transportation system. The co-optimization and coordination with other traffic should be also a key to achieve the goal, but the reviewer does not see it is well addressed from this project.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer remarked this project seems adequately funded.

Reviewer 2:
The reviewer said 1 year seems to be too aggressive for this project. In addition, the reviewer is not sure how the intersection management will be implemented in the real world. So far, the reviewer can only vision that it is a concept or up to simulation study.

Presentation Number: eems071
Presentation Title: Plug-in Hybrid Vehicle Optimization Using Vehicle-to-Cloud Connectivity
Principal Investigator: Earl Sharpe (Macchina)

Presenter
Earl Sharpe, Macchina

Reviewer Sample Size
A total of three reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer remarked this project undertakes a manageable approach in the Small Business Technology Transfer (STTR) Phase 1 to demonstrate feasibility of an aftermarket vehicle communication device (VCD) and cloud-based energy management strategy. The approach has a strong likelihood of increasing understanding regarding how large data sets from individual plug-in hybrid electric vehicles can be used to reduce energy consumption by maximizing electric-only operation.
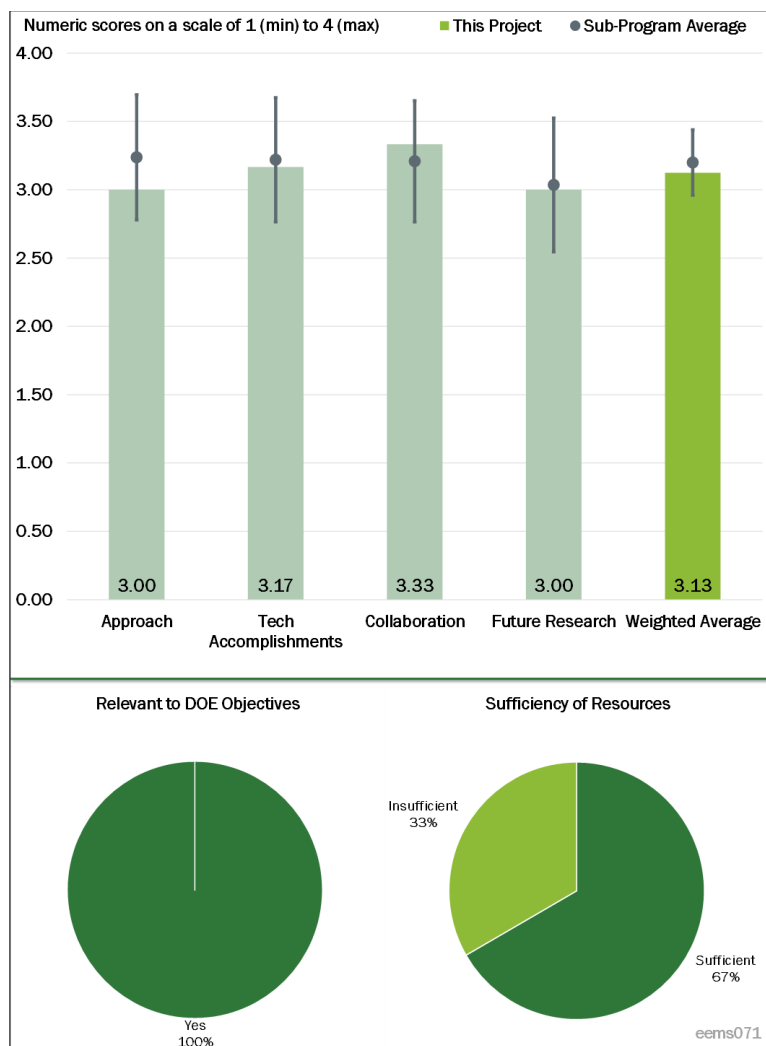

Figure 3-45 – Presentation Number: eems071 Presentation Title: Plug-in Hybrid Vehicle Optimization Using Vehicle-to-Cloud Connectivity Principal Investigator: Earl Sharpe (Macchina)

Reviewer 2:
The reviewer remarked communications between the VCD and the cloud was not adequately considered in project planning, resulting in the inability of the VCD to communicate with the cloud. This inhibits the autonomy of mode selection and requires manual intervention that is unrealistic for adoption of the technology.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer remarked although with the limited access of vehicle data, the project team is able to achieve successful results.

Reviewer 2:
The reviewer noted that actual fuel economy savings have been demonstrated. However, this was accomplished using pre-determined operating mode selection and is only one step advanced from a digital simulation.

Reviewer 3:

The reviewer said the project has largely completed stated objectives for Phase 2 STTR.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer remarked an EV battery expert to evaluate extension of electric only operating range on battery life can be of great addition

Reviewer 2:

The reviewer commented that coordination between the university and the contractor was good.

Reviewer 3:

The reviewer said that this project team is quite small with only two key collaborators and two partner organizations. However, the collaboration and coordination appear solid.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted that proposed future work is to apply the technology to other vehicles. It is suggested that achieving autonomous operation on the original Volt vehicle should be a higher priority.

Reviewer 2:

The reviewer remarked the project team has proposed a solid plan for potential work in STTR Phase 2, including the ability to obtain data from more plug-in hybrid electric vehicle models, which will be a key to proving a successful commercialization strategy and viable product and service.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said this project supports overall DOE objectives by utilizing cloud computing and harnessing the power of data to improve the energy efficiency of existing commercially available plug-in electric vehicles.

Reviewer 2:

The reviewer remarked the project is in line with the DOE target to increase vehicle efficiency.

Reviewer 3:

The reviewer remarked this project has demonstrated a potential for fuel savings. It now needs to demonstrate that it can be implemented.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said it appears that resources to establish cellular communications to the cloud will be required to achieve the project objectives.

Reviewer 2:

The reviewer commented STTR resources are sufficient for the size and scope of this project.

Reviewer 3:
The reviewer observed no evidence for missing or excessive resources.

**Presentation Number: eems072
Presentation Title: Charging
Infrastructure for Freight
Principal Investigator: Yutaka
Motoaki (Idaho National Laboratory)**

Presenter
Yutaka Motoaki, Idaho National
Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.

Reviewer 1:
The reviewer remarked the approach is
logical and reasonable, building up from
a segmentation analysis/use case
analysis and aligning that with current
and future performance of electric
trucks for these use cases. Developing a
charging infrastructure scenario for
Class 7-8 trucks is particularly timely
because of the considerable recent
discussion around electric trucks from
Daimler, Tesla, and other market
players. The reviewer said that
infrastructure limitations are often used
to dismiss the opportunity for
electrification in this space, so an
objective analysis of what would be
required to support electric trucks in this duty cycle will help answer whether they are feasible or not.

Figure 3-46 – Presentation Number: eems072 Presentation Title: Charging
Infrastructure for Freight Principal Investigator: Yutaka Motoaki (Idaho
National Laboratory)

Reviewer 2:
The reviewer found that this is a very useful topic to address.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.

Reviewer 1:
The reviewer remarked the overall accomplishments for this project are reasonable given the short duration of
the project. It is very important for the team to have provided an objective summary of the weight/capacity
issues with Class 8 electrified trucks. This information is often unclear in current public information from
electric truck manufacturers and is difficult to obtain. Weight of batteries is often used to dismiss
electrification as an option for commercial trucks, some characterize the battery needs of a long-haul truck as
requiring the full capacity of the trailer. So, understanding the real payload impacts are beneficial.
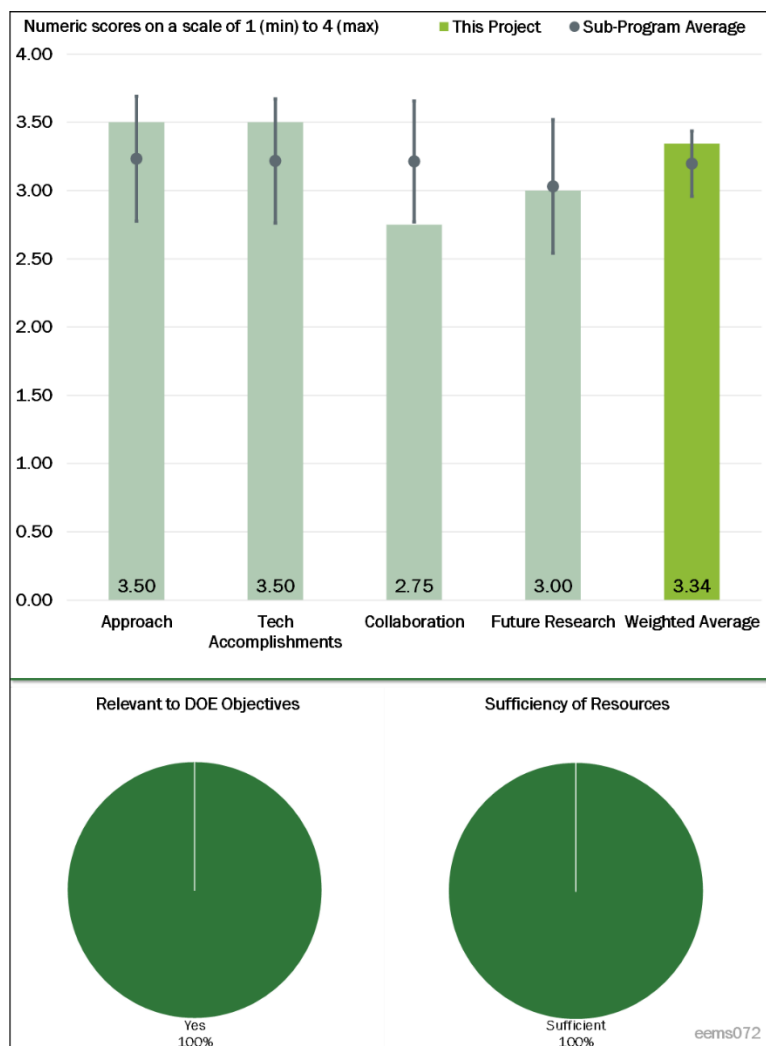
The reviewer pointed out that another interesting segmentation (conceptually) of the motor carrier market would be by company size/access to capital resources. Larger fleets such as UPS can afford to experiment with new technologies and have the capital to invest in some level of infrastructure, while the smaller carriers need to focus on technologies that can work and make a profit for them immediately. This has implications for uptake and the balance between private and public charging investment. The dependence on the Vehicle Inventory and Use Survey (VIUS) opens the project to criticism about its conclusions, as the fundamental data basis is so old.

The reviewer said that this project faces the same fundamental limitation that virtually all other freight analyses do, specifically the dependence on VIUS for a basic understanding of how the market is segmented. The current analysis work at National Renewable Energy Laboratory and Oak Ridge National Laboratory with the Lab-TRUCK Consortium may help answer some of these segmentation questions with more recent data, which would assist projects like this in having a more solid grasp on how many trucks are in a particular segment and how that segment is used.

Reviewer 2:
The reviewer said nicely broken down to the application and range levels.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer commented the project team is collaborating with the right labs within the EEMS team and is distributing responsibilities appropriately among the experts at these labs. Some input from fleet and manufacturer partners on the findings would add perspective if there was time within the project to secure this, potentially through a quick review from selected industry stakeholders with an existing connection to DOE VTO programs.

Reviewer 2:
The reviewer did not see any major collaboration efforts. Project is good but rather self-contained.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer remarked the future research plan to wrap-up this particular project is reasonable and should achieve the goals set forth for the project. The concepts suggested for follow-on research are a bit vague and would be more beneficial if more specifics on the actions to be taken were provided.

Reviewer 2:
The reviewer commented that there are no clear tasks and deliverables.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer found that this is very relevant to DOE VTO objectives. Gaining an understanding of the required charging infrastructure to meet regional-haul or long-haul duty cycle needs will help add to the discussion around electric trucks. The infrastructure is often downplayed in this early stage of technology development.

Reviewer 2:
The reviewer pointed out that charging is very relevant, if not one of the keys.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said the resources available to this project appear to have been sufficient to complete the work, and the project team is making good use of existing analytical resources to leverage its own work.

Reviewer 2:

The reviewer commented the project appears to have sufficient funds, possibly a little on the higher side.

**Presentation Number: eems074
Presentation Title: Systems and
Modeling for Accelerated Research in
Transportation (SMART) Cities
Topology – Curbs and Parking
Principal Investigator: Stanley Young
(National Renewable Energy
Laboratory)**

Presenter
Stanley Young, National Renewable
Energy Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer remarked the project
thesis is good given the lack of attention
to curbside impacts of TNC in
transportation system, traffic flow, and
energy modeling. The approach is
reasonable consisting of initial literature
review and identification of related
work followed by optimization
framework development and
reporting/presentation of results. The
reviewer would have liked to see some
mention of how the initial conceptual
framework may link to or augment
existing transportation models to
showcase project context and potential future work pathways.

Figure 3-47 – Presentation Number: eems074 Presentation Title: Systems
and Modeling for Accelerated Research in Transportation (SMART) Cities
Topology – Curbs and Parking Principal Investigator: Stanley Young
(National Renewable Energy Laboratory)

Reviewer 2:
The reviewer noted that the study is time-compressed and includes many stakeholders. Producing an
operational, high impact tool does not seem feasible. The project has the more modest goals of analyzing the
situation and incorporating it into a simulator. To move beyond this would require participation by several
cities. Such cooperation would appear to be unlikely until problems develop with TNC pick-ups and drop-offs.

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer said the project team has completed initial literature review and has completed draft summary
report. The project team is currently focused on state of practice for TNC modeling and is developing
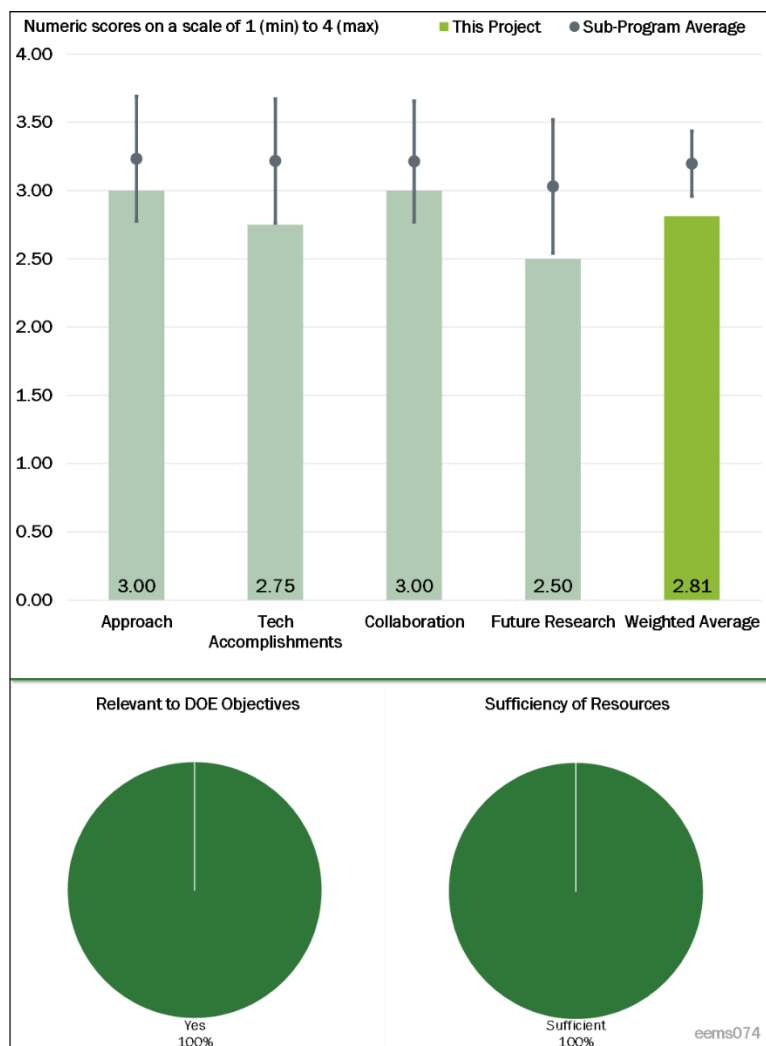
practitioner interview questions for gaining desired interview results. Also, the project team has developed first cut of the initial Conceptual Model.

Reviewer 2:

The reviewer noted that the project is 50% through the project period but only 20% complete. This may be as planned, because data collection and set-up are required before the real work can begin. This question has limited relevance for a 6-month project.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted that the team identified several collaboration efforts with National Renewable Energy Laboratory, Oak Ridge National Laboratory, and Transpo Collaborative effort includes other labs, industry and academia (State University of New York and Southwest Jiaotong University. The reviewer would like to have seen some mention of what the collaboration partner is doing, or is planning to do, within the project framework.

Reviewer 2:

The reviewer noted that given the short time-frame, it would seem unrealistic to involve more organizations.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said the future direction of the project is unclear. It is questionable how curb use affects traffic simulation results, it is unclear whether dynamic curb use will become a practice, and it is unclear whether the results are appropriate to incorporate into other simulators.

Reviewer 2:

The reviewer said the project team was non-definitive on future project directions. The reviewer would have liked to have heard more about further development of the initial conceptual framework and opportunities for potential interface with other models and modeling efforts that could benefit from this research.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said yes, this project is relevant in terms of its investigation of TNC and curbside impacts on traffic flow. TNCs continues to grow each year and is projected to comprise a significant portion of travel demand and transportation energy use in the future. TNC also has a role in within smart mobility and so better understanding of its impacts is useful to researcher, modelers, and policy makers.

Reviewer 2:

The reviewer said the simulation may or may not show an influence of curb use on traffic flow and energy use.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the milestones and the resources are both modest.

Reviewer 2:

The reviewer remarked resources should certainly be sufficient for this 6-month project.

Presentation Number: eems075
Presentation Title: General
Microsimulation to Meso-Simulation
Workflow
Principal Investigator: Xiao Lu-Yun
(Lawrence Berkeley National
Laboratory)

Presenter
Xiao-Yun Lu, Lawrence Berkeley
National Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer detailed that the formal
objectives of this project are to develop
a parameterized fundamental diagram
(PFD) that can cover a range of road
geometries and a variety of traffic
scenarios with different levels of market
penetration of CAVs (Lawrence
Berkeley National Laboratory) and
implement I/O processes for utilizing
the PFD in meso-simulation (Argonne
National Laboratory) and to model TNC
pick-up/drop-off with passenger cars
and CAVs in microscopic simulation. A
PFD quantifies aggregated traffic
behavior with difference function relationships; flow-density, speed-density, and speed-flow. The reviewer
noted that PFD is critical for calibrating mesoscopic mixed traffic with manually driven and connected
automated vehicles. The modeling of PFD can only use proper data from appropriate microscopic traffic
simulation at different locations of a freeway corridor. Currently no such real-world data with CAVs are
available to support validation. The modeling of TNC vehicle pick-up/drop-off at the microscopic level is
necessary to quantify TNC impacts on urban arterial traffic. The reviewer commented TNC modelling includes
different parking scenarios in different traffic situations. In short, this project is attempting to model mixed
aggregated traffic behavior at different CAV penetration levels on the freeway and arterials at the microscopic
level with the goal of ultimately scaling up to the mesoscopic level.

The reviewer noted that barriers have been identified including how to develop mesoscopic traffic simulation
for energy consumption evaluation for mixed traffic with different market penetration levels; no field data
exists with CAVs for meso-model calibration; and how the Fundamental Diagram modeled from microscopic
simulation with CAVs can be used for meso-simulation calibration. This project is principally addressing
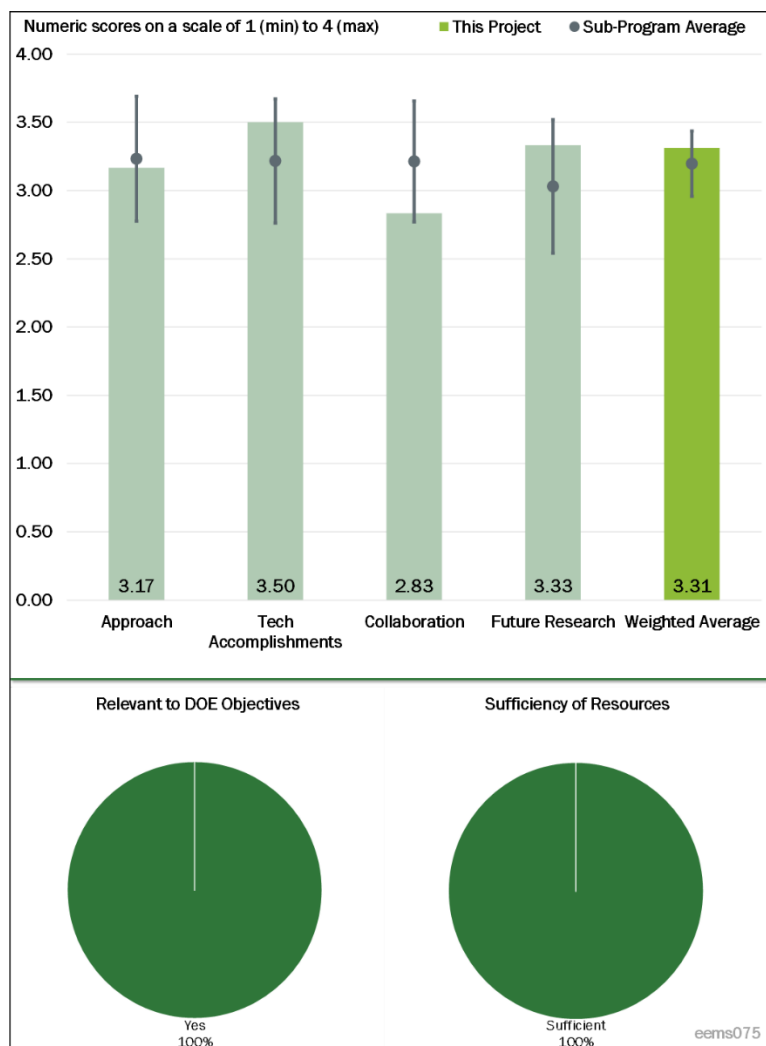barriers one and three.

Figure 3-48 – Presentation Number: eems075 Presentation Title: General
Microsimulation to Meso-Simulation Workflow Principal Investigator: Xiao
Lu-Yun (Lawrence Berkeley National Laboratory)

The reviewer noted that this project is strictly a complex modelling exercise which is attempting to determine the best microscopic models to use (three PFDs have been proposed and calibrated based on the Underwood Model and one new polynomial model for a 2-limb PFD), ascertain appropriate coefficients based on road geometries to refine the models, and the reviewer assumes, downselect to the best option, and ultimately apply at the mesoscopic level. Overall, this seems like a reasonable and feasible approach, which actually has been significantly detailed within the presentation. One concern is that it is difficult to ascertain what would be considered success within the modelling context. For example, the reviewer questions whether it would be considered success if one model could be fully developed and proven to be accurate at the microscopic level to within 10-20% of reality. Lacking real-world data, the reviewer questioned how this success would be validated. Overall, the reviewer understands the intent and proposed approach for this project, but is struggling with the definition and thresholds for determining success and the means through which modelling achievements will be actionable.

Reviewer 2:
The reviewer said the project team has defined an excellent approach to addressing specific limitations in mesosimulations and assessing TNC impacts in microscopic models.

Reviewer 3:
The project team is using an appropriately detailed approach to address the main research question; how do new mobility solutions affect traffic flow, either positively or negatively, and has the tool sets necessary to complete the work described. The reviewer said the project team is addressing an intriguing problem with real-world impacts, questioning whether the increased number of on-road pick-up and drop-off cycles from TNCs affect traffic flow, and if so, how. This is most of the problem, but the assumption that pick-up and drop-off occurs only in the parking spaces is a bit of a limitation. The reviewer questioned what the impact will be of TNC pickups or drop offs in areas where no open spaces are available.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer said accomplishments are extensive given the short 12-month timeframe for the overall project. The project team has successfully calibrated its model to real-world data and explored several CACC vehicle scenarios. The preparatory work for understanding TNC impacts has been completed and the team has clearly outlined what scenarios will be explored using this framework.

Reviewer 2:
The project has achieved a series of technical accomplishments with regard to developing and modeling the PFD to cover a range of road geometries and variety of traffic scenarios with different levels of market penetration of CAVs, including: PFD Modelling: Three PFDs have proposed and calibrated based on the Underwood Model. One new polynomial model has been created for the 2-limb PFD; Data preparation has been developed for model coefficients determination. This is based on freeway corridor microscopic simulation for SR-99 NB between Elk Grove and SR-50 interchange in Aimsun. The baseline traffic model has been properly calibrated from PeMS data; properly developed CAV model based on field test data in public traffic to capture dynamic interactions with other vehicles; Model coefficients have been determined at nine locations along the corridor to represent different road geometries and traffic demands. Data fitting has progressed; A comparison of the root mean square errors (RMSE) of the four PFD models has identified that the 1-limb flow-density model has the smallest error to date; and next steps will include generating microscopic simulation data for mixed traffic with other demand levels 5-35% more than the baseline (currently it is 20% demand), determining corresponding model coefficients, investigating other possible PFD models, and application of the PFD to mesoscopic simulation modeling.

The reviewer said that for the TNC modelling, technical accomplishments include modeling of TNC pick-up/drop-off including an arterial corridor, determining a microscopic 2D vehicle movement model for parking on curbside, preliminarily determining TNC parking location strategies, and coding the parking vehicle movement as MicroSDK in Aimsun for different scenarios. Overall, a strong list of technical accomplishments.

Reviewer 3:

The reviewer said the project has made significant progress to date including the generation of microscopic mixed traffic simulations with different CAV penetrations and created and defined multiple PFD models.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted that the project team consists of two EEMS labs as the main partners, but the team is also connected to a number of other EEMS researchers and projects as well as academia. Given the scope of the project, the team has the right expertise to address the tasks.

Reviewer 2:

The reviewer said the project only indicates direct collaboration with Argonne National Laboratory, as well as identifying other partner projects in the workflow (from Lawrence Berkeley National Laboratory and Argonne National Laboratory). Given the fundamental nature of this modelling effort, the reviewer suspected that more collaboration and coordination across the National Laboratory and university space would have occurred early on in the project. Broader and earlier collaboration may have generated additional ideas for project approaches, model development, and methods to overcome validation challenges.

Reviewer 3:

The reviewer said the project team has identified and collaborated with other lab projects with complimentary workflows.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said the tasks proposed for completing the current project are logical and will address the questions set forth at the start of the project. The proposed future research follow-on items appear to be useful and will add to the knowledge built in this project, particularly the exploration of TNC freight vehicle impact.

Reviewer 2:

The reviewer said the project has done a good job of identifying remaining challenges and barriers, including; what is the exhaustive list of PFD models needed for freeway corridors required for mesoscopic mixed traffic simulation modeling, how to apply the PFD models determined by the mixed traffic simulation data of one freeway corridor to other freeway corridors and to even larger traffic networks, and how to model the TNC vehicle microscopic behavior which a commercially available simulation package (Aimsun, VISSUM) does not have function to use.

The reviewer remarked a good and clear sense of proposed future research is provided. For the PFD, proposed efforts are to: model arterial corridors, determine an exhaustive list for PFD models for arterials, how to apply PFD to mesoscopic simulation, PFD for network traffic for both freeway and arterial, and determining if there is any relationship between the two types of PFDs (freeway and arterial) and how to quantify. For modelling TNC pick-up and drop-off vehicle effects on arterial traffic including more systematic consideration of TNC traffic in a network model, and modeling and simulating TNC freight vehicles such as parcel pickup and drop-

off effects on urban traffic at the microscopic level. The proposed research appears to make sense as next potential steps in the process.

Reviewer 3:

The reviewer said the project team has defined a comprehensive plan for future work, which leverages off the current project. The team has demonstrated clear and meaningful next steps for the research. Future research plans include addition PFD modeling including article corridors as well as additional research on how the newly developed PFD models can be applied to benefit mesosimulations.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said this project is relevant to broader VTO objectives because a detailed understanding of how CAVs and TNC vehicles affect traffic flow will feed into larger energy and mobility models of interest to EEMS and the research community.

Reviewer 2:

The reviewer remarked as CAVs enter the transportation system and the use of TNC services continues to grow, they will increasingly impact traffic flows and associated mobility, energy use, and emissions. The development of sound methods to model and accurately predict the consequences (both good and bad) of increased CAV and TNC market penetration will provide a foundation from which to make informed programmatic decisions. These informed decisions can better help steer CAV and TNC technologies toward more favorable outcomes such as enhancing mobility while minimizing energy demand. The reviewer said this supports overall VTO and DOE objectives to reduce energy demand and increase energy security.

Reviewer 3:

The reviewer noted that this research aims to address some of the current gaps in the interface between meso- and micro-simulations as well as better understanding of TNC impacts at the micro level.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said this 1-year, $400,000, non-cost share project has achieved a number of technical accomplishments and appears on track to meet identified milestones in a timely manner. Combined with no mention of funding constraints would indicate the project is sufficiently funded.

Reviewer 2:

The reviewer remarked the resources available to the project team appear to be sufficient to complete the work described.

Reviewer 3:

The reviewer commented resources look sufficient and the research team is making good progress.

**Presentation Number: eems076
Presentation Title: Workflow to
Simulate Connected and Automated
Vehicle Control under Realistic Traffic
Conditions
Principal Investigator: Dominik
Karbowski (Argonne National
Laboratory)**

Presenter
Dominik Karbowski, Argonne National
Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer remarked the project is
developing a process to transfer
RoadRunner vehicle to micro-
simulation and linking RoadRunner and
stochastic vehicle trip (SVTriP) for
traffic conditions simulation. The
impact of control strategies on traffic
flow will be evaluated through the
linkage with Aimsun.

Reviewer 2:
The reviewer said the project goals are
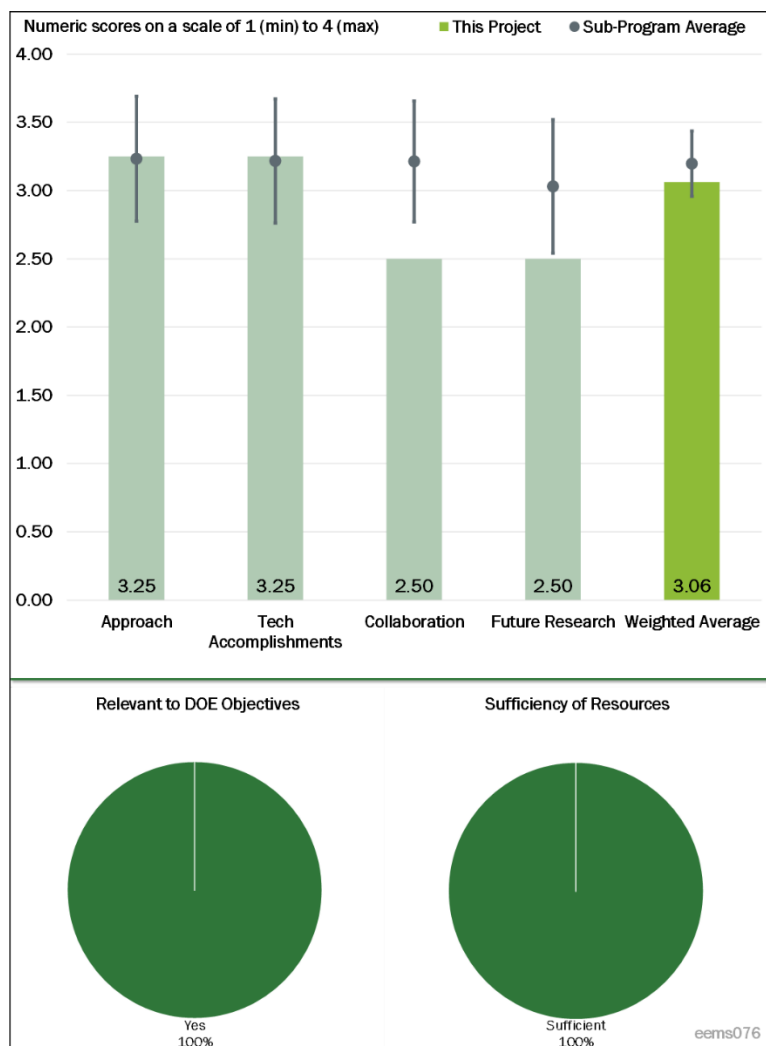defined, but are not going beyond, to a
bigger picture.

Figure 3-49 – Presentation Number: eems076 Presentation Title: Workflow
to Simulate Connected and Automated Vehicle Control under Realistic
Traffic Conditions Principal Investigator: Dominik Karbowski (Argonne
National Laboratory)

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer said the project identified the need to link the tools for simulation of driving and traffic.
RoadRunner does not model traffic as it is designed for CAV eco-driving control development. RoadRunner
and SVTriP have been integrated through a dummy vehicle that represents traffic.

Reviewer 2:
The reviewer said some accomplishments are mentioned, but not related to higher-level goals.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer pointed out that Argonne National Laboratory is conducting vehicle-centric simulation (RoadRunner and SVTriP) and Lawrence Berkeley National Laboratory develops and runs models of real-world traffic (Aimsun). Given the scope and duration of the 9-month project, the collaboration seems appropriate.

Reviewer 2:
The reviewer remarked the project collaboration and coordination is rather vague.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer remarked appropriate future vehicle-centric eco-driving research within RoadRunner, Aimsun and SVTriP models to improve in-vehicle implementation.

Reviewer 2:
The reviewer said that the proposed research is adequate, although, not necessarily a highlight.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer remarked this project enables SMART Workflow that is used to model mobility energy productivity within DOE VTO EEMS research. Microscopic traffic flow, multi-vehicle control, and trip profiles are addressed through RoadRunner linkages with SVTriP, and Aimsun.

Reviewer 2:
The reviewer said it supports a tedious task, which does not take project highlights.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer remarked the project funding of $375,000 seems appropriate for the proposed 9-month effort to achieve the two main milestones of RoadRunner linkages with SVTriP and traffic flow microsimulation tool.

Reviewer 2:
The reviewer stated that the project appears to have sufficient resources.

**Presentation Number: eems077
Presentation Title: Transportation
System Control for
Taxi/Transportation Network
Company Simulations
Principal Investigator: Josh Auld
(Argonne National Laboratory)**

Presenter
Josh Auld, Argonne National
Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.

Reviewer 1:
The reviewer commented the proposed
approach of building TNC simulations
can help address the barrier of analysis
of TNC system performance. The tasks
are clearly designed and planned. The
validation of the TNC simulation
models should be planned based on
realistic TNC data. This will further
enhance the fidelity of the simulation
models and results. Traveler and driver
behavior modeling needs to perform
user studies. Operator assignment model
needs to consider traffic situations
rather than distances.

Figure 3-50 – Presentation Number: eems077 Presentation Title: Transportation System Control for Taxi/Transportation Network Company Simulations Principal Investigator: Josh Auld (Argonne National Laboratory)

Reviewer 2:
The reviewer remarked the work is largely reinventing the algorithms used by Uber and Lyft and incorporating them into simulation. Doing so is difficult without access to proprietary data.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer pointed out that algorithms have been incorporated into POLARIS.

The reviewer said many of the slides lack numerical units on the vertical axis and are difficult to interpret. Slide 12 is problematic. Changes from baseline should have a units label, these are apparently meant to be a factor. The reviewer questioned how much of this is due to projected growth in TNC activity. The change to baseline resulting solely from increased TNC usage should be shown. The work appears to be projecting that VMT will increase by a factor of three to six even under the relatively benign conditions of scenarios A and B.
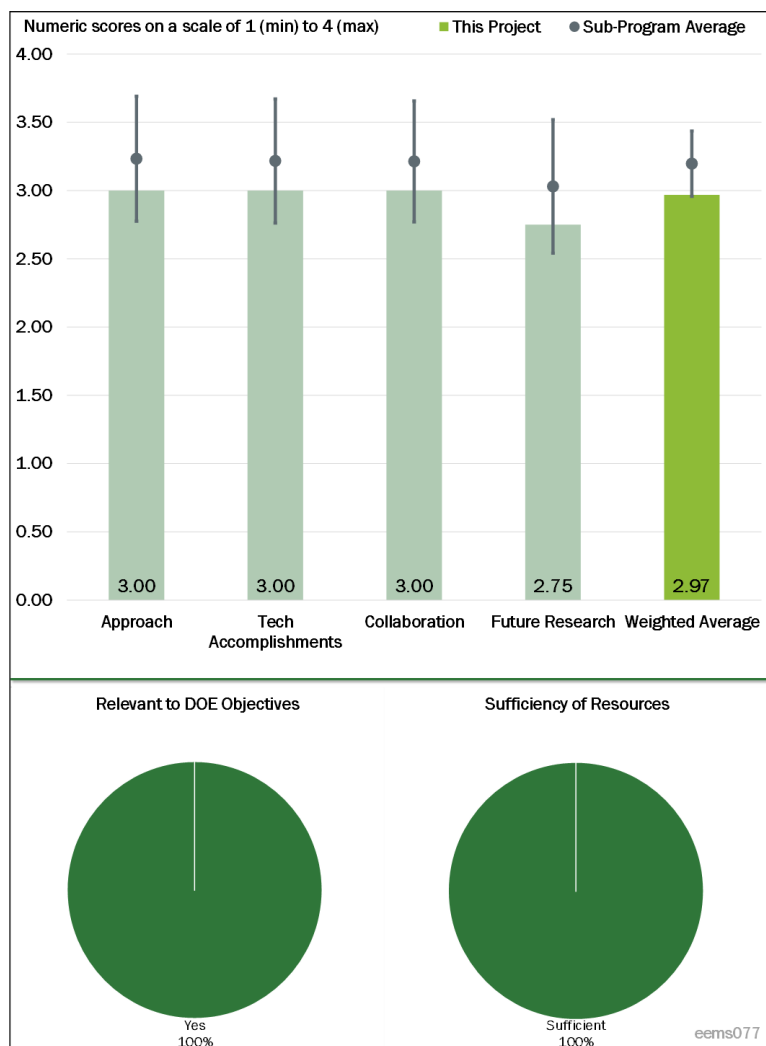
The reviewer questioned this finding, and also questioned if the slide addresses total VMT or just the VMT from TNC. Apparently, it is VMT from TNC. The reviewer questioned whether a Level 4 vehicle is considered TNC even if operated by a local transit agency.

Reviewer 2:

The reviewer said the team has provided many data by the simulation models. A comparison between the simulation results and realistic data is necessary. Without such a validation process, it is difficult to convince people on these analysis results. In addition, more realistic traveler and driver models, and more optimized operator assignment models, are needed to enhance the fidelity of the simulation models and results.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer remarked it is not clear whether the project partners are actively participating or have just been used as data sources.

Reviewer 2:

The reviewer commented the project team has multiple institutions including National Laboratories, universities, and CDOT. It looks as though three universities are collaborating on driver modeling, rideshare modeling, and TNC optimization. The presented results however lack these detailed model outcomes.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer said the proposed future research work is broad and logically planned. A validation of TNC simulation models with realistic data should be planned along with the simulation development.

Reviewer 2:

The reviewer remarked milestone Slide 4 appears incomplete. A number of difficulties and possible future work options have been indicated, but no plan to address them is included.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said yes, the project supports the DOE objectives by development TNC simulations to analyze the TNC performance including energy consumption.

Reviewer 2:

The reviewer pointed out that including the effect of TNC in ability simulation is relevant.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said yes, the resources seem adequate to conduct the proposed work. The team should leverage realistic TNC data to validate their simulation models.

Reviewer 2:

The reviewer remarked available data are not sufficient, but data are proprietary and not available.

**Presentation Number: eems078
Presentation Title: Simulation Model
Results for Energy and Mobility
Impact of Behavioral Scenarios in
POLARIS
Principal Investigator: Josh Auld
(Argonne National Laboratory)**

Presenter
Josh Auld, Argonne National
Laboratory

Reviewer Sample Size
A total of three reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer said the approach to
validate simulation model is not very
clear.

Reviewer 2:
The reviewer commented the project
approach for this year builds off
previous work under the POLARIS
model framework. Objectives are well-
defined and relevant including
TNC/ridesharing, CAV impacts on time
use and value, and traveler decision
making over time.

Reviewer 3:
Over the years, Argonne National
Laboratory has developed the POLARIS agent-based modeling tool. It makes good sense to utilize it for
behavior modeling and evaluation of induced impact. The reviewer would like to see the comparison results
between POLARIS and BEAM.

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer recommended a detailed sensitivity analysis to further quantify transportation choices.

Reviewer 2:
The reviewer said the project team has made significant progress including model development efforts in the
areas of activity generation, mode choice, activity scheduling, and transit simulation. Efforts to-date have
gained insights on e-commerce and income correlations, and inter-dependencies of transit and TNC.
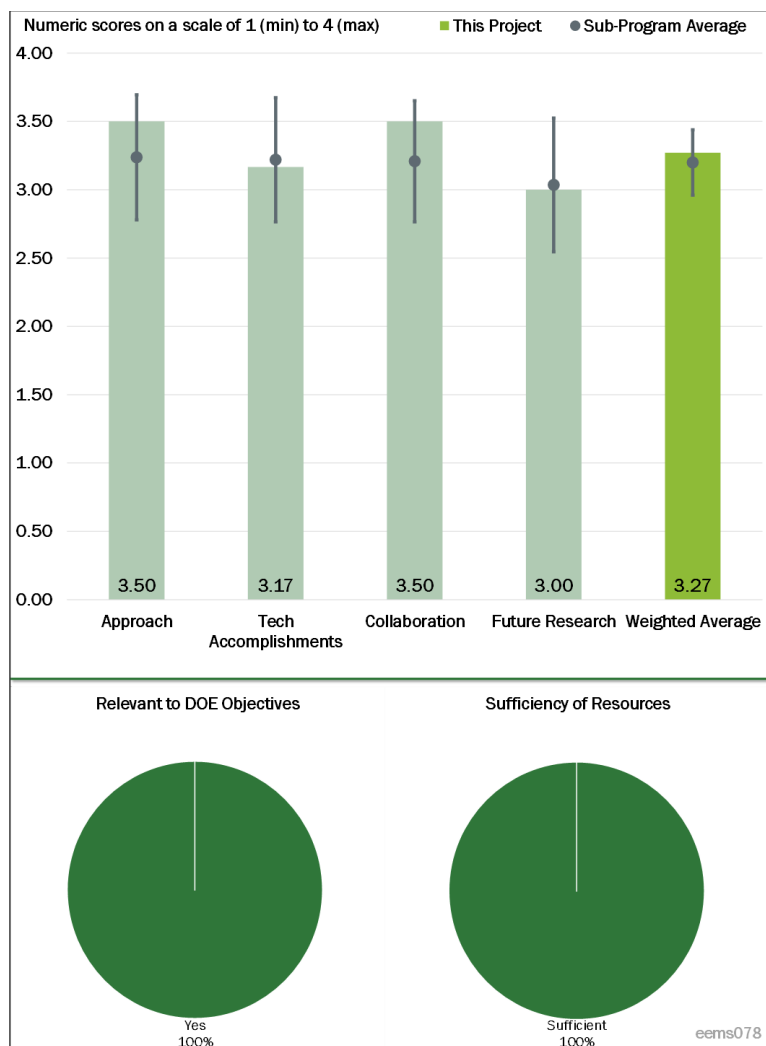

Figure 3-51 – Presentation Number: eems078 Presentation Title:
Simulation Model Results for Energy and Mobility Impact of Behavioral
Scenarios in POLARIS Principal Investigator: Josh Auld (Argonne National
Laboratory)

The reviewer commented the progress made so far seems to be reasonable and the results are interesting. This project seems to be quite related to other on-going projects from different angles, including traffic congestion impact.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer said the researcher exhibited excellent collaborative context with other EEMS-sponsored work. The project has six partners from other labs, government organizations, and universities. Each partner has well-defined roles within the scope of the project.

Reviewer 2:

The reviewer can vision the good mix of team members from academic and public agencies, and the contributions from each of one. For TNC, it would be great to see more data seeds from private companies although the reviewer understood it is always a challenging problem.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer recommended considering a detailed sensitivity model and analysis.

Reviewer 2:

The reviewer said plans have been defined and leverage off previous work. Future focus will be on household travel patterns and TNC business model impacts.

Reviewer 3:

The reviewer admits the value of travel time (VOTT) is one of the key factors to model the behavior change due to these emerging technologies and services. In the future, more other factors beyond VOTT and the closed-loop modeling (e.g., how the behavior change will affect land use) would deserve further investigation.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer said this project supports the overall DOE objectives from the modeling perspectives. The behavior modeling is a very fundamental, important, and challenging topic for energy (evaluation) related research in transportation. Therefore, a valid model would definitely help policy makers to steer the technology development towards a favorable direction.

Reviewer 2:

The reviewer remarked the project is in line with the DOE target to optimize transportation systems.

Reviewer 3:

The reviewer remarked this work continues to be highly relevant to EEMS and smart mobility initiatives.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer can see a good amount of resource and continuing work for the model development in POLARIS. Again, it would be great if those TNC data can be accessed for model validation and more research purposes.

Reviewer 2:

The reviewer commented that there is no evidence for missing or excessive resources.

Reviewer 3:

The reviewer remarked funding appears to be sufficient for the multi-partner team.

Presentation Number: eems079
Presentation Title: Travel-Time Use and Value With Mobility Services
Principal Investigator: Paul Leiby (Oak Ridge National Laboratory)

Presenter
Paul Leiby, Oak Ridge National Laboratory

Reviewer Sample Size
A total of four reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer said this project team did a great job of addressing the barriers of this project. Kudos!

Reviewer 2:
The reviewer remarked the project has clearly defined goals, very good.

Reviewer 3:
The reviewer commented the approach of this project to better understand how a traveler's time use and value impacts their decision to adopted connected and automated vehicles is a valuable fundamental research endeavor.

Figure 3-52 – Presentation Number: eems079 Presentation Title: Travel-Time Use and Value With Mobility Services Principal Investigator: Paul Leiby (Oak Ridge National Laboratory)

Reviewer 4:
The reviewer said the approach of data collection from commuters makes sense with regard to addressing lack of data relative to CAV adoption.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer said the project team focused on the person behavior data and presented it in a very clear and concise manner.

Reviewer 2:
The reviewer remarked that the project team nicely put together a model for travel choices.
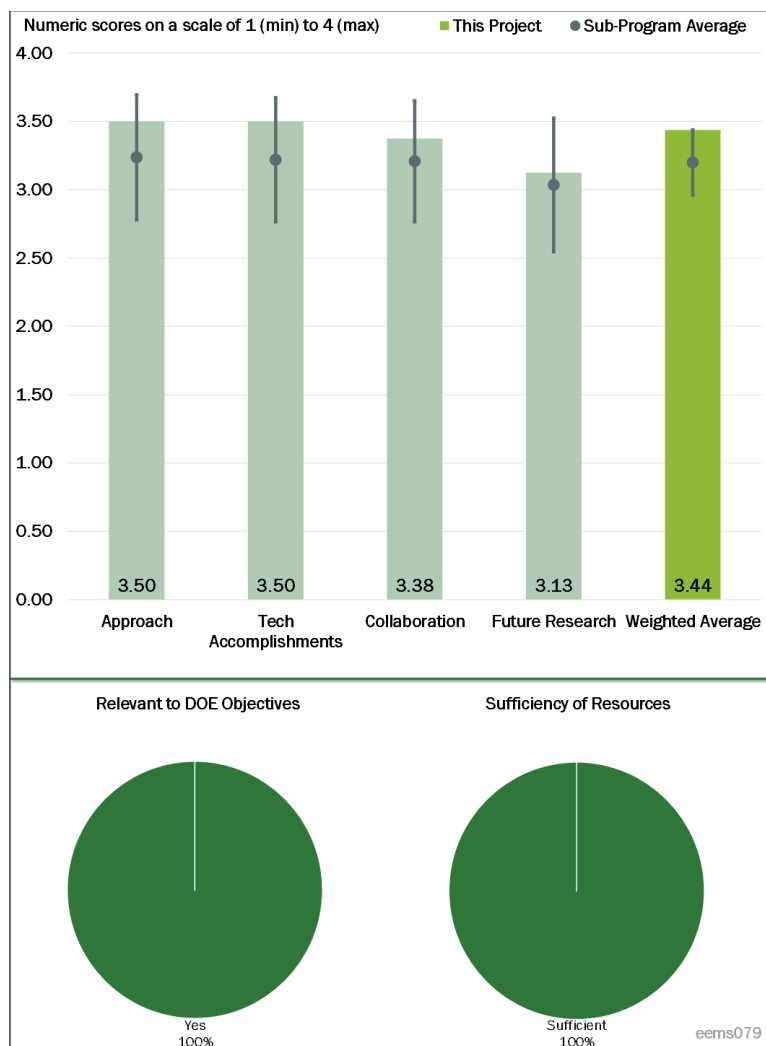
Reviewer 3:

The reviewer commented the project presentation showed good progress on collecting traveler survey data and exploiting the data via utility modeling. One of the conclusions is counter intuitive in that it suggests that multi-tasking reduces the VOTT.

Reviewer 4:

The reviewer remarked as a single year project, the project team has made significant progress toward meeting project objectives, including the production of initial study results on the effects of multitasking on VOTT.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer pointed out that the project provides its results to several other EEMS projects. The project also allows project partners to develop insights into key variables using differing methods. This type of collaboration is useful in that it helps to validate and increase the credibility of the results.

Reviewer 2:

The reviewer said a very good representation of proper actors in this space. Academia, other EEMS programs, and data gathering from Chicago Planning agency.

Reviewer 3:

There reviewer said two key authors were there, which is a very good sign.

Reviewer 4:

The reviewer said that this project has solid coordination but could benefit from more coordination with Whole Traveler Survey data in the future.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:

The reviewer noted a well-thought-out proposal for future research. They represent the next logical steps.

Reviewer 2:

The reviewer stated that the proposed research is not clearly defined.

Reviewer 3:

The reviewer said it is encouraging that the future research recognizes problems relative to inferring multitasking behavior based the current modes, which might be very different from the future mobility technologies. In addition, the reviewer wondered whether the EEMS program has placed too much focus on the VOTT parameter as a determining factor in the potential energy impacts of CAVS and other Smart Mobility transportation modes.

Reviewer 4:

The reviewer said proposed future research demonstrates the value of continued funding of the study of changed VOTT with new mobility services. Need improved clear linkage to energy impacts in future work.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:

The reviewer remarked the project helps establish benchmarks in an area not currently addressed and well represents future mobility trends.

The reviewer commented very relevant and useful research.

Reviewer 3:

The reviewer noted that the project seeks to develop information regarding what determines transportation mode choice and technology adoption.

Reviewer 4:

The reviewer said the project supports overall DOE objectives by improving fundamental understanding of how human behavior will impact the likelihood of automated and shared vehicles, thus informing the energy impacts of these technologies.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer remarked if there is more to support, please do. This is a very good project.

Reviewer 2:

The reviewer said the budget and time allocations seem adequate for the next phase.

Reviewer 3:

The reviewer commented the project has made good progress using the current funding levels.

Reviewer 4:

The reviewer said the limited timeline of the project is adequately served by the funding size of the project.

Presentation Number: eems080
Presentation Title: Typology of Cities for Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium
Principal Investigator: Paty Romero-Lankao (National Renewable Energy Laboratory)

Presenter
Paty Romero-Lankao, National Renewable Energy Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this project.

Question 1: Approach to performing the work—the degree to which technical barriers are addressed, the project is well-designed and well-planned.

Reviewer 1:
The reviewer pointed out the approach leverages existing efforts (Cities Leading through Energy Analysis and Planning [Cities-LEAP], MEP, and FHWA typology) and literature reviews to examine links between population clusters and adoption/impacts. A robust multi-layer typology resource data set from Cities-LEAP with 20 indicators is used to identify clusters of features in emergent transportation behavior and energy use across urban areas and socio-economic status groups.

Figure 3-53 – Presentation Number: eems080 Presentation Title: Typology of Cities for Systems and Modeling for Accelerated Research in Transportation (SMART) Mobility Consortium Principal Investigator: Paty Romero-Lankao (National Renewable Energy Laboratory)

Reviewer 2:
The reviewer said the approach incorporates several variables relevant to studying adoption of Smart Mobility technologies. This reviewer would like to have seen several hypotheses that could serve as focus or validation points for the study. That would allow the correlation information developed to have some immediate value added to reaching DOE objectives.

Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which progress has been made and plan is on schedule.

Reviewer 1:
The reviewer remarked the correlation matrix shows links between socio-economic status and urban form indicators as well as between urban form and impacts indicators.
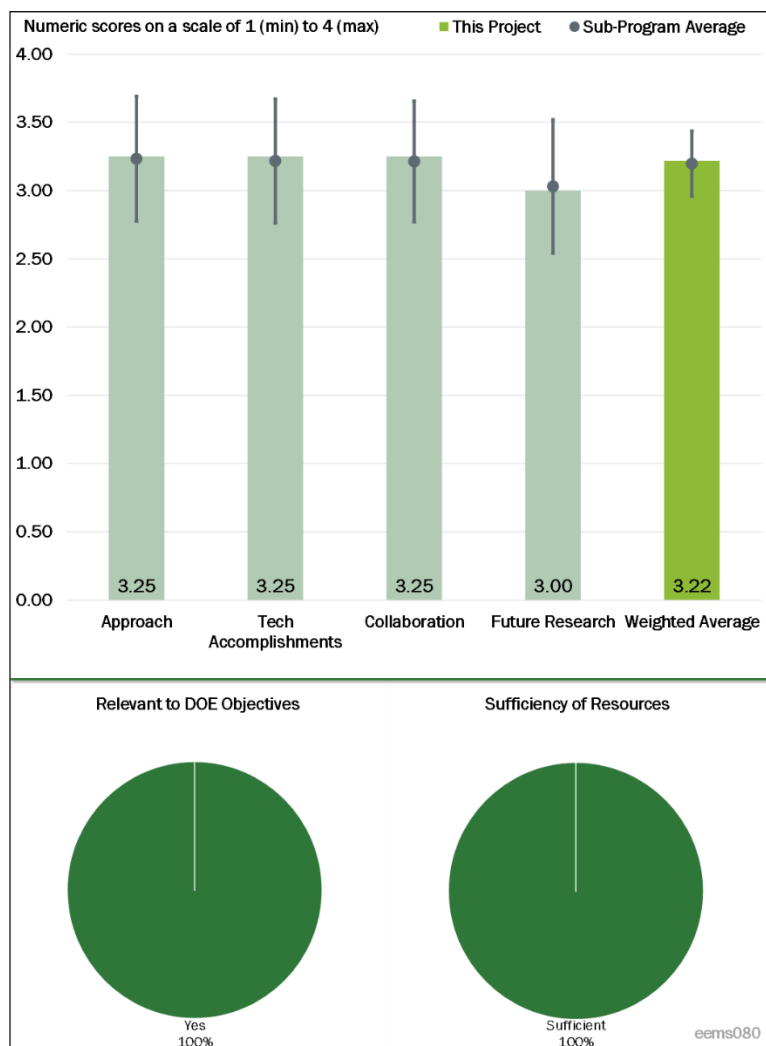
The reviewer commented the project presentation was able to show a correlation matrix that indicated relationships between the study variables.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer pointed out collaboration with Lawrence Berkeley National Laboratory to compare applicability to freight transport of clustering methods. Collaborations with several universities on typology including Massachusetts Institute of Technology and Colorado School of Mines; Pennsylvania State University/Western State University collaboration is pending. The reviewer noted Cities-LEAP collaboration for data on typology resources through SMART Mobility consortium.

Reviewer 2:
The reviewer said the project appears to have a broad range of collaborative activities in the work plan. The reviewer had the impression that most of these activities will occur in the near future.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted that if the typology is successful, identifying sub-units in urban areas would be a good next step for informing difficulties in the adoption of efficient transportation technologies and help provide tools to project adoption scenarios.

Reviewer 2:
The reviewer said the proposed future research recognizes that a significant risk is the lack of indicators of energy use and emissions by transport at a finer level of resolution. This statement deserves an associated risk mitigation strategy prior to the new research being funded.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer remarked this project is relevant to overall DOE objectives as it aims to enhance the value of SMART Mobility efforts by making relevant outcomes transferable among cities with similar characteristics. It also strives to create a multi-dimensional typology of adoption and impacts of emerging technologies via GIS.

Reviewer 2:
The reviewer said the project has potential to increase understanding of the common and unique drivers that influence transportation mode decisions across several U.S. metropolitan areas.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said the funding of $300,00 for a 10-month project and outlined scope seems appropriate to achieve the milestones.

Reviewer 2:
The reviewer commented the project appears to making progress at the current funding levels. Because it is early in this project's timeline, the reviewer would like to gauge the productivity and utility of the project results at the end of the period of performance to determine whether the funding was excessive or sufficient.

**Presentation Number: eems081
Presentation Title: Nationwide Energy
and Mobility Impacts of Connected
and Automated Vehicle Technologies
Principal Investigator: David Gohlke
(Argonne National Laboratory)**

Presenter
David Gohlke, Argonne National
Laboratory

Reviewer Sample Size
A total of two reviewers evaluated this
project.

**Question 1: Approach to performing
the work—the degree to which
technical barriers are addressed, the
project is well-designed and well-
planned.**

Reviewer 1:
The reviewer commented the approach
includes relevant literature review about
factors, which might impact energy
consumption in light-duty connected
and automated passenger vehicles to
update upper and lower nationwide
bounds for energy consumption. This
includes estimation of statistical
distribution of probable energy
outcomes from a variety of CAV
technologies. The reviewer said the
initial 2016 publication was widely
referenced and this update is timely.

Reviewer 2:
This reviewer appreciated that this
project is trying to think through the independent variables and their possible inter relationships in the context
of how they impact the key dependent variable of energy consumption.

**Question 2: Technical Accomplishments and Progress toward overall project goals—the degree to which
progress has been made and plan is on schedule.**

Reviewer 1:
The reviewer remarked energy consumption by CAVs has been investigated using the same methodology as in
the previous report with updated numbers and factors. Interactions between various factors have also been
considered and preliminary analysis has been conducted.

Reviewer 2:
The reviewer commented the project's poster at AMR showed results that incorporated several new
independent variables, independent variable ranges, considerations for linkages between independent variables,
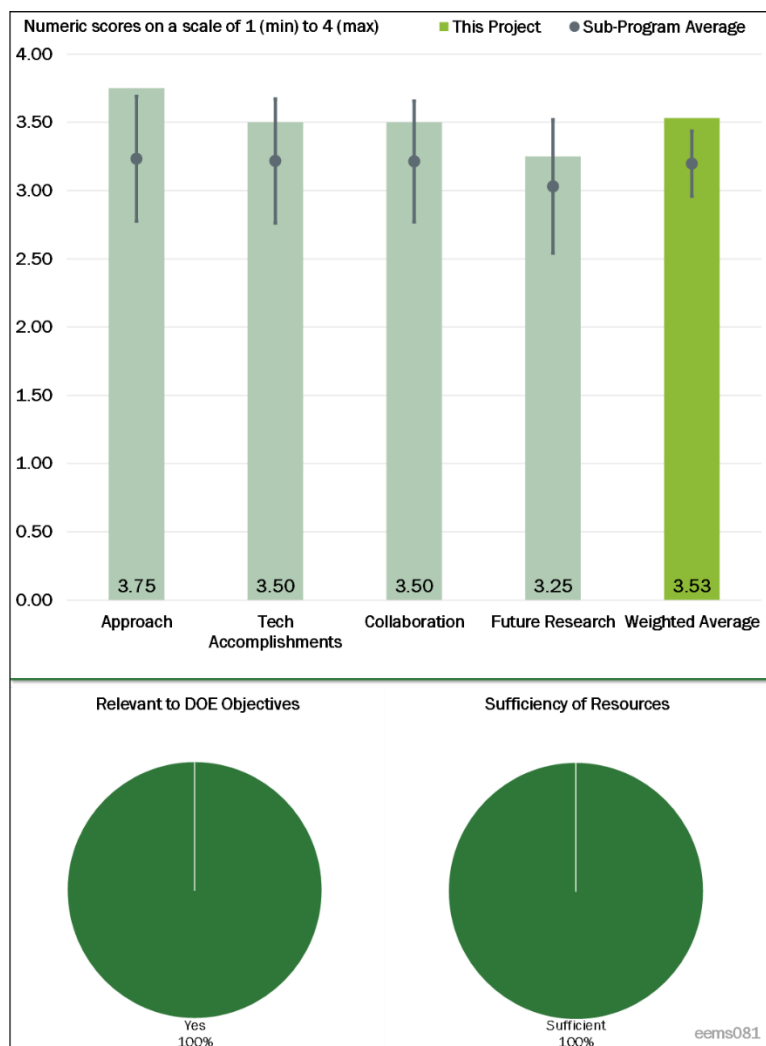

Figure 3-54 – Presentation Number: eems081 Presentation Title:
Nationwide Energy and Mobility Impacts of Connected and Automated
Vehicle Technologies Principal Investigator: David Gohlke (Argonne National
Laboratory)

and Monte-Carlo simulation/analysis. Taken together, these additions significantly increase the completeness and sophistication of study conclusions when compared to the original analysis.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer pointed out that Argonne National Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory are closely collaborating on this important effort. Data inputs come from the SMART Mobility laboratory consortium, which also includes Idaho National Laboratory and Lawrence Berkeley National Laboratory.

Reviewer 2:
There is not enough evidence of who is doing what on this project for this reviewer to evaluate how well the team is collaborating. The slides indicate that three laboratories are collaborating on the project.

Question 4: Proposed Future Research—the degree to which the project has effectively planned its future work in a logical manner by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and, when sensible, mitigating risk by providing alternate development pathways.

Reviewer 1:
The reviewer noted this is only a 1-year project, future work will refine interactions between different factors and quantify specific numbers to harmonize data from different studies.

Reviewer 2:
The reviewer did not see evidence of decision points in the proposed future research. The reviewer likes the proposed inclusion of scenario exercises. This work may benefit from a validation exercise that involves gaming by transportation subject matter experts. This gaming exercise would allow for relationships and assumptions to be discussed in a group environment. The discussion by "smart guys in a room" and back of the envelope calculations of this analysis is its strength and should be continued in future research.

Question 5: Relevance—Does this project support the overall DOE objectives?

Reviewer 1:
The reviewer said this project supports the overall DOE objectives as it helps quantify the potential energy consumption impacts of CAV technologies in the EEMS overall workflow of smart mobility. This in turn supports increasing mobility without increasing energy consumption; hence, directly supporting the VTO goal of reducing petroleum use.

Reviewer 2:
The reviewer remarked this analysis is directly relevant to achieving DOE's objective to evaluate the energy consumption impacts of CAVS and other SMART Mobility transportation modalities.

Question 6: Resources—How sufficient are the resources for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:
The reviewer said the allocation, $260,000, for this 1-year effort to update the energy consumption impacts of CAV technologies seems appropriate.

Reviewer 2:
The reviewer commented the project has produced significant progress toward its stated objectives using the current resource allocation.

Acronyms and Abbreviations

21CTP	21st Century Truck Partnership
ACC	Adaptive cruise control
AMBER	Advanced Model Based Engineering Resource
AMD	Automated mobility district
AMR	Annual Merit Review
ANL	Argonne National Laboratory
API	Application programming interface
ARPA-E	Advanced Research Projects Agency – Energy
ATC	Advanced traffic control
ATCS	Adaptive traffic control system
ATM	Active traffic management
ATSC	Active traffic signal control
AV	Automated vehicle
BEAM	Behavior, Energy, Autonomy, and Mobility
BEV	Battery electric vehicle
CACC	Cooperative adaptive cruise control, coordinated adaptive cruise control
CalTrans	California Department of Transportation
CAV	Connected and autonomous vehicle
CAVESIM	Connected and Automated Vehicle Energy Simulation
CC	Cruise control
Cities-LEAP	Cities Leading through Energy Analysis and Planning
CRADA	Cooperative research and development agreement
CRM	Coordinated ramp metering
CV	Connected vehicle
DCFC	Direct current fast charging
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation

DSRC	Dedicated short-range communications
DWPT	Dynamic wireless power transfer
Eco-CAC	Eco-Cooperated Automated Control
EEMS	Energy Efficient Mobility Systems
EPA	U.S. Environmental Protection Agency
EPM	Employer-provided mobility
EVI-Pro	Electric Vehicle Infrastructure Projection Tool
FAF	Freight analysis framework
FASTSim	Future Automotive Systems Technology Simulator
FHWA	Federal Highway Administration
FY	Fiscal Year
GATE	Graduate Automotive Technology Education
GDP	Gross domestic product
GHG	Greenhouse gas
GIS	Geographic information system
GPS	Global positioning system
GTFS	General transit feed specification
HD	Heavy-duty
HDV	Heavy-duty vehicle
HEV	Hybrid electric vehicle
HH	Household
HIL	Hardware-in-the-loop
HPC	High performance computing
I2V	Infrastructure to vehicle
ICE	Internal combustion engine
INL	Idaho National Laboratory
ITE	Institute of Transportation Engineers
ITS	Institute of Transportation Studies

km	Kilometer
kW	Kilowatt
LA Metro	Los Angeles County Metropolitan Transportation Authority
LBNL	Lawrence Berkeley National Laboratory
LD	Light-duty
LDV	Light-duty vehicle
LOS	Level of service
MA3T	Market Acceptance of Advanced Automotive Technologies
MA3T-MC	MA3T-Mobility Choice
MaaS	Mobility-as-a-system
MCV	Manually controlled vehicle
MD	Medium-duty
MDS	Mobility decision science
MDV	Medium-duty vehicle
MEP	Mobility energy productivity
mi	Mile
ML	Managed lane
MOU	Memorandum of understanding
MOVES	Motor Vehicle Emission Simulator
MPG	Miles per gallon
MPH	Miles per hour
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
NACTO	National Association of City Transportation Officials
NB	Northbound
NDA	Non-disclosure agreement
NEMA	National Electrical Manufacturers Association
NHTS	National Household Traveler Survey

NREL	National Renewable Energy Laboratory
O-D	Origin-destination
OEM	Original equipment manufacturer
ORNL	Oak Ridge National Laboratory
PFD	Parameterized fundamental diagram
PI	Principal Investigator
PMT	Personal miles traveled
POLARIS	Planning and Operations Language for Agent-based Regional Integrated Simulation
PPT	PowerPoint
Q&A	Question and answer
RMSE	Root mean square error
ROI	Return on investment
SAE	Society of Automotive Engineers
SMART	Systems and Modeling for Accelerated Research in Transportation
SME	Subject matter expert
SR	State Route
STTR	Small Business Technology Transfer
SUMO	Simulator of Urban Mobility
SVTrip	Stochastic vehicle trip
SWPT	Stationary wireless power transfer
TCO	Total cost of ownership
TMC	Technology Maintenance Council
TNC	Transportation network company
TPO	Transportation Planning Organization
TRB	Transportation Research Board
TSDC	Transportation secure data center
TSRC	Transportation Sustainability Research Center
TTI	Texas Transportation institute

UCB	University of California at Berkeley
UIC	University of Illinois at Chicago
UPS	United Parcel Service
V2I	Vehicle to infrastructure
V2I	Vehicle to infrastructure
V2V	Vehicle to vehicle
V2X	Vehicle to anything
VAD	Vehicle awareness device
VCD	Vehicle communication device
VIL	Vehicle-in-the-loop
VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle miles traveled
VOTT	Value of travel time
VSA	Vehicle speed advisory
VSL	Variable speed limit
VTO	Vehicle Technologies Office
VTTI	Virginia Tech Transportation Institute
WTF	Workflow Task Force
WTS	Whole Traveler Survey
xEV	Reference to an electric vehicle, including battery electric vehicle (BEV), hybrid electric vehicle (HEV), plug-in hybrid electric vehicle (PHEV), etc.