

### 3. Energy Efficient Mobility Systems

The Vehicle Technologies Office (VTO) supports research, development, deployment, and demonstration (RDD&D) of new, efficient, and clean mobility options that are affordable for all Americans. The office's investments leverage the unique capabilities and world-class expertise of the national laboratory system to develop new innovations in vehicle technologies, including: advanced battery technologies; advanced materials for lighter-weight vehicle structures and better powertrains; 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); combustion engines to reduce greenhouse gas (GHG) emissions; and technology deployment and integration at the local and state level. In coordination with the other offices across the Office of Energy Efficiency and Renewable Energy (EERE) and the U.S. Department of Energy (DOE), the Vehicle Technologies Office advances technologies that assure affordable, reliable mobility solutions for people and goods across all economic and social groups; enable and support competitiveness for industry and the economy/workforce; and address local air quality and use of water, land, and domestic resources.

The Energy Efficient Mobility Systems (EEMS) subprogram supports research, development, and demonstration of innovative mobility solutions that improve the affordability, accessibility, and energy productivity of the overall transportation system. EEMS leverages emerging disruptive technologies such as connected and automated vehicles, information-based mobility-as-a-service platforms, and artificial intelligence-based transportation control systems to accelerate the transition to a zero carbon-emission transportation future. The EEMS subprogram also develops and utilizes large-scale transportation modeling and simulation capabilities to evaluate the impacts of new mobility solutions across multiple geographies and populations, ensuring that all Americans, especially underserved and energy communities, benefit from the development and deployment of clean transportation technologies.

The EEMS subprogram consists of two primary activities: Computational Modeling and Simulation, and Connectivity and Automation Technology. The subprogram's overall goal is to identify feasible system-level pathways and develop innovative technologies and systems that can dramatically improve mobility energy productivity for individuals and businesses when adopted at scale. The EEMS subprogram has developed a quantitative metric for mobility energy productivity, which measures the affordability, energy efficiency, convenience, and economic opportunity derived from the mobility system. The metric, while encompassing multiple vehicle classes and modes for passenger and goods movement, is used by the subprogram to evaluate success and by the transportation community to inform planning decisions. The EEMS subprogram's target is a 20 percent improvement in mobility energy productivity by 2040 relative to a 2020 baseline.

## 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
eems013	ANL Core Tools: AMBER and Autonomie	Phil Sharer (ANL)	3-5	3.25	3.13	3.50	3.13	<b>3.20</b>
eems037	Big Data Solutions for Mobility	Jane Macfarlane (LBNL)	3-9	3.25	3.25	3.00	3.00	<b>3.19</b>
eems041	ANL Core Tools-Hardware	Kevin Stutenberg (ANL)	3-11	3.00	2.88	3.38	3.13	<b>3.00</b>
eems061	Scaling up the Realtime Data, Simulation and Artificial Intelligence (AI) and Control for Optimizing Regional Mobility	Jiboananda Sanyal (ORNL)	3-15	3.50	3.33	3.67	3.33	<b>3.42</b>
eems062	Deep-Learning for Connected and Automated Vehicle (CAV) Development	Robert Patton (ORNL)	3-19	3.50	3.50	3.50	3.50	<b>3.50</b>
eems066	Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing	Lauren Spath-Luhning (NREL)	3-23	3.25	3.63	3.50	3.00	<b>3.44</b>
eems067	Virtual and Physical Proving Ground for Development and Validation of Future Mobility Technologies	Dean Deter (ORNL)	3-28	3.38	3.38	3.38	3.00	<b>3.33</b>
eems069	Next Generation Intelligent Traffic Signals for the Multimodal, Shared, and Automated Future	Andrew Powch (Xtelligent)	3-32	2.83	3.00	3.50	3.17	<b>3.04</b>

2021 VTO ANNUAL MERIT REVIEW RESULTS REPORT – ENERGY EFFICIENT MOBILITY SYSTEMS

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems082	Validation of Connected and Automated Mobility System Modeling and Simulation	Reuben Sarkar (American Center for Mobility)	3-36	3.50	3.33	3.33	3.17	3.35
eems083	CIRCLES: Congestion Impact Reduction via CAV-in-the-Loop Lagrangian Energy Smoothing	Alexandre Bayen (University of California at Berkeley)	3-39	3.50	3.50	3.83	3.33	3.52
eems084	Energy-Efficient Maneuvering of Connected and Automated Vehicles (CAVs) with Situational Awareness at Intersections	Sankar Rengarajan (Southwest Research Institute)	3-42	3.25	3.50	3.13	3.50	3.39
eems087	Computation of Metropolitan-Scale, Quasi-Dynamic Traffic Assignment Models Using High Performance Computing	Jane Macfarlane (LBNL)	3-46	3.50	3.50	3.00		3.43
eems088	Chicago Transit Authority: Transit Network Efficiency Using POLARIS	Omer Verbas (ANL)	3-49	3.17	3.33	3.33	3.00	3.25
eems089	Energy Efficient CAVs: Workflow Development and Deployment	Dominik Karbowski (ANL)	3-53	3.33	3.33	3.50	3.17	3.33
eems091	TCF: Ubiquitous Traffic Volume Estimation	Venu Garikapati (NREL)	3-56	2.83	2.83	2.83	2.83	2.83
eems092	BEAM CORE	Anna Spurlock (LBNL)	3-59	3.25	3.08	3.58	3.33	3.22
eems093	Transportation System Impact: POLARIS Workflow Development, Implementation and Deployment	Aymeric Rousseau (ANL)	3-63	3.00	2.88	3.38	2.88	2.97

2021 VTO ANNUAL MERIT REVIEW RESULTS REPORT – ENERGY EFFICIENT MOBILITY SYSTEMS

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
eems094	Development and Validation of Intelligent CAV Controls for Energy-Efficiency	Dominik Karbowski (ANL)	3-67	3.50	3.25	3.50	3.25	<b>3.34</b>
eems095	Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use	Timothy Laclair (ORNL)	3-71	3.33	3.17	3.50	3.00	<b>3.23</b>
eems096	Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies, Sensors, and Connectivity	Thomas Wallner (ANL)	3-74	3.13	3.13	3.25	3.13	<b>3.14</b>
eems097	Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE)	Andrew Duvall (NREL)	3-78	3.38	3.00	3.38	3.00	<b>3.14</b>
eems098	Optimizing Drone Deployment for More Effective Movement of Goods	Victor Walker (INL)	3-82	3.25	3.00	3.00	3.00	<b>3.06</b>
eems099	Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems	Venu Garikapati (NREL)	3-86	3.50	3.38	3.75	3.38	<b>3.45</b>
eems100	Dynamic Curb Allocation	Chase Dowling (PNNL)	3-90	3.50	3.50	3.25	3.13	<b>3.42</b>
eems101	RealSim	Dean Deter (ORNL)	3-94	3.50	3.00	3.25	3.38	<b>3.20</b>
<b>Overall Average</b>				<b>3.29</b>	<b>3.22</b>	<b>3.38</b>	<b>3.17</b>	<b>3.25</b>

**Presentation Number: eems013**  
**Presentation Title: ANL Core Tools: AMBER and Autonomie**  
**Principal Investigator: Phil Sharer (Argonne National Laboratory)**

Presenter

Phil Sharer, Argonne National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

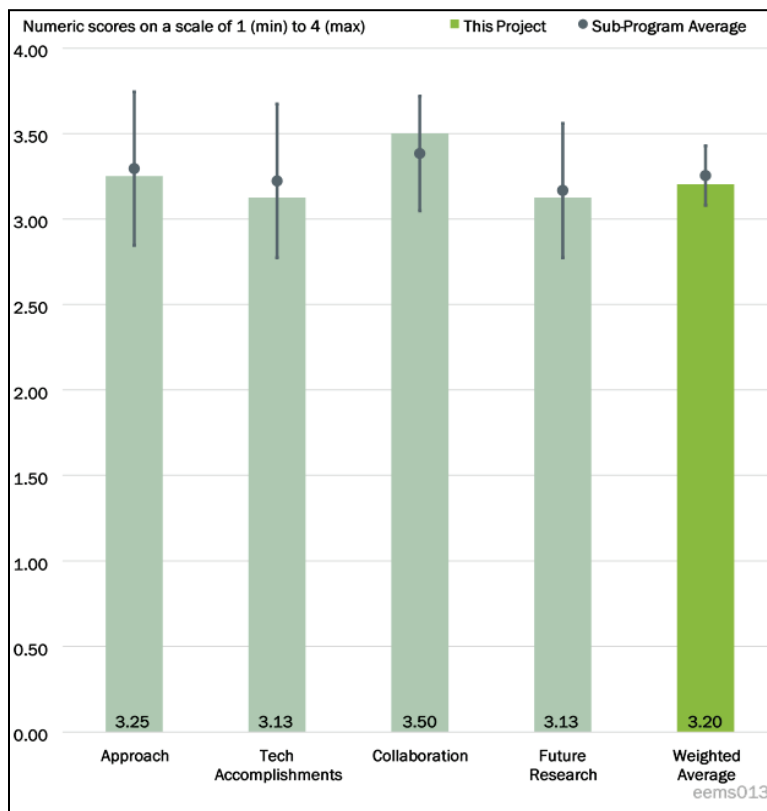


Figure 3-1 - Presentation Number: eems013 Presentation Title: ANL Core Tools: AMBER and Autonomie Principal Investigator: Phil Sharer (Argonne National Laboratory)

**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 observed a strong approach with the Advanced Model Based Engineering Resource (AMBER) model-based design framework supporting any system simulation workflows and the Autonomie vehicle system simulation continuously collecting data and inputs from many different sources. Reference to this project and Core tools by many other Vehicle Technologies Office (VTO) Annual Merit Review (AMR) presentations—28 referenced them during the 2020 AMR—shows the effectiveness of addressing barriers.

Reviewer 2:

According to the reviewer, continuous improvements in the tool set, methods, available models, and distribution scheme address these critical issues in carrying out successful analyses—wider tool availability, ease of use of many moving parts, and good models.

Reviewer 3:

This reviewer noted the team has done a good job of addressing concerns that were expressed in previous reviews and has kept improving the tool chain and processes every year.

Reviewer 4:

The reviewer stated that this is a collection and integration of complex models. This level of layering and handoff always adds complexity and uncertainty and can reduce transparency and traceability in the model.

The reviewer indicated that a presentation with less marketing and more detailed discussion of the technical issues is needed to sufficiently understand how this is handled. The material did not appear responsive to prior concerns from the 2020 AMR, which should remain active and will need to be addressed moving forward. The reviewer noted that the narrative focuses too much on what it can do and does not effectively discuss constraints—for what it can or should not do or be used. How is the model useful and what are its bounds of usefulness?

***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 progress over the last year has been excellent; Autonomie EXPRESS is a very welcome addition for users who do not necessarily develop vehicle models but need to use them in analysis. The progress in adding new features that reflect new control schemes and powertrain configurations has been very good.

Reviewer 2:

The reviewer noted that many new accomplishments have been made over the past year highlighting several important additions to the Core models. More than 140 new features and enhancements have been added over the past year based on user feedback (including government, academia, and industry). Autonomie EXPRESS has been added as a new and faster version with a large number of predefined vehicles to increase tool adoption by targeted users, not just the developer. The new workflow has been developed to estimate energy and costs from the most commonly used microsimulation tools. Autonomie was also updated to evaluate new and emerging technologies with a focus on medium-duty (MD) and heavy-duty (HD) vehicle applications.

Reviewer 3:

The reviewer asserted that the slide deck focuses on the initiatives but does not clearly articulate the goals beyond two releases per year. Every year, the presenter(s) conveys how much the model has improved and how powerful it is. This implies that, in fact, there were a lot of weaknesses and gaps in prior years. The reviewer suggested that work needs to be more forthright with regard to the limits and gaps relative to the desired end state.

Reviewer 4:

Although excellent progress was observed, the reviewer did have some concerns about the direction that the overall project is taking. Specifically, commercialization of the tool and addition of multiple new features will require significant resources on the part of the ANL team to support customers (especially industry customers), which may be detracting from the key responsibilities of the national laboratories. On the one hand, the reviewer realized that commercial tools that can do the same job are unavailable; so, tools that address the specific simulation needs have to be developed. The ANL team has to find a way to balance the dual requirements of developing, maintaining, and supporting the tools, and using the tools to perform simulations and generate data that can be used to support and advise the DOE objectives and priorities.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer commented that the team has taken feedback from the user community and other stakeholders who need the results generated by the tool and has done a good job of addressing the needs of the community. The user base covers both academia and industry.

Reviewer 2:

According to the reviewer, the work is designed to foster alignment and collaboration and does it well. Collaborators contributed important input that was acted upon by the team.

Reviewer 3:

The reviewer said that the Core tools are developed and supported by Argonne National Laboratory (ANL). Users include companies and research and development (R&D) organizations. The collaboration takes place in terms of user feedback via technical support requests. Core tools are used by many VTO R&D projects (primarily in the Vehicle Analysis [VAN] and Energy Efficient Mobility Systems [EEMS] research areas).

Reviewer 4:

This reviewer referenced prior comments and indicated that the large number of users can provide useful feedback that allow the tools to be improved as well as plant seeds that could lead to future productive areas of research.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The proposed future work is a natural outgrowth of the work done to date and supports EEMS ongoing objectives. The plan to support users appeared sound to the reviewer, given the expanding feature set.

Reviewer 2:

Proposed future work looked good to this reviewer, who commented that it would be worth ensuring that Autonomie Express can run using Octave besides Matlab, thereby making it truly “free.” Of course, this assumes that Autonomie Express is available for anyone to use. Otherwise, this reviewer opined that institutional users of Autonomie Express probably would not have a problem because they would have access to Matlab.

Reviewer 3:

This reviewer reported that Fiscal Year (FY) 2021 was the last year of this project. Because many VTO R&D projects in VAN and EEMS area rely on the Core tools, the reviewer asserted that it is important to continue supporting these projects. The challenge with these increasingly sophisticated tools will be to maintain their support and licenses—over 25 different software packages are used. The reviewer commented that proposed future work includes expanding the workflow and model capabilities as well as expanding stakeholder engagement and deployment. If not used already, the reviewer suggested that perhaps a technical advisory committee comprised of several key stakeholders—U.S. Department of Energy (DOE), VAN and EEMS Technology Managers, key national laboratory researchers, automotive industry partners, and other research organizations—could be helpful to provide future development direction and ensure Core tools continue supporting the VTO R&D mission.

Reviewer 4:

The reviewer stated that there is good coverage of the “what” but not the “how.”

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer commented that this project directly supports VTO objectives by developing simulation tools and models that are widely used across the VAN and EEMS research areas. In AMR 2020, 28 projects were related to AMBER and Autonomie, which are the two main tools supported by this effort. The EEMS Core Tools

project has supported VTO R&D target setting and benefits analysis across these program areas as well as the 21st Century Truck Partnership and United States Driving Research an Innovation for Vehicle Efficiency and Energy sustainability (U.S. DRIVE).

Reviewer 2:

The software tools generated by this project are some of the main vehicle and transport system modeling tools used for EEMS studies. The reviewer indicated that they are mission critical.

Reviewer 3:

The reviewer stated that the work is at the core of the VTO systems simulation. At a high level, the work is the type of activity that supports transportation energy efficiency.

Reviewer 4:

This reviewer stated that the core tools form a critical part of the Systems and Modeling for Accelerated Research in Transportation (SMART) mobility workflow.

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

Reviewer 1:

Resources appeared adequate to the reviewer. As the number of users grows, that may change. The team appears to have thought about this and made appropriate plans.

Reviewer 2:

Resources seemed sufficient to this reviewer, with the details covered in individual projects.

Reviewer 3:

Resources are sufficient from this reviewer's perspective.

Reviewer 4:

This project was funded at \$1.25 million per year over 3 years, which seemed sufficient to the reviewer. However, future work in this area should be managed to ensure that Core capabilities are maintained and new capabilities are added, while not expanding the reach beyond efforts that support the VTO mission if VTO is the only funding source. With numerous software licenses and simulation platforms, the reviewer asserted that it can be very challenging to maintain all the systems without needing to increase funding.



**Presentation Number: eems037**  
**Presentation Title: Big Data Solutions for Mobility**  
**Principal Investigator: Jane Macfarlane (Lawrence Berkeley National Laboratory)**

**Presenter**

Jane Macfarlane, Lawrence Berkeley National Laboratory

**Reviewer Sample Size**

A total of two reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

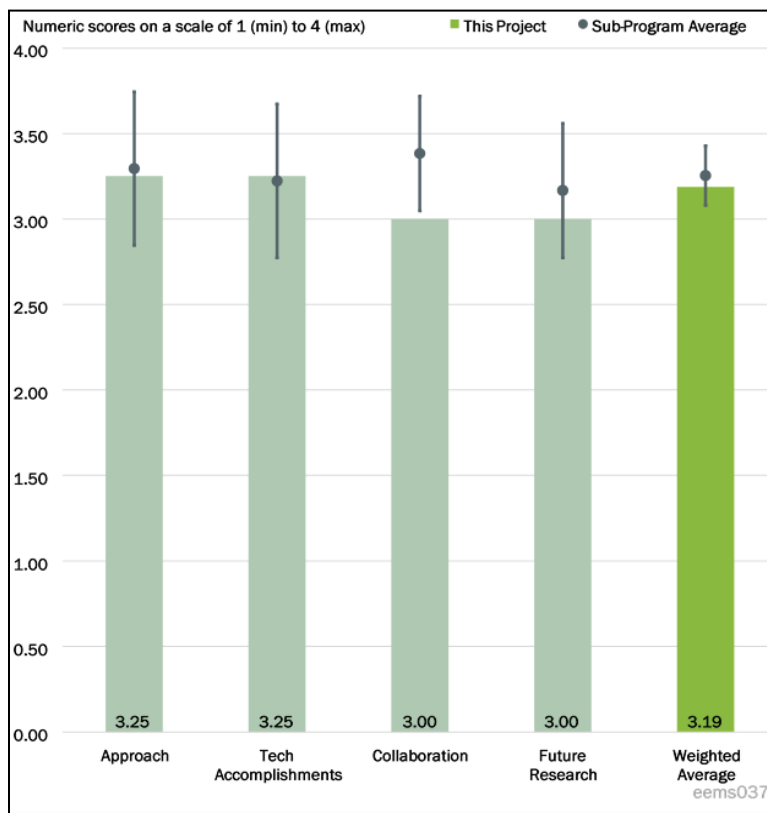


Figure 3-2 - Presentation Number: eems037 Presentation Title: Big Data Solutions for Mobility Principal Investigator: Jane Macfarlane (Lawrence Berkeley National Laboratory)

**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 observed a fascinating concept and thought that the approach got caught up too much in the technology.

Reviewer 2:

This reviewer described the approach as well planned and timely in the face of increasing congestion. Looking forward, the reviewer wondered if the future is taken into account. For example, if traffic doubles, would the model be effective?

**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:

Although this project is just getting started, the reviewer found the choice of partnering with Uber interesting.

Reviewer 2:

The reviewer indicated that the project, which is on a timeline of 2 years, seems to show a 10% completion rate so far. The reviewer observed that the project team may need to increase the pace, taking into account a pandemic accounted for over a year of lost time. The integration of the Diffusion Convolutional Recurrent Neural Network DCRNN into Mobility was a major step in incorporating more ability to decipher data inputs.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

This reviewer reiterated that this is just getting started and was curious as to what the cities want out of this project. How can it really help them and how could this be used—for traffic routing when there are rolling blackouts, or if there is an earthquake? The reviewer expressed interest in seeing this tied to electrical grid concerns.

Reviewer 2:

It appeared to the reviewer as though the teams are very well organized and able to make great progress collaborating with each other. The reviewer noticed that there seemed to be a lack of another department of transportation that could lend valuable data on traffic, patterns, road conditions, and construction.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer was also at “good” here. The reviewer thought there is more a fascination with the modeling versus asking what it can really do and what big problems the project team would like to see resolved. The reviewer thought that more work needs to be done on that and was unsure if this is going to be “handed over” to a user.

Reviewer 2:

This reviewer noted the first point on the Future Research slide was “Finding appropriate data to improve our data driven approach.” The reviewer did not know what the appropriate data means. It sounds as though what the project team is currently using is not what it really wants, or not what it is really looking for.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer stated that the overall project looks for ways to reduce traffic congestion, which results in excessive idle time, energy inefficiency, harmful air pollutants, and motivation to entertain alternative fuel vehicles.

Reviewer 2:

The reviewer asserted that this project supports the overall DOE objectives, but suggested that this needs more thought. The reviewer was more interested in whether this can be used for rolling blackouts on the West Coast, if the grid crashes in a certain region, for EV charger modeling, disaster planning, and/or helping with autonomous vehicle (AV) roll-out.

***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, but the reviewer believed that U.S. Department of Transportation (DOT) information would be helpful.

Reviewer 2:

Although the project is just getting started, the reviewer emphasized that the project team should think bigger.

**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 four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

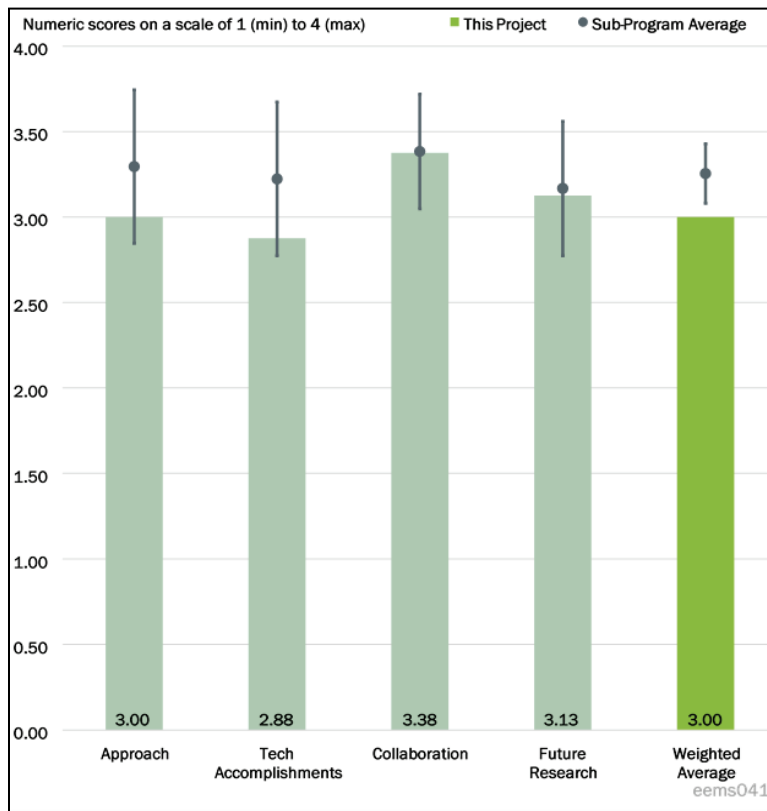


Figure 3-3 - Presentation Number: eems041 Presentation Title: ANL Core Tools-Hardware Principal Investigator: Kevin Stutenberg (Argonne National Laboratory)

**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 of creating an advanced mobility technology lab on a four-wheel chassis dynamometer is an excellent foundational step to testing algorithms and control for connected and automated vehicles (CAVs).

Reviewer 2:

Given the constraints imposed by vehicle testing and the degree to which original equipment manufacturer (OEM) vehicle controls are accessible, the reviewer found that the approach taken is very good. The team has developed a good mix of techniques to get the data needed to assess a moving technology that is still at a nascent stage.

Reviewer 3:

The approach was reasonable to this reviewer, who commented that vehicle-in-the-loop (VIL) is necessary for calibrating and validating simulations.

Reviewer 4:

The reviewer indicated that the project is tackling relevant issues related to simulation versus the real world. As the reviewer noted in a prior review, there is a need to generalize findings. The response was insufficient and there remains concern over what this means for real-world data versus specific controlled experimental data and the relationship to system-wide energy impacts.

***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 work on VIL has been excellent and integral to related EEMS projects. The on-road test data acquisition process has been well done, and results—such as measurement of road load changes due to aerodynamics of platoons—is of great interest. The reviewer further observed good use of open-source solutions.

Reviewer 2:

The reviewer stated that accomplishments are solid and include the integration of direct override and actuator methods for the longitudinal dynamics of 15 experimental vehicles, alignment with the EcoCAR VIL system, use of the SMART 2.0 workflow for controls and model development, integration of open-source solutions (i.e., Simulation of Urban Mobility [SUMO] and Computer-Assisted Related Language Adaptation [CARLA]), integration of microsimulation (i.e., Advanced Interactive Microscopic Simulator for Urban and Non-Urban Networks [AIMSUN]) for multi-vehicle traffic, collaborative testing across facilities, and refinement of aerodynamic models.

Reviewer 3:

According to the reviewer, progress is satisfactory considering the delays due to coronavirus disease 2019 (COVID-19).

Reviewer 4:

The reviewer remarked that direct microsimulation testing results show a large difference—34.44%--and questioned if there is really this level of precision. This difference should be viewed as a substantial problem for the results and usability. The differences are likely to increase as more complexity is added with more vehicles. The ANL XIL data appear fitted to the chassis dynamometer results; so, the good match is as expected. How generalizable to the real world are the results and what is the real knowledge? The reviewer commented that aerodynamic results were unclear, better results at a wider gap are antithetical to the intended use of CAVs, and the explanation for not doing smaller gaps was insufficient.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer reported that this work is tied into several other projects and noted excellent collaboration to achieve the results demonstrated.

Reviewer 2:

The reviewer found that this project is foundational to a few other projects, indicating that the project team collaborates and coordinates with the broader community very well.

Reviewer 3:

There appeared to the reviewer to be good collaboration between ANL, EcoCAR, and DOT National Highway Traffic Safety Administration (NHTSA), on this project.

Reviewer 4:

The collaboration appeared to the reviewer to be sufficient to accomplish the work and provide necessary support.

**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. Note: if the project has ended, please state project ended.**

Reviewer 1:

The reviewer stated that the proposed future research topics are well formulated and include testing methodologies with the VIL environment, incorporation of vehicle connectivity, standardized communication interfaces, driver-in-the-loop experimental methods, expansion of the vehicle fleet with various powertrains, lateral loads modeling, aerodynamic model refinement, vehicle platooning, etc.

Reviewer 2:

According to the reviewer, the proposed MD and HD work, along with electric powertrains, is likely to be high impact.

Reviewer 3:

The reviewer noted that the next steps follow logically from the work done so far.

Reviewer 4:

This reviewer indicated that future work topics seem appropriate but lack explanation.

**Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?**

Reviewer 1:

The reviewer stated that this project aims to develop and refine an advanced VIL simulation environment that is targeted at simulating CAVs. This will help develop advanced algorithms and control strategies for efficient transportation systems that use less energy and reduce congestion and accidents.

Reviewer 2:

This reviewer asserted that the project supports the overall DOE objectives. Having VIL for simulations can help validate simulation results and ascertain energy impacts of control strategies.

Reviewer 3:

The reviewer said that vehicle testing and data collection are needed to establish ground truth for many of the simulation studies that are being done as part of EEMS.

Reviewer 4:

The reviewer remarked that the work supports the objective by trying to bring empirical calibration to DOE's models.

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

Reviewer 1:

Resources appeared adequate to the reviewer, given vehicle availability. The team has managed the COVID-19 disruptions of the last year fairly well.

Reviewer 2:

This reviewer commented that work is being accomplished despite COVID-19. The reviewer further explained that technical expertise and equipment needed are part of the project and no obvious gaps exist.

Reviewer 3:

The reviewer noted that the allotted funds of \$750,000 for VIL work and \$220,000 for aerodynamic work are adequate for the 2021 goals. The project will be completed in September of 2021.

Reviewer 4:

The resources are sufficient, according to the reviewer.

**Presentation Number: eems061**  
**Presentation Title: Scaling up the Realtime Data, Simulation and Artificial Intelligence (AI) and Control for Optimizing Regional Mobility**  
**Principal Investigator: Jiboananda Sanyal (Oak Ridge National Laboratory)**

**Presenter**

Jiboananda Sanyal, Oak Ridge National Laboratory

**Reviewer Sample Size**

A total of three reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

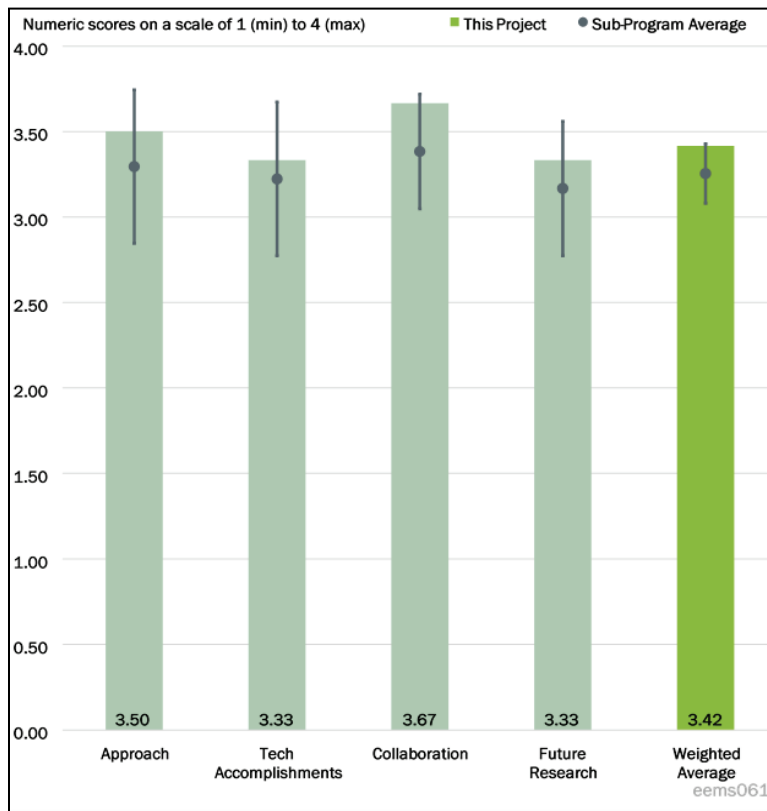


Figure 3-4 - Presentation Number: eems061 Presentation Title: Scaling up the Realtime Data, Simulation and Artificial Intelligence (AI) and Control for Optimizing Regional Mobility Principal Investigator: Jiboananda Sanyal (Oak Ridge National Laboratory)

**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 believed the project team is very thorough on what goals are being pursued. The time limit is extensive and covers short and long term. The team also has a good group of collaborating partners to draw from all aspects of near real-time data.

Reviewer 2:

The reviewer liked the approach of building a mirror model that will allow control schemes to be theorized. The one thing the reviewer thought about was a question from the previous review on trying to account for drivetrain changes. As propulsion types change with more electric and hybrid drive trains, the typical Mobility Energy Productivity (MEP) modeling metrics could change. Chattanooga is a good place to test this, given the abundance of Nissan LEAFs in the area. The reviewer would have liked to see some discussion on this with regard to how it could affect the approach. The overall approach is good.

Reviewer 3:

The project team has been able to coordinate across multiple jurisdictions and data sources to create a robust digital twin to better understand real-world conditions in and around Chattanooga. This addresses the identified challenges of disparities in gathering transportation data and getting real-time data. In addition, the

project team has made strong progress in building a digital twin that addressed computational complexities to get to understanding regional energy savings. The reviewer called the work well done.

The reviewer commented that additional clarity and explanations between the digital twin and how they translate into energy savings would have been helpful. This was covered in the question and answer (Q&A) to some degree, but more information in the overall project description would be helpful, especially as it relates to the identified barriers of understanding energy savings at the regional level. Providing more highlights on the other MEP metrics (i.e., time and cost savings) could also be valuable for scaling up, translating this to other metropolitan areas, and gaining a better understanding of savings overall.

***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, progress on this project is remarkable considering that the project started with the pandemic and quick adjustments were needed to continue moving forward. The project team has completed milestones on time, including the development of the digital twin along with securing data. The progress to date has built a strong foundation for moving forward, fine tuning specific data (i.e., understanding the movement of HD vehicles), and understanding what types of data are critical for the real-time understanding of the system (i.e., balancing computational capacities). The progress to date has built a strong foundation for achieving other milestones identified over the next year.

Reviewer 2:

The reviewer graded this as excellent, given the pilot test that achieved 16% energy savings, which shows the project has some potential. The fact that this was accomplished shows progress to anchor the larger scale-up. The reviewer realized that tests were conducted in February of 2020 in the last phase, but thought the results point toward a good target and the progress being made.

Reviewer 3:

The best form of progress can be measured in the ability to use the tool. The reviewer stated that the project was able to combine real-time situational awareness combined with modeling and simulation to actually use that information in weak signal light software for energy savings of 18%.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer stated that the project team has pulled together an impressive list of collaborators. The identified partners are truly impressive and include two state DOTs, research organizations, laboratories, and a local municipality. Coordination between these partners will make this project robust and provide a good template for translating this to other metropolitan areas in the country. This reviewer described the collaboration and coordination as well done.

Reviewer 2:

The reviewer thought the partners in this project were able to supply a lot of data by allowing all aspects of vehicle monitoring through sensors, signals, radar, and even incident reports. More information leads to better conclusions. The reviewer remarked that the DOT was probably the best source of information.

Reviewer 3:

The reviewer liked the fact that there are a lot of partners in supporting data at the city, state, and multi-state level. This will help in any future deployment and acceptance of the technology.



***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer indicated that the future research proposal moves in the direction of putting into play what has already been learned. The reviewer suggested that the next logical step would be to scale it up and make it available to other regions for trial.

Reviewer 2:

The reviewer noted that there seemed to be an almost implicit modeling approach/objective about modeling existing controls to improve MEP metrics. The reviewer would have liked to see some discussion on using explicit modeling to determine what issues are caused by future stop lights and what controls get implemented at the city and regional level. The reviewer found that a lot of commuter delays are also caused by suburban growth and the addition of new traffic signals going in. Regarding future efforts, it would be interesting to see how this could be added to the modeling to evaluate those types of common changes as development increased in previously undeveloped and unpopulated areas.

Reviewer 3:

The reviewer said that the team’s proposed future research and timeline are practical and logical. The identified challenges and barriers are clearly identified and are being addressed by the project team. This may be outside the scope of the project; however, this type of research is timely, and many state and local DOTs would find value in understanding where the weakest and/or most energy intensive parts of their system are located. The reviewer questioned if it would be possible to incorporate other MEP metrics (i.e., time and cost savings) to provide a more holistic picture of the metro study. The reviewer wanted to know what is needed to scale this project to other metropolitan areas and regions. It appeared to this reviewer that the Chattanooga regional area has a variety of data sources and a robust network of sensors. What data and sensors would be necessary to replicate this in other areas around the country to get a robust digital twin? Additionally, the reviewer asked if cybersecurity has been addressed in this project. There is an incredible amount of data, and if expanded, how would these data be secured?

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer opined that anytime there is a project to reduce traffic congestion, it is relevant to fuel savings, idle time, pollution, and so on. These issues make it perfect as a DOE project.

Reviewer 2:

The reviewer found that this as an interesting approach to model the control aspects, use data to anchor the model, and then use algorithms to see what can be improved. The reviewer thought that the approach is relevant for the stated objective.

Reviewer 3:

This project is aligned with DOE objectives and goals, according to the reviewer. Seeking to understand energy usage across a region to improve traffic flows to reduce petroleum use, to advance EEMS, and to advance coordination and collaboration across jurisdictions is aligned with VTO and 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 stated that the project appeared to be sufficiently funded to achieve the milestones and goals of the project.

Reviewer 2:

The reviewer thought the project team has all the data it needs at its disposal, based on the partners in the project.

Reviewer 3:

The reviewer did not have enough knowledge on the cost and resources needed for this project to really weigh in on this topic. Coding and data aggregation are typically complex, and \$4 million seems adequate for the overall scope.

**Presentation Number: eems062**  
**Presentation Title: Deep-Learning for Connected and Automated Vehicle (CAV) Development**  
**Principal Investigator: Robert Patton**  
**(Oak Ridge National Laboratory)**

***Presenter***

Robert Patton, Oak Ridge National Laboratory

***Reviewer Sample Size***

A total of four reviewers evaluated this project.

***Project Relevance and Resources***

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 75% of reviewers felt that the resources were sufficient, 25% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

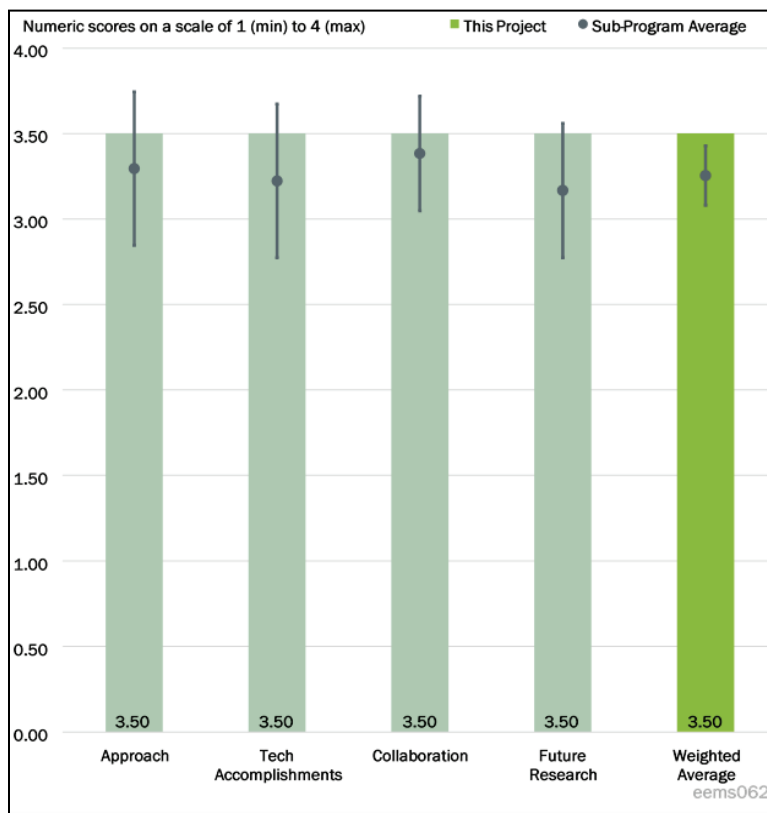


Figure 3-5 - Presentation Number: eems062 Presentation Title: Deep-Learning for Connected and Automated Vehicle (CAV) Development Principal Investigator: Robert Patton (Oak Ridge National Laboratory)

***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 project has well defined objectives and an appropriate status. The project team has identified pitfalls and problems and developed ways to understand and deal with them opportunistically.

Reviewer 2:

The reviewer reported that the approach in this project has been to develop high-performance computing (HPC) for CAV perception, control, and communication. The reviewer stated that this is a good complement to current methods that use primarily real-world data collection.

Reviewer 3:

The reviewer referenced the presentation, which noted that “Further exploration of machine learning for energy efficient CAV operation is needed.” The reviewer said that the approach is a necessary first step for finding energy impacts but stops short.

Reviewer 4:

The reviewer remarked that the Principal Investigators (PIs) have correctly identified key barriers to broadly applying machine learning (ML) and artificial intelligence (AI) to CAVs. In particular, the PIs have properly identified the proprietary nature of the existing tools and the amount of computational horsepower needed by those tools. The team also points out that most of the effort to date by others has focused on sensing and perception (object recognition in particular) with little or no effort directed to the downstream functions of path

planning, actuation, and vehicle-to-everything (V2X). The reviewer believed that the team’s approach and goals begin to address those barriers, some of which the team has demonstrated in the progress reported. The reviewer emphasized concerns regarding the limited amount of funding that is available for the project team to apply to the tasks at hand. More specifically, the \$4 million listed for FY 2020 and FY 2021 seems to be quite small in comparison to the amounts that have been, and continue to be, directed to similar efforts (some even more narrowly focused) by the likes of Google, General Motors (GM), and other major OEMs, etc.

***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 solid accomplishments that include synthetic image generation, training AI with synthetic data, evaluation of driving metrics, adversarial testing, reinforcement learning (RL), and fusing neural networks.

Reviewer 2:

According to the reviewer, the project has a clear schedule, objectives, and results thus far.

Reviewer 3:

The reviewer opined that the researchers have developed a metric for how well a car drives, which is not an energy efficiency metric. The energy efficiency metric that would make the most sense is kilowatt (kW) per passenger for a given trip at a given speed.

Reviewer 4:

The reviewer said that the PIs described a wide range of accomplishments toward their goals. Regarding training sets, generation of synthetic image data certainly seems to have significant advantages over real-world image data collection in terms of independently varying aspects of the same scene (i.e., combinations of weather and sun on a given physical landscape) as well as being able to construct corner cases that may be hard or impossible to obtain via real-world collection.

The reviewer emphasized that one key item not addressed was the comparison of training efficacy between using real-world data versus synthetic data. The use of a quantitative evaluation metric for simulated driving performance (in combination with a tiered approach to increasing complexity) was excellent, as is the use of Gremlin for adversarial testing to find and highlight failures and overall problem areas.

The discussion of RL applied to path planning, actuation, and subsequent tracking was well done. The reviewer believed that the value of this approach may be even greater than stated, in that many self-driving car algorithms calculate (simultaneously and in real time) an optimal path in addition to multiple acceptable contingency paths for a given environment. The simulated improvements (i.e., fuel efficiency, travel speeds, vehicle capacity, etc.) from RL in cooperative and infrastructure guided modes (the reviewer assumed this relies heavily on V2X) are impressive. However, the reviewer emphasized that it is not clear how much of the benefit is derived from RL applied to cooperative and infrastructure guided modes versus cooperative and infrastructure guided modes alone (without RL). The reviewer was curious if there can be a simple, preliminary opportunity to confirm one of these results in a real-world demonstration (perhaps as part of Milestone 4 in FY 2021 Quarter [Q] 4).

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer observed clear collaboration between Oak Ridge National Laboratory (ORNL) and the National Renewable Energy Laboratory (NREL) based on the presentation and PDF. There is a natural split in scope

and areas of focus for the team members. The linkages and dependencies between the elements are appropriately addressed.

Reviewer 2:

According to the reviewer, there appears to be good collaboration between NREL, ORNL, and GM.

Reviewer 3:

The reviewer noted that each team member is engaged and active in supporting the project.

Reviewer 4:

The reviewer stated that interfacing with the CARLA development team is limited. Solutions for CARLA driving have not been publicly released. It would be beneficial to get more input from the open-source community and increase collaboration with the CARLA developers.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The research team presented proposed future research for FY 2021 as a series of research questions—logically grouped by topic area—rather than a research plan. The topics and individual research questions seemed appropriate to the reviewer and are important extensions to the work completed.

Reviewer 2:

The reviewer observed that researchers have developed a tool that can be applied to optimized CAVs for energy. It will be most effective when widely disseminated.

Reviewer 3:

The reviewer said that several good topics were proposed.

Reviewer 4:

The reviewer commented that future plans include energy efficient AI, scaling RL tools for driving simulators, and scaling scenario generation.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer remarked that this project attacks the problem of creating better ML algorithms for automated driving, which would lead to more efficient and potentially safer transportation systems.

Reviewer 2:

The reviewer asserted that this project definitively supports DOE objectives. The combined efforts of ORNL and NREL are geared to the following: improving and accelerating the maturation of ML, AI, and RL techniques needed for CAVs to become a meaningful part of the vehicle fleet; and accelerating the potential efficiency gains (increased overall vehicle fleet fuel economy, reduced carbon dioxide [CO<sub>2</sub>] emissions, etc.) that can be realized with sufficiently high CAV penetration.

Reviewer 3:

The driving metric is a prerequisite for measuring energy efficiency of CAVs, according to this reviewer.

Reviewer 4:

The reviewer commented that it is interesting to correlate directly, but it is very important for the vehicles to know where they are and not create any traffic disturbances in the AV world. Even though the quantitative analysis is very difficult, it is known that there will be a positive energy impact.

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

Reviewer 1:

The reviewer observed that the project is on track and will soon be completed with the allotted funding of \$1.8 million during FY 2021.

Reviewer 2:

There seems to be enough staff and knowledge, according to the reviewer.

Reviewer 3:

The reviewer's comment regarding insufficient resources is specific to the amount of money being applied (i.e., \$4 million for FY 2020 and FY 2021) toward achievement of broadly applicable results that can be applied and leveraged to speed CAV development and implementation. The reviewer emphasized that the comment does not reflect on the researchers, ORNL, or NREL.

Reviewer 4:

Resources appeared adequate to the reviewer, though achieving an energy metric is problematic. It is unfortunate that GM did not contribute financially to the project, which may have provided GM with the motivation for better integration with CARLA.

**Presentation Number:** eems066  
**Presentation Title:** Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing  
**Principal Investigator:** Lauren Spath-Luhring (National Renewable Energy Laboratory)

**Presenter**

Lauren Spath-Luhring, National Renewable Energy Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

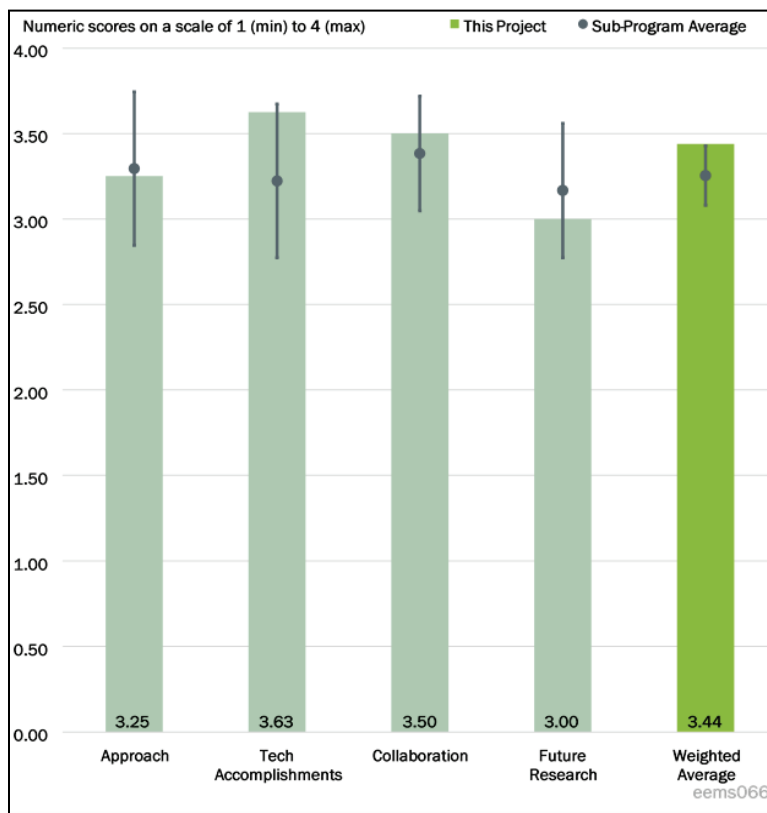


Figure 3-6 - Presentation Number: eems066 Presentation Title: Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing Principal Investigator: Lauren Spath-Luhring (National Renewable Energy Laboratory)

**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 appreciated the project approach and responsiveness of the PI and core team to build a platform and system that could be used for sharing mobility data. The reviewer explained that the Livewire platform builds on the effectiveness of existing data-sharing platforms, which is appreciated and needed for EEMS research. The attention to detail in providing factor authentication was also an example of responsiveness to owner and user need. This will give leads and owners of the data assurances of who has access, especially for sensitive and proprietary data.

The reviewer described this type of data platform as timely because many cities, metropolitan planning organizations (MPOs), state DOTs, and others are seeking to better implement energy efficiency mobility systems and services. This type of data platform could allow for better cross collaboration with these entities, and they work on projects and modeling. This addresses a barrier to access to data and the owners of those data.

Reviewer 2:

The reviewer gave this project good marks for approach. The project team recently convened the EEMS Data Working Group to identify priorities, and the reviewer was pleasantly surprised to see that although this is a

recent accomplishment, the team’s remaining milestones on Slide 4 have space for the Livewire development team to develop some of the priorities identified by the Livewire Data Working Group (the reviewer wished the team would have given more information on exactly which priorities are being considered to tackle). Additionally, the PIs did a great job of being responsive to last year’s AMR reviewers’ feedback (particularly with respect to metrics). The reviewer did not completely see how the team’s remaining milestones are going to help overcome the two barriers identified on Slide 2.

Reviewer 3:

The reviewer commented that the approach used by the team is to leverage prior successful data platforms and build a new platform that is easy to use and versatile in terms of allowing secure access, data quality measures, and broad collaboration.

Reviewer 4:

The overall approach to this project is well designed, especially to address the technical challenges, and to a lesser degree the people challenges inhibiting sharing of data. The reviewer asserted that the cultural, people, and organizational challenges are the toughest to overcome and, in the future, will require further sustained attention and diligence to truly surmount.

Leveraging existing platforms (e.g., [a2e.energy.gov](https://a2e.energy.gov), [api.data.gov](https://api.data.gov), and the application performance interface [API] Umbrella) was the right approach, according to the reviewer.

***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 Livewire project appeared to have achieved all targeted milestones to date this year and is on track to achieve the remaining ones in the balance of FY 2021. Overall, a significant number of technical accomplishments have been achieved, including updated project and dataset pages for enhanced utility and user experience; development of detailed metadata and security; the establishment of role-based member engagement including a tiered role system to manage, upload, and download data; platform development including multi-factor authentication (MFA); implementation of a data quality assessment process; and establishment of the Livewire Data Working Group. Most notably, the reviewer opined that the strongest accomplishments and potentially most influential over the long-term are the establishment of the EEMS Data Working Group; development of new tools to facilitate the manipulation, analysis, and accessibility of data; and new security measures including implementation of a threat-based analysis of the platform.

Reviewer 2:

This project has made significant progress over the last year, especially with respect to improving metrics on project and dataset pages and adding role-based member management. The reviewer was particularly excited about the role-based member management and the opportunity that it creates by opening Livewire to .gov, .mil, and .edu email addresses.

Reviewer 3:

The reviewer noted that Core services are in place such as storage, security, access management, metrics, better search tools, and data visibility. Usage growth is at a healthy level. Project and dataset pages are updated. According to the reviewer, progress has been made on the development of tools to create detailed metadata and to secure sensitive datasets. Data quality assessment metrics are in place, and a broad-based working group has been established.



Reviewer 4:

The reviewer commented that the Livewire platform is making progress to completion. Further, the project appeared to be on schedule.

The reviewer appreciated the team's approach for making a data platform that focused on user experience and overall utility. The metrics and overview page is extremely helpful and includes the overview of the metadata.

The reviewer asked whether Livewire is available to communicate with the other data platforms—Atmosphere to Electrons and the API Umbrella. While the reviewer realized that all the data may not be crosscutting for the databases, an understanding of other data sets may be helpful for users, modelers, and researchers.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

This project had an impressive list of collaborators from across DOE and outside organizations. The reviewer remarked that it was great to see a mix of non-governmental organizations (NGOs), cities, research institutions, and industry represented as participating organizations in the database. In addition, the Livewire Data Working Group's efforts to identify and prioritize data was helpful and appreciated.

The reviewer was unclear who was represented in the Livewire Data Working Group from the project slide deck. It would be helpful to detail the participants in this group.

Reviewer 2:

There is clearly great coordination across the internal project team itself—Idaho National Laboratory (INL), NREL, and Pacific Northwest National Laboratory (PNNL). But, perhaps even more noteworthy is the way that the core project team has involved EEMS and the Smart Mobility Consortium to ensure that Livewire is able to meet all the project's needs. The reviewer agreed with the project team on Slide 18 and thought that there are opportunities with other agencies like DOT and the U.S. Environmental Protection Agency (EPA) to expand the user group of Livewire and potentially diversify the datasets available on Livewire. For example, the project team mentions barriers that have caused difficulty in sourcing empirical real-world data applicable to new mobility technologies like connectivity and automation, but DOT currently has several test track and field projects collecting data about CAVs that might be able to be shared on Livewire (or linked to Livewire through hosting on [data.transportation.gov](https://data.transportation.gov) or the Intelligent Transportation Systems (ITS) DataHub).

Reviewer 3:

Throughout the life of this project, collaboration and coordination appeared strong to this reviewer. The three national laboratories involved (NREL, INL, and PNNL) have all significantly contributed, utilizing their unique positions and strengths, and more recently Lawrence Berkeley National Laboratory (LBNL) and ORNL are adding their expertise and perspectives through the Livewire Data Working Group.

Moving forward, the reviewer suggested that it would be good to consider expanding participation within the Livewire Data Working Group to other entities. This could serve to provide new, non-laboratory and government perspectives on needs and requirements, as well as greasing the skids to expand the universe of potential data contributors to and users of the Livewire system.

Reviewer 4:

There is well-established collaboration within the project team between INL, NREL, and PNNL, as well as connections to EEMS, SMART, and Technology Integration (TI).

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer hoped that the project team pursues opening Livewire to .edu email addresses; it is not on the FY 2021 quarterly milestones but was mentioned on Slide 18 under “Proposed Future Research”. The reviewer thought Livewire data would be a huge resource for Doctor of Philosophy (PhD) and master’s students.

Reviewer 2:

Future work will require scaling up for larger and diverse groups. The reviewer opined that that may be challenging from a technology infrastructure, as well as a funding, perspective.

Reviewer 3:

The future research and next steps are well thought out. The reviewer appreciated the issue and topic areas that the Livewire team is considering and how to include additional users. It certainly seems that interdepartmental (DOT and EPA) collaboration (and potentially academic, state, and local government participation) may be a solution for the scaling up and longevity challenges for funding and demonstration of the importance of a data platform like Livewire.

How does DOE plan on marketing the platform in order to get more subscribers and data? Will this be marketed to practitioners (state and local DOTs, other federal departments, research institutions, etc.)?

For growing the scope, how does the Livewire team plan on training new users to ensure the platform is being used appropriately and that the data, once entered, are standardized (especially for use by and for local governments, transit organizations, and state governments)? Additionally, would Livewire be seeking to solicit input from these groups to help strengthen data that are housed on Livewire?

If proprietary data are downloaded, do users need to execute non-disclosure agreements (NDAs) for those data?

Reviewer 4:

The proposed future research indicates an intention to expand beyond the EEMS community to users from the .gov, .mil, and .edu domains. Additionally, the proposal is to look at other programs within DOE that have data-sharing and preservation needs. This seemed like a good approach to the reviewer, as well as considering interagency collaboration where possible with entities such as DOE and EPA. Specifically, what would be the best methods to reach out and understand the potential needs and requirements of these groups? Would it potentially be beneficial to include some entities from these communities in the Livewire Data Working Group and/or potentially survey them to gauge potential interest, needs, and requirements?

Future proposed activities include the evolution of platform capabilities, such as standardizing data across projects, enabling querying and filtering data before downloading, and offering the ability to download subsets of data. The reviewer opined that these options would appear to benefit users’ ability to manipulate and analyze data, which could help incentivize greater Livewire participation.

The reviewer also asked if there are specific objective metrics for Livewire usage in the near future (in the next year or two).

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer observed that the Livewire project does support overall DOE objectives to reduce energy consumption, reduce GHG emissions, and improve transportation mobility by providing a system to discover, share, and preserve transportation and mobility data. This project serves to advance transportation R&D and ultimately deployment- of advanced transportation vehicles.

Reviewer 2:

The reviewer noted that tools and platforms such as Livewire will allow broad-based collaboration and data sharing, which will accelerate the development of energy efficient transportation systems.

Reviewer 3:

This project promotes scientific research and technological innovation by creating a data platform for sharing up to date and innovative mobility data with modelers, researchers, and practitioners. According to the reviewer, this “one stop shop” allows practitioners to incorporate data into real-world projects and allows for creators of the data to collaborate to strengthen and improve on existing data.

Reviewer 4:

The reviewer commented that this project supports DOE objectives and more generally supports wider government initiatives to promote government transparency and private sector innovation (especially if Livewire is opened up beyond .gov email addresses through the role-based structure the team is currently developing and implementing).

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

Reviewer 1:

The resources to complete the building and milestones of the platform are sufficient. There should be conversations about funding this project over the long term, but the reviewer believed those discussions are outside the scope of this project.

Reviewer 2:

The reviewer stated that \$3.25 million for 3 years appears to be an adequate level of funding, given the scope of the work.

Reviewer 3:

Resources provided for this project to date have proven to be sufficient to achieve targeted objectives, according to the reviewer.

Reviewer 4:

Not applicable was indicated by this reviewer.

**Presentation Number:** eems067  
**Presentation Title:** Virtual and Physical Proving Ground for Development and Validation of Future Mobility Technologies  
**Principal Investigator:** Dean Deter (Oak Ridge National Laboratory)

**Presenter**

Dean Deter, Oak Ridge National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

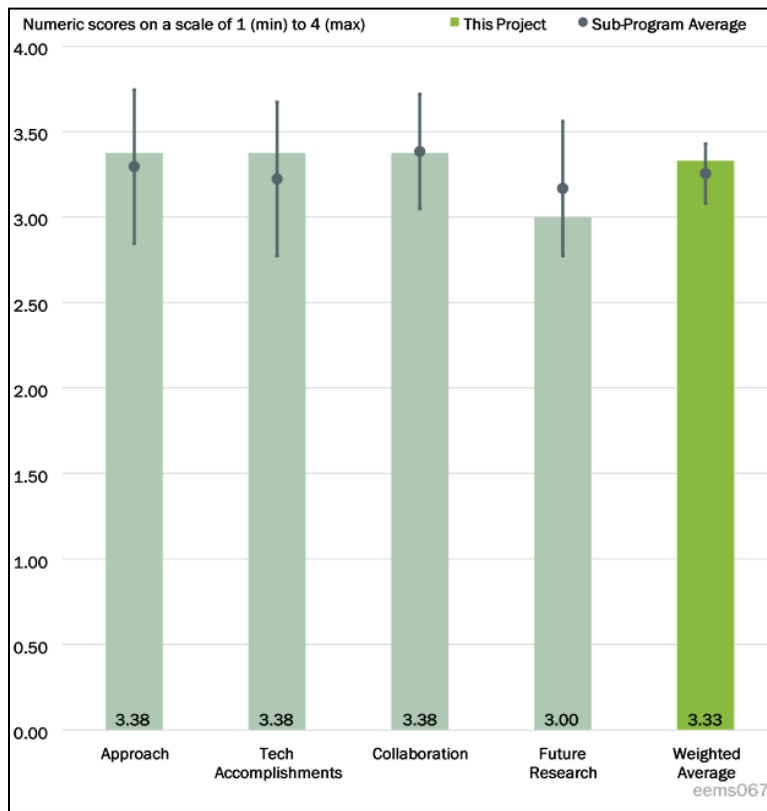


Figure 3-7 - Presentation Number: eems067 Presentation Title: Virtual and Physical Proving Ground for Development and Validation of Future Mobility Technologies Principal Investigator: Dean Deter (Oak Ridge National Laboratory)

**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 project is following along with the approach already established in the past. The PIs also seem to have adequately addressed reviewer feedback from the previous year.

Reviewer 2:

The approach was realistic and appropriate, although large in scope (which was acknowledged by the presenter). The reviewer wanted to know if the approach can be translated to MD and HD vehicles and if the Connected and Automated Vehicle Environment (CAVE) Laboratory allows for translations to MD and HD.

Reviewer 3:

The reviewer commented that the ORNL team has done a great job of identifying a need and addressing it.

Reviewer 4:

With the leveraging of ORNL’s capability and the support from partners, the project approach (divided into two tasks) made sense to the reviewer. The reviewer believed that the project team would address most of the technical barriers, especially on Task 1. Regarding Task 2, how to address the V2X communication modeling in a realistic manner with such a virtual-physical testbed was not so clear to the reviewer. Collecting real-world data from the experiments at the American Center for Mobility (ACM) definitely helps mitigate this concern,

but how to generalize the communication model built on this dataset to the other sites or scenarios would need further investigation.

***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 accomplishments of the project are on target, even considering technical and mechanical challenges with the testing equipment.

Reviewer 2:

This reviewer indicated that the project seemed to be progressing well, per the project plan.

Reviewer 3:

The reviewer stated that the technical accomplishments and progress are reasonable, considering the potential interruption by COVID-19. The laboratory equipment failure could be expected, and a backup solution or risk mitigation techniques could be considered and deployed to ensure the progress.

Reviewer 4:

This reviewer remarked that there is good progress in integrating the various software. It may, perhaps, be worthwhile to talk with various software vendors, researchers overseas, and perhaps OEM labs as well to have them share what non-proprietary information they can share on how they intend to perform the same tasks laid out in the scope of this project, because it does seem that a process such as the one this project is developing would be of great interest to OEMs working on advanced driver-assisted systems (ADAS) and autonomous vehicles (AVs).

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The collaboration and coordination across the project teams is good. The reviewer was curious if there are other laboratories that could help support the work related to CAV technologies and testing. This does seem like an area of cross-laboratory collaboration that could be explored.

Reviewer 2:

The partners were properly identified, where the physical environment facilitator (ACM) and virtual facilitators (dSPACE and CARLA) are involved with the support from both hardware (e.g., Cummins and dSPACE) and software (e.g., dSPACE and CARLA). The reviewer expected that the project would have fruitful results with the collaboration and coordination of these strong partners.

Reviewer 3:

Collaboration between the project team seemed efficient and effective to this reviewer.

Reviewer 4:

This reviewer suggested that the project could benefit from collaboration with an automotive OEM that is working on ADAS/AVs. It would help define the needs better and would ensure project success. Perhaps the team has already reached out to OEMs and was unsuccessful in enlisting their involvement.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The project team has identified a clear pathway for continued research throughout 2021, according to the reviewer.

Reviewer 2:

The reviewer indicated that it would be nice to tie the specific future tasks (virtual physical proving ground [VPPG] proof of concept, etc.) to some higher-level goals and outcomes that would advance the industry's pool of knowledge.

Reviewer 3:

Considering that the project will end in another 3 months, the reviewer commented that proposed future research efforts may be a bit challenging to complete. The reviewer suggested focusing more on the V2X wireless communications part, as this part seems to be missing or at least not well addressed. The reviewer acknowledged this portion is very challenging for such a virtual-physical platform, but it is a key enabler for cooperation among CAVs and boosting the system efficiency. Besides the V2X wireless communications, another important part is the human-in-the-loop simulation. The project team touches on this topic a bit but not too much. To the reviewer, future research should highlight this area as it is of pragmatic value within the foreseeable time span and involved with more interesting research questions.

Reviewer 4:

The reviewer referenced prior comments.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

This project definitely supports the overall DOE objectives. More in-depth research on CAVs requires more advanced modeling and evaluation tools. This has been an emerging trend. Thanks to the advances in computing and communication technologies, digital twins or physical-virtual environments are considered as a viable solution to decision-support processes in a variety of areas, including transportation and energy. The reviewer asserted that this project is timely and results, if successful, should be very helpful for VTO's blueprint.

Reviewer 2:

The reviewer remarked that this project is aligned with EEMS and DOE objectives by creating a framework to evaluate vehicle level testing for V2X technologies.

Reviewer 3:

Research conducted in the project is certainly relevant to CAVs, which in turn are one of the focus areas for DOE.

Reviewer 4:

The reviewer stated that this project would help with validating the various modeling tools that form part of the SMART Mobility workflow.

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

Reviewer 1:

The reviewer commented that project funds are sufficient for the scope of this project.

Reviewer 2:

From this reviewer’s perspective, the project seemed to be doing well for the resources allocated.

Reviewer 3:

Sufficient resources were observed by this reviewer.

Reviewer 4:

The reviewer believed the resources are sufficient for the project to achieve its stated milestones, although the breakout of COVID-19 may bring about some hiccups.

**Presentation Number:** eems069  
**Presentation Title:** Next Generation Intelligent Traffic Signals for the 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.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 67% of reviewers felt that the resources were sufficient, 33% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

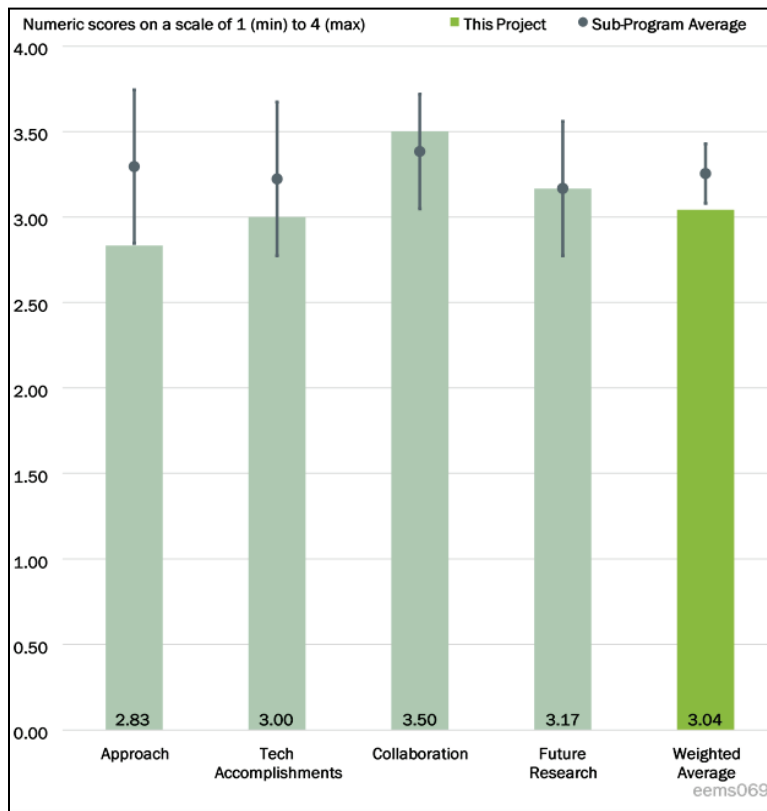


Figure 3-8 - Presentation Number: eems069 Presentation Title: Next Generation Intelligent Traffic Signals for the Multimodal, Shared, and Automated Future Principal Investigator: Andrew Powch (Xtelligent)

**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 one of the main barriers was the impact of COVID-19 and repercussions this had on the work (from its impact on data to partner timelines). In spite of this challenge, the work seems to have been conducted and advanced thoughtfully (with, for example, a 5-day data baseline, hourly data comparisons, and net flush-time comparisons to compare and evaluate the impact of different control systems on queue length, normalizing for differences in traffic volume). The reviewer observed that the data updates recognize the results and associated limitations (for example, low penetration or difficulty aggregating certain types of data), which put findings in context.

Reviewer 2:

Although the approach seems novel, the reviewer noted that the lack of market penetration seems to be a weakness in this approach. The project change to incorporate physical sensor data to help overcome this issue points to this problem.

Reviewer 3:

The reviewer stated that the approach of augmenting infrastructure sensors with streaming and connected vehicle sensors is good. This provides information to the proportionally fair (PF) adaptive traffic control system (ATCS) along the entire road and not just where the physical sensors are deployed.



According to the reviewer, the team’s approach to work with the National Transportation Communications for ITS Protocol (NTCIP) Management Information Base (MIB) is a strength even though the different existing traffic signal controller manufacturers have interpreted and implemented the NTCIP MIB in different ways.

The approach for achieving Objective 4 relies on the ability to capture enough streaming and connected vehicle data to support the traffic signal control algorithms without relying on physical and infrastructure-based sensor data. However, there was not enough market penetration of vehicle data sources and/or availability and access to this type of data to achieve Objective 4. This may have been COVID-19 related, but the reviewer commented that there is not a new or updated approach to overcome this shortcoming for Objective 4.

***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 this project is slated to end August of 2021. Though Objective 4 is not possible at this time and the project faced delays, the impacts of COVID-19 were far outside the control of this project. For example, the project team had to wait for the COVID-19-related reductions in traffic volume to lesson before researchers could test and establish a meaningful baseline. Given the setbacks presented by COVID-19, the reviewer thought that the team did an excellent job at advancing the work in a reasonable way in the manner possible.

Reviewer 2:

This reviewer noted that the team’s baseline testing was impacted by COVID-19 and light traffic volumes. The participating agencies even reverted their signal timing plans to run in an uncoordinated “free” mode. This exaggerated the improvement to the baseline of the PF ATCS control. When traffic began to return to normal, the team was able to work with the participating agencies to implement a more normal time-of-day control so that a more robust baseline comparison could be made. The reviewer remarked that this accomplishment demonstrates the team’s adaptability and strong working relationship with local traffic control agencies. Additionally, a user interface to the PF ATCS system was developed outside of the grant funding, which may improve commercialization prospects.

On the negative side, the reviewer indicated that the team was unable to obtain adequate location data services to test the traffic control system using connected vehicle data only. COVID-19 impacted the willingness of data providers to participate in the project.

Reviewer 3:

Once again, the lack of market penetration seems to hold back the technical accomplishments and progress. Given the unfortunate impacts caused by the timing with COVID-19, the reviewer suggested that extending the period of performance might be something to consider if a strong commitment from some OEMs can be achieved for data streams.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

This project pulls in a variety of partners. Based on project progress and achievements thus far, particularly given the challenges presented over the past year, the coordination seemed solid to the reviewer.

Reviewer 2:

The reviewer commented that there is good collaboration with the city agencies where the PF ATCS is being implemented. Two sites have currently deployed the PF ATCS traffic control system, and a third is planning to start soon.

Reviewer 3:

The reviewer liked the diversity of locations and partners in the project. Having those California urban location areas in combination is important.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

According to the reviewer, the project articulates the current progress and barriers, as well as identifies areas for potential future follow-up. For example, streaming location data integration was notably impacted by COVID-19. Xtelligent recognizes that they will not be able to test the full integration of these data within the project period of performance but remains committed to pursuing this as location data become more readily available.

Reviewer 2:

The reviewer thought that the project evolution to incorporate some physical sensors is good. In the reviewer's opinion, the market timing for the onboard OEM data is still just a little bit early. The reviewer would have liked to see if some specific vehicles could be instrumented so they can be tracked through the physical sensors and then compared to the OEM EV data. That would provide a much clearer picture and validation of the OEM data for modeling purposes.

Reviewer 3:

It was not clear to the reviewer how ANL is approaching the evaluation of the pilot. Will the lab solely base the analyses on the data collected during the pilot deployments, or will the lab also be using data collected in the pilot deployments to develop better inputs and parameters for a simulation-based analysis? A high-level description of the ANL evaluation approach would be beneficial.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer affirmed that, yes, this project supports DOE objectives by incorporating new sources of data into traffic signal control systems to make them more responsive to current traffic demand and reduce energy usage at intersections and along corridors. And, by designing the PF ATCS system to be low cost, the goal is to make it widely deployable.

Reviewer 2:

This project is exploring ways to improve the energy productivity of the overall transportation system and increase the affordability of transportation systems by avoiding installation of costly physical sensor infrastructure. As increasing mobility energy productivity and building “an affordable, efficient, safe, and accessible transportation future” is the mission and vision of EEMS, the reviewer asserted that this work supports DOE objectives.

Reviewer 3:

The reviewer responded affirmatively and felt that this is a novel approach in trying to use a new data platform that could be of value, especially for those areas and regions that are low on physical sensors. Given COVID-19, the timing for this project seemed early to the reviewer and would probably have a better chance when connected vehicle (CV) data become more commonplace.

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

Reviewer 1:

While more time and resources could help to further gather data and better capture associated real-world complexity, the reviewer stated that overall resources seemed to be sufficient to provide value, COVID-19 constraints aside.

Reviewer 2:

Given where this is, if the period of performance were extended to pick up non-COVID-19 impacted data, the reviewer stated that more resources would probably be necessary.

Reviewer 3:

Resources are sufficient to conduct this current pilot. However, the scope of the pilot had to be reduced due to lack of access and availability of streaming data. If this is something that could be overcome by additional funding, the reviewer suggested that it could be considered.

**Presentation Number: eems082**  
**Presentation Title: Validation of Connected and Automated Mobility System Modeling and Simulation**  
**Principal Investigator: Reuben Sarkar (American Center for Mobility)**

**Presenter**

Reuben Sarkar, American Center for Mobility

**Reviewer Sample Size**

A total of three reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

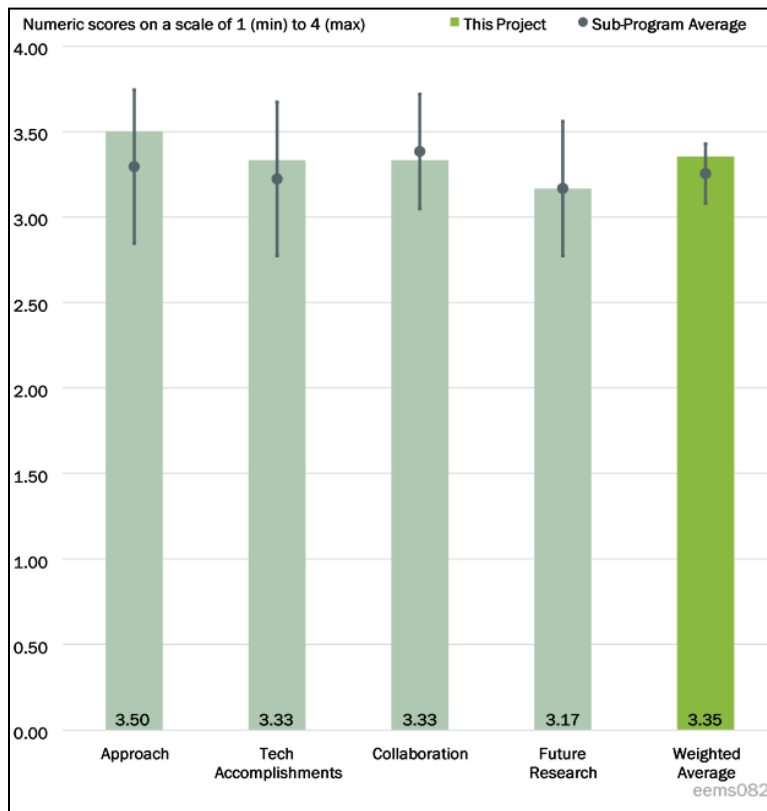


Figure 3-9 - Presentation Number: eems082 Presentation Title: Validation of Connected and Automated Mobility System Modeling and Simulation Principal Investigator: Reuben Sarkar (American Center for Mobility)

**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 is well thought out, according to the reviewer. It involves preparing lab algorithms for implementing in vehicles, building vehicles and infrastructure, testing vehicles with lab algorithms, and comparing against simulation results.

Reviewer 2:

It appeared to this reviewer that great care has been taken to achieve statistical validity; all the data have been recorded to ensure that a complete data set is available. Having been a user of data that have been acquired on various road trips, the reviewer appreciated how hard it is to have a set of data that can be used for future projects as well. The data show excellent repeatability, which is critical when testing and comparing short-duration driving scenarios with a real vehicle on roads rather than a dynamometer.

Reviewer 3:

The project has a strong approach to improving models through the incorporation of physical testing results. For the approach, the reviewer asked the project team to please clarify what the human driver model for speed harmonization is representing. Is this based on a project engineer who is trying to match the same speed profiles as the controlled vehicle, or will the team be using test subjects to try to match the speed profiles? This reviewer additionally asked whether the speed commands to the human driver will be transmitted and communicated via display or audio command in the vehicle, or whether the speed profile will be given to the

human driver at the start of the test. Also related to approach, will dedicated short-range communication (DSRC) be the sole communications technology that will be tested on the test track for the duration of the project, or will the approach include testing of cellular vehicle-to-everything (C-V2X) 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:

Accomplishments to date include automated vehicle controls and instrumentation, baselining, lab model integration, implementation of lab controllers, testing, and data generation. The reviewer said that the accomplishments are very impressive.

Reviewer 2:

The project was granted a time extension due to delays caused by COVID-19 restrictions. Given this, it appeared to the reviewer that the project team is making very good progress toward the project goals.

Reviewer 3:

Good progress, overall, was noted by this reviewer. Understanding the network latency and delay is an important aspect of the project. The investigators state that network support for real time control is feasible but may be affected by traffic density. The reviewer asked whether there is a level of traffic beyond which this becomes infeasible. Additionally, are the three cases listed—speed harmonization, merging, intersections and eco-driving—the only scenarios being investigated? If so, on what basis were these chosen? It appeared to the reviewer that other cases may be considered in the future.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer emphasized that there appears to be excellent collaboration across a large team, including ACM, Michigan Technological University (Michigan Tech), ORNL, ANL, and NREL.

Reviewer 2:

The reviewer found that good project collaboration is evident by the slide on “Vehicle Testing Overview” showing ACM, Michigan Tech, ORNL, and ANL components being incorporated and tested. Weekly meetings of the project team also serve a collaboration function.

Reviewer 3:

Good collaboration between academia, national laboratories, and ACM was highlighted by this reviewer. California Partners for Advanced Transportation Technology (PATH) is listed as a collaborator, but its role/responsibility was unclear.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The proposed work plan is sound. Future work includes an experimental study of merging, intersections, and eco-driving. Beyond that, the reviewer observed that the workplan includes experimentation on public smart roadways, dynamic wireless transfer, congestion studies, etc. The reviewer asserted that this is a sound plan and suggested that it would be a good idea to compare data and results with Ohio State University’s study on similar topics (energy savings from eco-driving, platooning, etc.).

Reviewer 2:

The reviewer stated that extension to include a variety of use cases would add value to the project. Also, including extreme weather conditions—snow, heavy rain (which is becoming more common)—would be a good extension as well. Finally, the reviewer further recommended that evaluating network performance under stress such as very heavy traffic, emergency situations, etc., would be helpful as well.

Reviewer 3:

The proposed future research meets the objectives of the project and appears to be reasonable. However, from the presentation it was not clear to the reviewer whether any simulation studies will be conducted using the improved models to assess the potential energy savings of speed harmonization, merging, and eco-driving on a corridor, arterial, or some other highway network segment. Is this part of the future research plans?

In Budget Period 2, the reviewer wanted to know if testing of eco-driving using a single vehicle traveling through a traffic signalized road will be conducted without any other vehicles present. If so, does Budget Period 3 include adding other vehicles to the eco-driving scenario so that the equipped vehicle must consider them in its speed profile?

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

According to the reviewer, this project is very relevant to the goal of developing improved models to assess the energy impacts of CAV technology.

Reviewer 2:

The reviewer stated that the topic under investigation will provide algorithms and strategies to reduce energy use and enable more efficient transportation.

Reviewer 3:

The reviewer indicated that this project helps understand the real-world energy consumption benefit of connectivity and autonomous driving, supporting 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 allotted budget of \$7.6 million over 2½ years for this type of software, hardware, and vehicle project involving multiple collaboration and partners seemed reasonable to the reviewer.

Reviewer 2:

The reviewer commented that resources appeared sufficient to achieve the stated milestones.

Reviewer 3:

This reviewer asserted that resources are sufficient.

**Presentation Number: eems083**  
**Presentation Title: CIRCLES: Congestion Impact Reduction via CAV-in-the-Loop Lagrangian Energy Smoothing**  
**Principal Investigator: Alexandre Bayen (University of California at Berkeley)**

**Presenter**

Alexandre Bayen, University of California at Berkeley

**Reviewer Sample Size**

A total of three reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

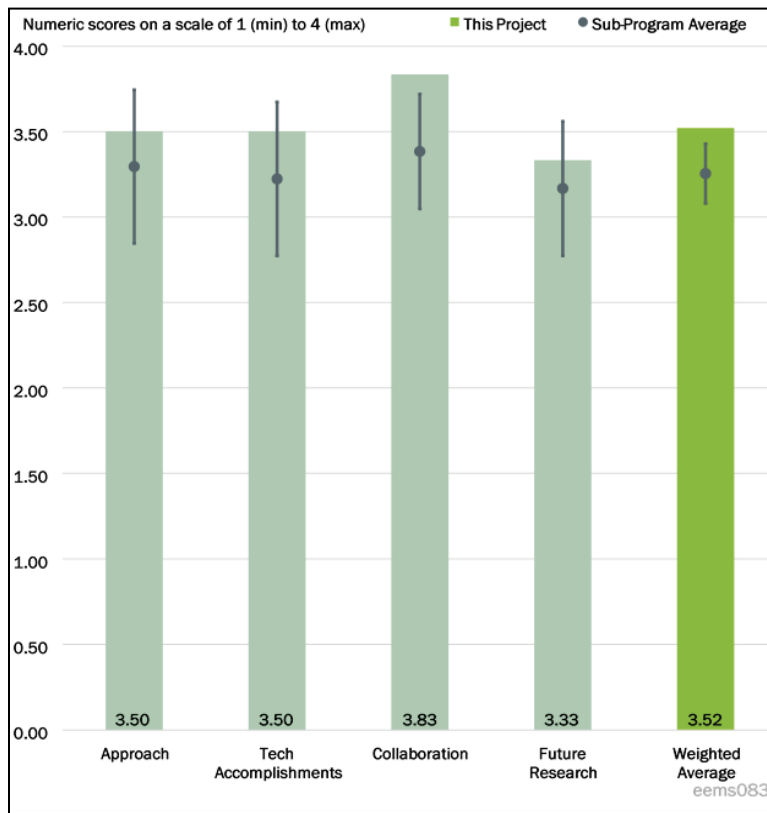


Figure 3-10 - Presentation Number: eems083 Presentation Title: CIRCLES: Congestion Impact Reduction via CAV-in-the-Loop Lagrangian Energy Smoothing Principal Investigator: Alexandre Bayen (University of California at Berkeley)

**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 this to be a well-designed experiment with clear schedule and deliverables.

Reviewer 2:

The reviewer remarked that the approach addresses a key barrier to accurately measuring the potential for system-wide energy benefits of CAVs in the traffic stream. Typically, these types of benefits are measured with models, but this project is attempting to use a large number of vehicles (e.g., 100) in the traffic stream to directly measure the trajectories of all vehicles using pole-mounted video capture of all vehicles traveling on the highway.

Related to the approach, the reviewer asked whether the team has developed the approach for processing and cleaning the vehicle trajectory data. Initial trajectory data generated from video capture typically require “cleaning” to remove errors that result in unrealistic trajectories. Given the size of the proposed data both in terms of length of the segment and the volume of trajectories, this “cleaning” process will be very extensive.

Reviewer 3:

The work seemed to the reviewer to have been thoughtfully designed, including field tests of multiple scenarios (evaluating, for instance, the cumulative effect of traffic smoothing down the roadway and



measuring the effect of adjacent lanes smoothing traffic). During the presentation, the reviewer believed it was also mentioned that the team is working with approximately 10 vehicle classes. Remaining challenges and barriers were addressed later in the presentation as well. As a minor note regarding slide and presentation design, a couple of the color-coded schemes—such as on the “Components of the Approach” and the first “Technical Accomplishments and Progress” slide—may be hard to read and somewhat inaccessible to individuals with red and green color blindness. The reviewer suggested avoiding use of these colors as differentiators in slide visuals.

***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:

This project started at the beginning of 2020 and is scheduled to end at the end of next year. At 55% complete, the project team appears to have largely stayed on track with their timeline thus far. The presentation tracked goals and respective progress, as well as also laying out the next steps for advancing the work (for example, further model validation, testing, fine-tuning, etc.). The reviewer found the team’s progress to be particularly notable, given the degree to which the past year has been potentially disruptive to work and research.

Reviewer 2:

The team has been making progress in all aspects of the project and is planning to execute small- and medium-scale field tests in the summer of 2021. According to the reviewer, these results and lessons learned from the smaller field tests will be invaluable to the team’s continued progress toward the 2022 large-scale field test.

Reviewer 3:

The reviewer indicated that there is still quite a bit of work required on the corridor and experiment itself.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer explained that this project pulls in a variety of partners (including various universities, as well as a representative from government and industry). The roles seemed well delegated and have resulted in collaborative work that is on track (which is particularly notable given unexpected challenges since early 2020).

Reviewer 2:

The reviewer commented that the team’s collaboration is strong, as evidenced by the accomplishments to date in all areas of the project scope.

Reviewer 3:

The reviewer noted that all partners are involved, and their roles are clear.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer reported that the project has outlined proposed tasks delegated to FY 2021 and FY 2022, respectively (such as first executing small-scale and then medium-scale field tests, followed by a 100-CAV demonstration in 2022 and evaluating findings). The plan seemed to have a clearly planned, logical structure broken out by milestone. It also budgets for logistical tasks, such as submitting the work for approval. The reviewer was interested to learn about the results.



Reviewer 2:

The proposed future research is in line with the objectives of the project. The reviewer made one recommendation—begin the collaboration with the Tennessee Department of Transportation (TDOT) and the Institutional Review Board (IRB) as early as possible for the large-scale test as this process may take a long time and may require additional levels of approval beyond the approvals required for the smaller scale tests. The submission for approval could incorporate lessons learned from the smaller scale tests.

Reviewer 3:

There are many follow-ups that could be possible, but at this stage in the experiment, it is probably difficult to name them clearly. The reviewer would expect to see more next year.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

This project is working to advance CAV technology and control algorithms to smooth traffic and save energy. As increasing mobility energy productivity and efficiency is part of the mission and vision of EEMS, the reviewer indicated that this work supports DOE objectives.

Reviewer 2:

According to the reviewer, this project is very relevant to the DOE objectives of using CAV technologies to provide smoother and more energy efficient traffic flow.

Reviewer 3:

Although it will be difficult to measure, in theory, the reviewer opined that the traffic smoothing should have a positive impact on energy usage.

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

Reviewer 1:

While microsimulation is challenging and it was mentioned during the presentation that there is no certainty about certain data type availability—both of which could perhaps be improved with additional time and resources—overall, the available resources seemed sufficient to the reviewer. The project has made what seems like reasonable progress for where it is in its timeline and seems generally on track with current resources.

Reviewer 2:

There are enough people in academia and industry to make this a complete team, and the reviewer commented that the presentation showed that the resources are being well used.

Reviewer 3:

The reviewer indicated that resources appeared to be adequate to complete this test.

**Presentation Number: eems084**  
**Presentation Title: Energy-Efficient Maneuvering of Connected and Automated Vehicles (CAVs) with Situational Awareness at Intersections**  
**Principal Investigator: Sankar Rengarajan (Southwest Research Institute)**

***Presenter***

Sankar Rengarajan, Southwest Research Institute

***Reviewer Sample Size***

A total of four reviewers evaluated this project.

***Project Relevance and Resources***

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

***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:

This reviewer affirmed that the overall approach is sound and uses a combination of simulation, dynamometer, and test track. With respect to reporting the simulation results from High Street, it seemed that, from the short description and the small image of an intersection on High Street (both on Slide 27), High Street may have some configurations and traffic patterns that are not representative of a “typical” traffic signalized road. Is the research team planning on generalizing the High Street simulation results as representative results, and, if so, what is the approach for this?

Reviewer 2:

The research is a practical and reasonable approach to a difficult problem. The reviewer suggested that the researchers should clarify and address how the improvements in the corridor affect perpendicular and parallel routes. The steps to create more realistic scenarios in the model, like bottlenecks, is important.

Reviewer 3:

The project was designed to provide validation across a range of simulations (including road network for traffic simulation, macroscopic traffic simulation, traffic simulation with intersection functionality, vehicle and powertrain models for energy consumption on transient drive cycles, etc.) The research team also accounts for

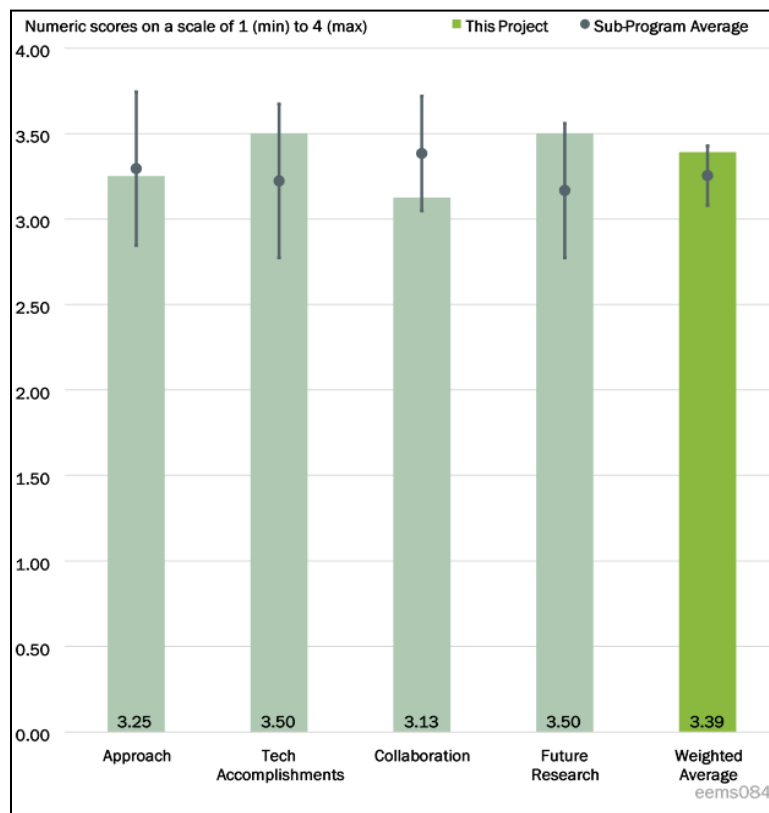


Figure 3-11 - Presentation Number: eems084 Presentation Title: Energy-Efficient Maneuvering of Connected and Automated Vehicles (CAVs) with Situational Awareness at Intersections Principal Investigator: Sankar Rengarajan (Southwest Research Institute)

different powertrain types and levels of automation. This design breakdown allows for more nuanced analyses of an urban corridor and the impacts and benefits of CAVs. The approach taken seemed thoughtful to the reviewer, and various barriers are addressed in detail. As a minor design note regarding the presentation slide deck itself, graphics, such as the table on Slide 12, that leverage a green and red color scheme could be difficult for individuals with red and green colorblindness to differentiate. The reviewer suggested switching to an alternate color scheme to make the presentation more accessible.

Reviewer 4:

This is a very interesting project and there are a number of variables to be addressed. There seem to be so many variables that it may be difficult to reach a sound conclusion. If the control scenario is clear, then the variables will be defined well. So far, this was not clear to the reviewer.

***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:

This project started in October 2019 and is scheduled to end at the end of 2022. With approximately 50% of the work complete, the research team seemed to be fully on track to the reviewer. Only one milestone has not yet started. This is particularly notable, given the unexpected hurdles to work and changes in mobility patterns over the past year. In the presentation, the team provided a detailed breakdown of technical accomplishments and progress pertaining to corridor traffic simulation, vehicle powertrain modeling and validation, intersection stack validation, and software-in-the-loop [SIL] testing, among other updates and breakdowns.

Reviewer 2:

Researchers are clear on what has been accomplished and where challenges exist. Researchers provided good detail to assess the merit and quality of the results and progress. More details on the possible intersection maneuvers, including factoring in pedestrian behavior, should be provided, according to the reviewer.

Reviewer 3:

The reviewer stated that the project is well managed and on track.

Reviewer 4:

The reviewer described technical accomplishments to date as good. The intersection stack validation results on Slide 12 show that the average speed error of less than 7.5% can only be achieved if speeds lower than 10 miles per hour (mph) are filtered out. Given this, the reviewer wanted to know if the vehicles will be more susceptible to low-speed crashes? Or, because the actual magnitude of the speed differences is small, will this have little impact on the number of low-speed crashes?

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

This project pulls in a variety of partners, each with a different role that is articulated in the presentation deck. While only modest details were provided regarding the specifics of group coordination—based on project progress and achievements thus far and particularly given the challenges presented over the past year—the reviewer asserted that the collaboration and associated delegation seem to be solid.

Reviewer 2:

The role of each partner is clear and additive. The reviewer opined that how coordination and hand-off happen need more detail.

Reviewer 3:

The other partners' roles were discussed briefly, but it seems Southwest Research Institute (SwRI) is the lead and doing most of the work. The reviewer would like to have seen the industry involved more.

Reviewer 4:

The reviewer would like the research team to elaborate on goals for engaging the city of Austin. The reviewer wanted to know if the team is looking for the city to deploy this technology during the project time frame. If not, what are Austin's plans with respect to this technology?

***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. Note: If the project has ended, please state project ended.***

Reviewer 1:

The presentation included future plans, both via dedicated summary slides and across other themed slides. An example is referencing that tech-to-market highlights will be updated semiannually, or that in FY 2022 the team will transition from dynamometer to track testing (among other plans). According to the reviewer, the team also addresses select barriers, such as barriers related to penetration characterization and associated metrics. This future research seems logically articulated and communicated in an organized manner.

Reviewer 2:

There will most likely be additional research in this area needed due to the complexity. The reviewer found that these topics were listed and explained well.

Reviewer 3:

Future work has a clear, rational, and measurable objective. In addition to higher traffic flux conditions, the reviewer suggested that more complex conditions would add useful output.

Reviewer 4:

For the future test track demonstration, given the recent Federal Communications Commission (FCC) ruling, the reviewer would like to know if the research team will need to change from DSRC technology to C-V2X? If the team plans to change communications technology, will this impact cost or schedule? For future reporting, the term "traffic flux" is not typically used in traffic-related studies. A term such as "traffic volume" might be more appropriate.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

According to the reviewer, this project is working to better understand and quantify the impact of CAVs as well as the impact and benefit that smart and eco-vehicles could have across an urban corridor, particularly with respect to energy efficiency. This supports VTO's mission to improve transportation energy efficiency—"The EEMS Program conducts early-stage R&D at the vehicle, traveler, and system levels, creating new knowledge, tools, insights, and technology solutions that increase mobility energy productivity."

Reviewer 2:

The reviewer indicated that, yes, this is well aligned with DOE objectives of using CAV technologies for more energy efficient traffic.

Reviewer 3:

This reviewer noted a very interesting project to see the total merit of penetration smart vehicles for energy savings. The variables and dynamic movement of the vehicles will greatly influence this, and it will be good to see if there is a solid conclusion.

Reviewer 4:

The reviewer opined that the work clearly contributes to improved vehicle efficiency. Continuation of this rating will depend on real-world testing following completed validation of the dynamometer. If the value is in the low single digits, this may indicate no real value.

***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 the partners bring the necessary resources through direct or in-kind contribution.

Reviewer 2:

Workforce and members are well managed and right sized, according to the reviewer.

Reviewer 3:

While more work could be done to supplement existing efforts, this reviewer noted that the project appeared to be on track and progressing well with the allocated resources. Given this, the current resource level seems sufficient.

Reviewer 4:

Resources appeared to the reviewer to be sufficient to meet the project milestones.

**Presentation Number:** eems087  
**Presentation Title:** Computation of Metropolitan-Scale, Quasi-Dynamic Traffic Assignment Models Using High Performance Computing  
**Principal Investigator:** Jane Macfarlane (Lawrence Berkeley National Laboratory)

**Presenter**

Jane Macfarlane, Lawrence Berkeley National Laboratory

**Reviewer Sample Size**

A total of two reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

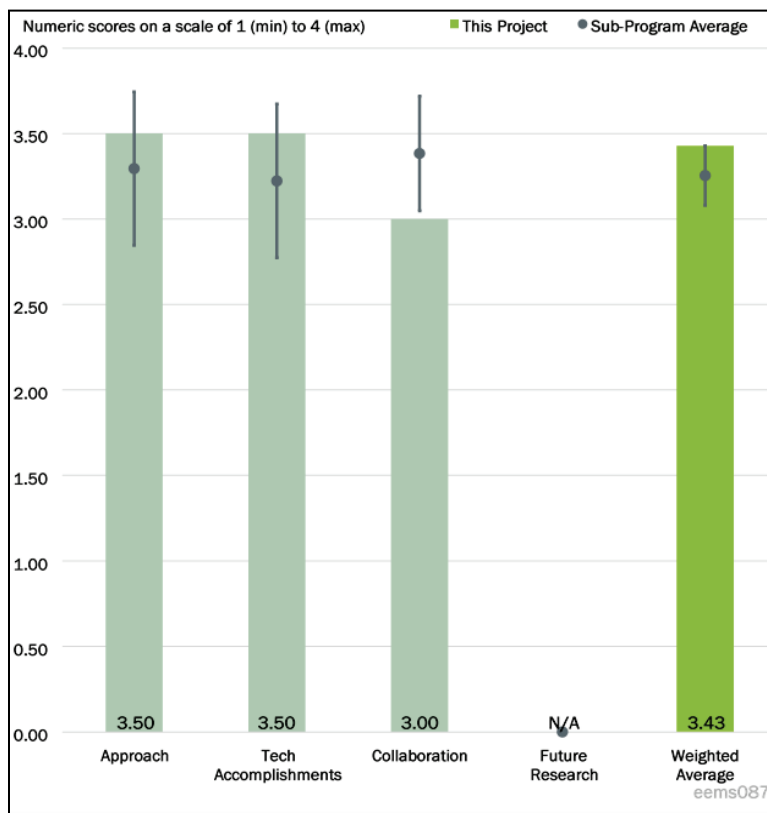


Figure 3-12 - Presentation Number: eems087 Presentation Title: Computation of Metropolitan-Scale, Quasi-Dynamic Traffic Assignment Models Using High Performance Computing Principal Investigator: Jane Macfarlane (Lawrence Berkeley National Laboratory)

**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 praised the research approach as excellent in addressing multiple barriers, including assessment of energy use at the system level, and addressing the scalability and computational limitations of dynamic traffic-flow modeling. The research approach was aimed at developing a metropolitan-scale, dynamic traffic-flow model with significantly shorter computational run time using parallel algorithms through the support of high-performance computing (HPC). Model development focused on the ability to evaluate both time-based and energy-based use scenarios at the system level.

Reviewer 2:

The project seems to have been able to resolve technical HPC issues to arrive at the relatively quick results in different urban regions. The reviewer commented that dividing time into 15-minute blocks was a smart move.

**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:

This reviewer noted research that made significant progress in addressing the original technical barriers cited. The quasi-dynamic traffic assignment (QDTA) algorithm developed under the project was shown to generate

more realistic results than the static traffic assignment (STA) algorithms as far as representing the temporal nature of demand, ensuring only active demand assignment per time interval, and carrying over residual demand across time intervals. The reviewer observed that the “parallelized” computing approach to traffic assignment using HPC resulted in significantly reduced run times for large metropolitan networks like San Francisco and Los Angeles. The research’s evaluation results for socially aware metrics—neighborhoods, safety, mobility, equity, and environment—were effective in visualizing impacts for following three model optimization functions, including user equilibrium travel (UET) time, system optimal travel (SOT) time, and system optimal fuel (SOF) use. These results also showcased the utility of model results for comparing impacts across different metropolitan areas.

Reviewer 2:

Project and progress seemed complete to the reviewer with respect to objectives being met.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The researcher provided an interesting list of collaborators, including national laboratories (LBNL), universities (the University of California), commercial entities (HERE and Uber), government agencies (the City of San Jose and the San Francisco County Transportation Authority), and associations (the Southern California Association of Governments). However, the reviewer asserted that the particular roles and contributions of these collaborative parties were not clearly defined by the researcher.

Reviewer 2:

According to the reviewer, coordination and collaboration among partners appear to be well coordinated based on information gleaned from the presentation.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer commented that this question is not applicable since the project was completed in May of 2021.

Reviewer 2:

The reviewer stated that the project has ended.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer said that this project advances the knowledge base and toolset for evaluating large-scale metropolitan system-level traffic, user mobility experience, emerging technologies and practices, and the resulting energy use.

Reviewer 2:

The reviewer indicated that this project supports improving transportation energy efficiency at the traveler and system levels through the creation of tools.

***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 was successfully completed on schedule and within budget.

Reviewer 2:

The reviewer stated that \$300,000 for this project was sufficient.



**Presentation Number: eems088**  
**Presentation Title: Chicago Transit Authority: Transit Network Efficiency Using POLARIS**  
**Principal Investigator: Omer Verbas (Argonne National Laboratory)**

**Presenter**

Omer Verbas, Argonne National Laboratory

**Reviewer Sample Size**

A total of three reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

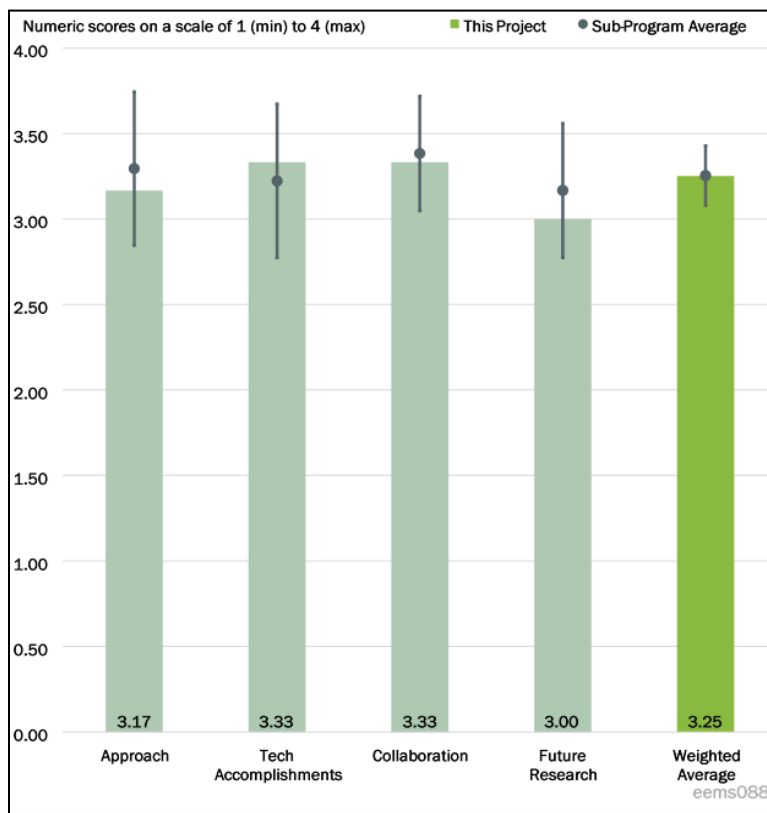


Figure 3-13 - Presentation Number: eems088 Presentation Title: Chicago Transit Authority: Transit Network Efficiency Using POLARIS Principal Investigator: Omer Verbas (Argonne National Laboratory)

**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 overall approach has proven relatively sound. Quantifying the impact of the proposed strategies is necessary to simulate the entire transportation system (or system of systems). This requires HPC to enable analysis of a large number of scenarios, conducting predictive scenario assessment, and implementing ridership recovery scenario analyses, ultimately leading to the quantification of potential impacts. Optimization algorithms have proven critical to this process in order to evaluate improved transit strategies, including new routes, reallocating frequencies, and so forth.

The project has provided a reasonable list of barriers, including computational models and design and simulation methodologies. It also includes COVID-19-related shifts in Chicago Transit Authority (CTA) focus and altered user behavior resulting from COVID-19.

Reviewer 2:

The reviewer commented that the technical approach to this project appeared to be well laid out for addressing computational and knowledge barriers due to the impacts of COVID-19 on the Chicago transit system. Using the Planning and Operations Language for Agent-based Regional Integrate Simulation (POLARIS) platform, the research set out to model risk perception for shared transit modes and improve the telecommuting model based on survey data, calibrating mode choice, routing, and timing choice parameter based on ridership data. It also modeled risk perception to validate traffic count data based on roadway data. The research plan prescribed

HPC attributes for supporting predictive scenario analysis related to COVID-19 impacts on agency budget reduction, increased telecommuting, and increased modal risk perception, as well as analysis of ridership recovery scenarios for optimizing modal frequencies and adding bus rapid transit (BRT) lines. Through this approach the research team planned to quantify system impacts on ridership, congestion, economy, user experience, energy, emissions, and equity.

Reviewer 3:

The approach to this research is solid, though some aspects did not seem to be well balanced to the reviewer. Among other questions, if the researchers need HPC, this suggests this is a rather advanced and sophisticated modeling and computational environment. However, to the reviewer's knowledge, the information for the COVID-19 impacts is based on only a few hundred respondents from the University of Illinois at Chicago (UIC) study. Is that enough to extract valid information to inform COVID-19-related scenarios? What sample sizes can the researchers count on? Is this enough to account for the heterogeneity in behaviors with respect to public transit use and teleworking? Also, the assumptions made to model COVID-19 scenarios are not clearly displayed. Are the researchers assuming that the fundamentals of travel (e.g., model coefficients) in POLARIS will not change, but only the values (e.g., variable levels) are modified? The fact that the model seems to substantially overestimate rail ridership during COVID-19, but to underestimate bus ridership during the same time seems to suggest that the model is not properly capturing different behaviors among various groups of riders (e.g., higher income rail riders who are more likely to telecommute, while captive bus riders continue to ride transit, as it seems to be evident from the American Public Transportation Association [APTA] and other public transit data). Also, the reviewer would like to know how the researchers plan to evaluate the type of service improvements considered as most effective. Does the team have a module to evaluate cost effectiveness of the improvements? For example, doubling frequency can be very expensive, and the results show that BRT takes riders away from the subway, so these solutions might not be very appropriate recommendations.

***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 has successfully achieved a respectable list of technical accomplishments and results:

- Development of an optimization algorithm and simulation to improve transit service, including transit route design and redesign, new transit route frequencies and timetables, and service cuts under predictive scenarios.
- Results have determined that telecommuting and COVID-19 risk perception have more impact than service cuts on transit ridership. COVID-19 risk perception has the potential to disrupt ridership more than deep service cuts or telecommuting.
- Analyses have quantified that the increase in fuel use and GHG emissions per day in the Chicago metropolitan area are a result of the loss of ridership under various scenarios.
- Under the ridership recovery scenario analysis, modeling has identified optimized service cuts, assuming scenarios with budget cuts of 20% and 55%. Service improvements through increasing frequencies of routes and the addition of BRT lines have been identified.
- Results further indicate that optimizing route frequencies shifts service and ridership from bus to rail without impacting total ridership and improving overall user experience. Increasing route frequencies or adding BRT lines induces transit ridership and shifts travelers from rail to bus.

Reviewer 2:

This reviewer remarked that the research team presented meaningful results as related to the original goals and objectives of the work. As part of its predictive scenario analysis, results indicated that telecommuting and COVID-19 risk perception have more system level impacts than Chicago transit service cuts alone, and that COVID-19 risk perception had a greater impact on demand than either deep service cuts or telecommuting. In regard to ridership recovery scenario analysis, results showed optimizing frequencies shifted ridership from bus to rail but had no impact on total system ridership and improved overall user experience. Increasing frequencies or adding BRT induced overall system ridership and shifted modal use from rail to bus. The reviewer suggested that it would seem these results could be useful for extrapolation to other transit systems as well.

Reviewer 3:

According to the reviewer, the researchers made a great effort in customizing the research to account for the mutated conditions during the COVID-19 pandemic in a rather solid way.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer indicated that the research appeared to receive valuable data and insight from multiple collaborative partners, including CTA for ridership and fleet data, modeling scenario input, and results analysis; Chicago Department of Transportation (Chicago DOT) for roadway data and modeling scenario input; and UIC for COVID-19 impacts and user behavior modeling.

Reviewer 2:

The project team is well rounded and has proven appropriate for the task at hand, including ANL, CTA, UIC, and the Chicago CDOT. The reviewer stated that roles and responsibilities of each partner have been identified.

Reviewer 3:

The team seems to be collaborating well across the national laboratory, the academic team at UIC, and the public transportation agencies. The reviewer suggested that it would be desirable to link this framework to the new mobility options too, something that had been in the original proposed work but not in the COVID-19 modified work.

***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. Note: If the project has ended, please state project ended.***

Reviewer 1:

The researchers are aiming to address a very complex topic with the combination of the future transit planning and route selection. The reviewer opined that more details on how the project team wants to accomplish that would be required, as it is a very complex problem (in particular in the formulation given by the researchers, including both fixed route transit but also first-mile and last-mile (FMLM) options with ride hailing, which would return almost infinite possibilities for change in the future public transportation network). The evaluation of cost effectiveness of the future solutions should be an important priority.

Reviewer 2:

The reviewer reported that this project concluded in May 2021. Remaining challenges and barriers have been identified satisfactorily: risk perception models need to be continuously updated; frequency optimization by itself is not sufficient to recover or increase ridership; and optimizing route design and frequencies jointly is

necessary to dramatically increase ridership. Proposed future research include joint optimization of route design and frequency setting; transit signal priority; timed transfers; transit bus electrification; and integration with FMLM services.

The reviewer believed that the first and last items are spot on, especially within the context of aiming to increase ridership. However, it was unclear how the aforementioned items the middle three items will directly impact ridership in a significant way, as these elements seem to work more at the margins.

Moving forward, it may be good to consider unique approaches to how these analyses and future efforts can be combined with and augment CTA's traditional route analysis and optimization processes.

The reviewer believed that it is questionable that in the current COVID-19—and soon post-COVID-19—environment it is feasible to re-establish pre-COVID-19 ridership levels, much less improve upon them in the near future. Furthermore, these analyses may prove useful to rationalize CTA expectations for increasing ridership.

Reviewer 3:

The reviewer noted that the project was completed in May 2021.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer found the project to be relevant due to the need to re-envision the future of transit services as a result of COVID-19 and subsequent steep losses in ridership. Transit is the most energy efficient transportation mode on a passenger-mile basis and means to stabilize and regain ridership are badly needed in the post-COVID-19 environment. Improving transit efficiency and increasing ridership reduces energy consumption and GHG emissions.

Reviewer 2:

According to the reviewer, the research expanded the use of the existing POLARIS platform to evaluate and understand the pandemic's impacts on a major metropolitan area's transit system for improving future mobility, user experience, and energy resiliency for the system and other similar systems.

Reviewer 3:

The project is clearly linked to the future of transportation and its impacts on energy consumption and environmental emissions. The reviewer commented that the electrification of public transit is probably the easiest part to model in terms of assumptions to introduce in the future work.

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

Reviewer 1:

From the reviewer's understanding of the work, it seems that the available resources are appropriate.

Reviewer 2:

The reviewer said that resources have proven sufficient to achieve the required project objectives.

Reviewer 3:

The project was successfully completed on schedule and within DOE's budget. The researcher did indicate that additional National Virtual Biotechnology Laboratory (NVBL) funding was used to support completion of the project.

**Presentation Number:** eems089  
**Presentation Title:** Energy Efficient CAVs: Workflow Development and Deployment  
**CAVs:** Workflow Development and Deployment  
**Principal Investigator:** Dominik Karbowski (Argonne National Laboratory)

**Presenter**

Dominik Karbowski, Argonne National Laboratory

**Reviewer Sample Size**

A total of three reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 67% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 33% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

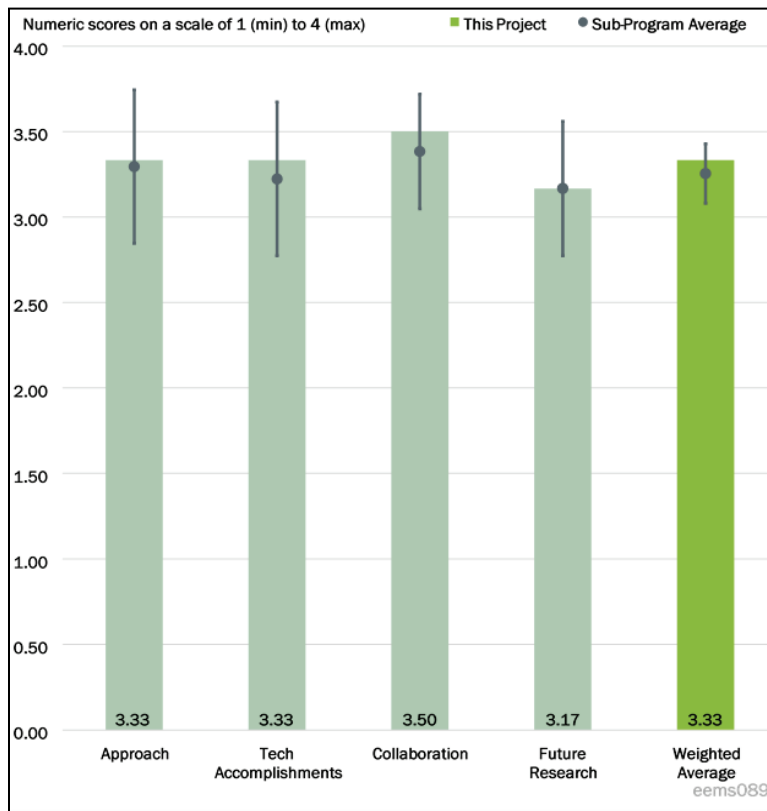


Figure 3-14 - Presentation Number: eems089 Presentation Title: Energy Efficient CAVs: Workflow Development and Deployment Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

**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 successfully addresses gaps in the study of CAV technologies, which is somewhat of a moving target. For that reason, the maximum flexibility in tools is required, and the reviewer asserted that the project team did well in managing to attack the uncertainties involved.

Reviewer 2:

This reviewer has been familiar with the workflows that are being developed in this project and agreed with the statement that energy efficiency has not been a primary motivator for companies developing AVs. There is significant potential to improve energy efficiency as well as increase capacity of the transportation system network, to mention a couple of things. The reviewer asserted that this project is developing the tools and workflow to understand these aspects.

Reviewer 3:

The approach was reasonable to the reviewer. However, the software development portion of the scope appears to be excessive.

***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:

Making the tools useable is critical to success. The integration of stochastic vehicle trip prediction (SVTRIP) into AMBER is a major milestone, according to the reviewer. The addition of anything-in-the-loop (XIL) and vehicle-to-vehicle (V2V) features also advances the capability to analyze CAVs in the mobility environment.

Reviewer 2:

Progress is satisfactory. The optimization results seemed particularly encouraging to the reviewer.

Reviewer 3:

The reviewer reported that several improvements to the models and workflow processes have been made, including driver model and automated calibration. Model calibration is typically a time-consuming process, and this should help speed up the workflow significantly.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The project involves three distinct aspects and requires streamlined project management and coordination. The reviewer opined that the progress indicates that the project team is collaborating and coordinating well.

Reviewer 2:

Proving out the driver model simulation results with real vehicle testing is very valuable, and the reviewer found collaboration with OEMs to be a good step here.

Reviewer 3:

Successful collaboration with an OEM to obtain data for model validation was noted by this reviewer. However, these cover relatively low levels of autonomy. Perhaps more data from vehicles with higher levels of autonomy—possibly the Tesla Autopilot—could help improve the models further.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The next steps made sense to the reviewer. It should be interesting to see how lateral dynamics impact the system results.

Reviewer 2:

Although the proposed future research appeared reasonable to the reviewer, the software development efforts appear excessive. Those tasks are beyond research and best left to the private sector.

Reviewer 3:

Several features are being released or developed, and this reviewer had similar concerns that have been expressed previously on other Autonomie projects. Specifically, is the software development and support (to non-government users) taking up too much time so as to affect execution of the other projects? How does ANL balance the requirements of software support and executing DOE projects?

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer commented that the CAV technology modeling work is a critical part of assessing these new features of the transport infrastructure and their impact on transport energy consumption.

Reviewer 2:

The reviewer commented that the models and processes developed here support the SMART workflow.

Reviewer 3:

The reviewer affirmed that, yes, the workflow ensures that energy efficiency is considered in CAV controls development.

***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 work is progressing well with the available resources.

Reviewer 2:

According to the reviewer, the resources dedicated to software development appear to be excessive.

Reviewer 3:

Sufficient resources were noted by this reviewer.



**Presentation Number: eems091**  
**Presentation Title: TCF: Ubiquitous Traffic Volume Estimation**  
**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.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 67% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 33% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

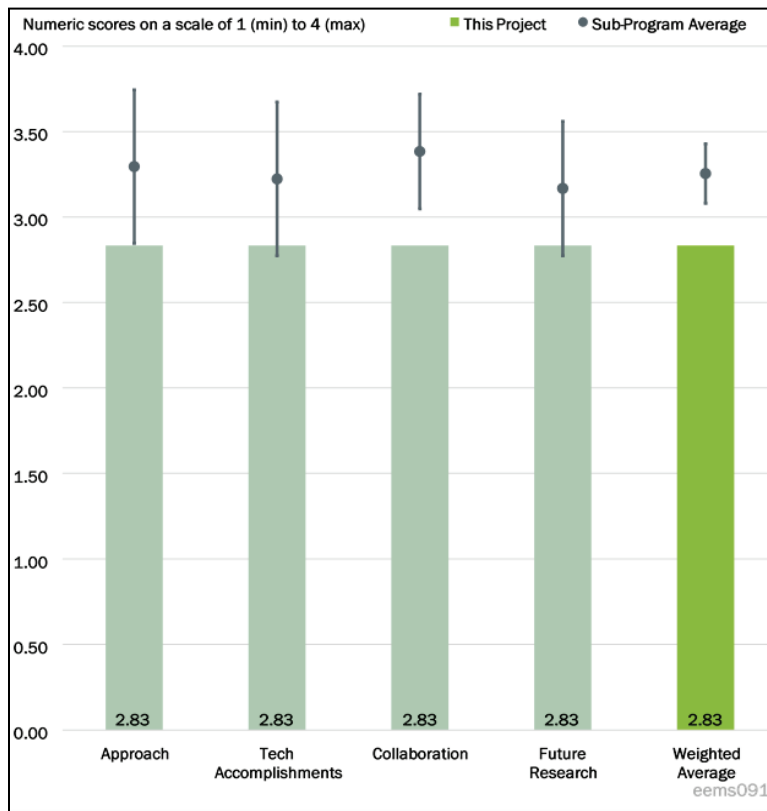


Figure 3-15 - Presentation Number: eems091 Presentation Title: TCF: Ubiquitous Traffic Volume Estimation Principal Investigator: Venu Garikapati (National Renewable Energy Laboratory)

**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 liked the approach here, especially of comparing model data developed from one city and applying them to another city. The only thing the reviewer recommended for this is trying to project some of the modeling to a much larger or smaller city to see what the potential is for that type of extrapolation.

Reviewer 2:

Traffic volume estimation techniques already exist. Startups are already using these techniques to improve signal timing. The reviewer was not sure what core technologies this Technology Commercialization Fund (TCF) project is commercializing and how that fills a gap.

Reviewer 3:

The project seemed well designed to the reviewer, but suffers from unforeseen obstacles (e.g., lack of data availability and latency and inability to detect traffic anomalies).

**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 liked the progress made to date.



Reviewer 2:

This reviewer commented that progress seemed on track, except the last milestone is probably more difficult to meet given the lack of a method to identify true traffic anomalies.

Reviewer 3:

The local outlier probability (LoOP) procedure does not appear to work well. The spatial transfer results seem less than satisfactory. The results shown on Slide 15 are also not too impressive.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer liked the good range of partners across different states and the partnership with private entities that provides a pathway to market development of this technology.

Reviewer 2:

The reviewer was not sure how exactly the project team is obtaining advice from university partners.

Reviewer 3:

The reviewer said that this question is hard to judge.

***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. Note: If the project has ended, please state project ended.***

Reviewer 1:

The reviewer liked the planned future research, especially with the different vehicle classifications. The reviewer went on to say that it would be important for future research to also compare the relative percentage of MD and HD vehicles to the light duty vehicles in the different cities to ascertain the impacts these vehicles have for the city-to-city data transfer. Correlating those data to areas that have significant goods movement traffic will also be needed in the future to make the model more robust.

Reviewer 2:

The reviewer was worried about the lack of a proven method to identify real traffic anomalies with respect to the last milestone.

Reviewer 3:

According to the reviewer, this work just appears to be behind the times. The proposed work is already being done in industry.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer believed that this project supports the overall relevance to the topic area given the commercialization potential, which also provides more value for this effort and makes it usable for industry.

Reviewer 2:

The reviewer said that the project supports early-stage R&D to develop innovative technologies that enable energy efficient future mobility systems (although the energy consumption part is not a component of this project).

Reviewer 3:

Traffic volumes are critical in energy modeling, 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:

This project seemed to the reviewer like good “bang for the buck,” with good progress being made for the budget to date.

Reviewer 2:

The reviewer remarked that \$500,000 seems sufficient, but it is hard to judge.

Reviewer 3:

The project seemed excessive to the reviewer, considering the extensive existing work that is already out there.

**Presentation Number:** eems092  
**Presentation Title:** BEAM CORE  
**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.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

**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 very impressed with the progress and vision laid out for Behavior, Energy, Autonomy, And Mobility (BEAM) at AMR. The reviewer believed that the approach that is outlined makes significant contributions to current modeling barriers, and the reviewer especially looked forward to hearing the results of the comparison with POLARIS and some of the new equity-related analyses that can be conducted with updates to BEAM. On Slides 29 and 30, it appears that all Q3 and Q4 milestones are on track, so the reviewer had no concerns to document here.

Reviewer 2:

The continued development of BEAM and its companion pieces is well planned. The short-term and long-term effects are addressed well with the ongoing and planned work. The reviewer asserted that BEAM Comprehensive Regional Evaluator (CORE) is an excellent synthesis of these pieces to answer regional questions in a more thorough manner.

Reviewer 3:

Having seen the POLARIS-based projects and the BEAM-based projects, it was good for this reviewer to see the slightly different approach (and perhaps a stronger focus on longer term modeling) used by BEAM. The reviewer was initially of the opinion that it was a waste of valuable resources to duplicate the effort but has since changed positions. The different approach to addressing (more or less) similar problems can actually

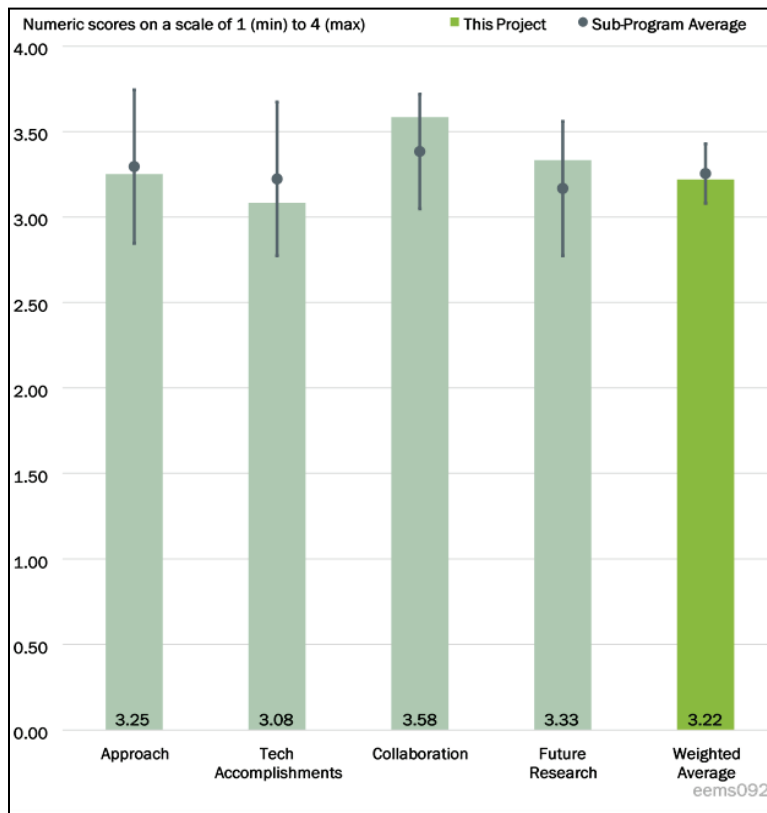


Figure 3-16 - Presentation Number: eems092 Presentation Title: BEAM CORE Principal Investigator: Anna Spurlock (Lawrence Berkeley National Laboratory)

yield valuable insights and the BEAM team is doing an admirable job along with the POLARIS team. The longitudinal focus also helps answer several questions as we try to understand the future of mobility.

Reviewer 4:

The modeling approach is comprehensive. The concern that the reviewer had is how much the comprehensive system can integrate with other existing modeling tools already in use. It is unlikely that a planning organization will adopt an entirely new modeling system from scratch (even though it does happen from time to time).

Reviewer 5:

At a high level, the approach made sense to the reviewer. There are a lot of interactions and handoffs between the models and insufficient transparency needed to help users understand and interpret the results and manage uncertainty. The presenters spoke to transparency. However, there is substantial room for improvement. The computational complexity makes it hard to see how changing a lever or multiple levers that interact changes the results. The researchers answered a question on scenario versus forecasting. This needs to be reconciled further. The research questions like future fleet composition suggest a predicted outcome versus a scenario, with implications for how the results should be used and interpreted.

***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 excellent progress is being made on making the software system more useable with speed improvements, greater automation, and more regional simulations. Household and vehicle ownership models are more difficult to pull off but handled well, given the data that are available.

Reviewer 2:

The choice to go open source was an interesting one to this reviewer. Because software like BEAM is not something that is easy to use, this presents a big problem in terms of support. Is the software going to be offered as-is with a user manual and no support? This would limit the usefulness of the software. The reviewer presumed that the main users of the software will be governmental agencies, planning authorities, and the like. However, the more it gets deployed outside of LBNL, the more support it will need for it to be successful and for it to provide useful feedback to the BEAM team. The reviewer added that deploying the models in multiple regions is good and asked whether the software takes into consideration resource availability as it is used to model land use evolution. For instance, extended drought causing a scarcity of water resources in the west, and its effect on land use.

Reviewer 3:

The project appears to be making good progress. However, it does not appear as if all the recent progress has been committed to the GitHub repository. The reviewer encouraged the project team to commit often to accelerate technology transfer.

Reviewer 4:

For Task 2, the reviewer noted that the research team completed model formulation with data but did not show validation runs.

Reviewer 5:

Again, based on the reported milestones, it appears that this project is on schedule. The reviewer did not see any discussion of performance indicators (beyond the defined milestones), making this question a little challenging to answer.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer said that the project has many moving parts across a number of organizations and is well managed.

Reviewer 2:

The team seemed well integrated to the reviewer and is functioning as a cohesive unit.

Reviewer 3:

According to the reviewer, the project team appears to collaborate well.

Reviewer 4:

On Slide 57, it appears that collaboration is working well across the project team. The presenter seems to have identified all the important stakeholders and has them involved in the research. The reviewer encouraged the research team to think more about technology transfer (in addition to stakeholder engagement, which the reviewer expanded upon previously).

Reviewer 5:

Great collaboration between various labs, universities, and other organizations was observed by this reviewer. It would, perhaps, be worthwhile to engage with universities and organizations outside the US to get fresh perspectives on these problems. The reviewer was not sure if similar work is being performed elsewhere, but it seemed that it would be beneficial.

***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. Note: If the project has ended, please state project ended.***

Reviewer 1:

The reviewer noted that the freight module and the stakeholder engagement efforts are definitely of high value.

Reviewer 2:

The proposed next steps were logical to the reviewer and are needed to achieve future modeling goals and get wider usage of the tools.

Reviewer 3:

It was clear to this reviewer that BEAM is still evolving to address a variety of issues, and the plan laid out by the team appears to be appropriate.

Reviewer 4:

The reviewer thanked the research team for including the top takeaways from the listening sessions and found it insightful to read them to understand stakeholder feedback and how that will inform BEAM CORE and BEAM CORE Application and Collaboration Tool (ACT) moving forward.

The reviewer stated that the only piece of constructive feedback for the BEAM team at this point is to encourage the team to start thinking about technology transfer sooner rather than later. The reviewer was glad to hear that BEAM is pivoting to focus on open-source tools but has found that sometimes open-source tools are a bit hard to work with (e.g., documentation may not be easy to follow, there is not as much support, sometimes there is not a graphical user interface, etc.). The reviewer thought that the work BEAM is doing is incredible and will enable planners to answer a lot of new and important questions. Is the team thinking about how to transfer the final model to an MPO planner? Will the planner require additional skillsets or training?

What is the BEAM development team doing to ensure that, once the model is developed, it can be easily deployed?

Reviewer 5:

Future work appears to be targeted at challenges such as run time. The reviewer opined that the research team needs to clarify if the 30% runtime cut includes full population runs or if adding the full run will overwhelm the runtime savings.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer said that BEAM CORE provides a mobility system modeling capability that complements other tools and may be uniquely positioned to answer certain “what-if” questions posed in the EEMS work.

Reviewer 2:

The reviewer affirmed that, yes, the transportation activities have important energy impacts.

Reviewer 3:

The reviewer remarked that the results aim to inform real-world decision-making, with an impact on transportation energy use.

Reviewer 4:

The reviewer stated that this project is aimed at understanding how mobility is going to evolve in the future, and as such, supports DOE objectives.

Reviewer 5:

Without advanced modeling tools like BEAM, DOE cannot explore many of the important questions surrounding energy use and consumption. The reviewer commented that the questions are too complex for models that are commercially available today.

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

Reviewer 1:

Progress has been excellent in the first year without reported delays due to lack of resources. The reviewer concluded that the resources are adequate.

Reviewer 2:

The resources are sufficient, according to the reviewer.

Reviewer 3:

Resources were described by this reviewer as sufficient.

Reviewer 4:

The monetary resources are at least sufficient and could be excessive. It was clear to the reviewer that the partners have access to the necessary tools like HPC clusters.

Reviewer 5:

Not applicable was indicated by this reviewer.

**Presentation Number: eems093**  
**Presentation Title: Transportation System Impact: POLARIS Workflow Development, Implementation and Deployment**  
**Principal Investigator: Aymeric Rousseau (Argonne National Laboratory)**

**Presenter**

Aymeric Rousseau, Argonne National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 50% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 50% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

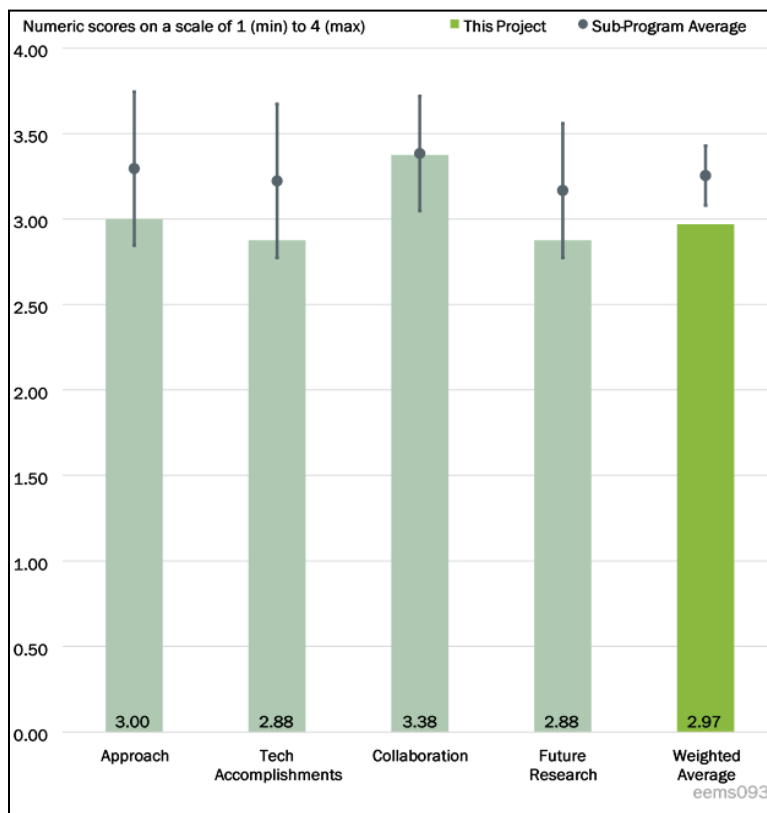


Figure 3-17 - Presentation Number: eems093 Presentation Title: Transportation System Impact: POLARIS Workflow Development, Implementation and Deployment Principal Investigator: Aymeric Rousseau (Argonne National Laboratory)

**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 very impressed with the work completed by the POLARIS team. The work seems very well designed and systematic. The reviewer had no concerns about the feasibility of the work proposed.

Reviewer 2:

This reviewer has been looking at the various results coming out of the POLARIS software, and the team has been addressing the issues and concerns raised by the stakeholders and doing so very well. The software is unique in its scope and the reviewer commented that the team has worked hard to make its capabilities more relevant to addressing DOE needs.

Reviewer 3:

Researchers should consider if trying to integrate and add functionality in many areas simultaneously is more or less effective than focusing on adding and ensuring robustness in a limited area. The reviewer questioned what work needs to happen in parallel, what work can happen serially, and what is the rank order. On Slide 6, it is usually better to have the stakeholders define the desired new features, not the other way around.

Reviewer 4:

The reviewer had serious concerns about how the POLARIS model system has ballooned into such as massive and costly effort, yet it is a closed system that the wider community cannot access. Yes, the model can be licensed and the team is working with stakeholders, but the cost is prohibitive for most medium and smaller areas. Also, the speed of technology transfer is limited to the team’s ability to expand. The transportation agencies have long had issues with DOE models because they are costly and cumbersome to use. This issue is only getting worse. If DOE headquarters (HQ) is serious about addressing the barriers listed in this presentation, it should urge the laboratories to release POLARIS as open source. POLARIS developers should develop training materials and democratize the model and its underlying algorithms. As is, there is no way for any reviewer to judge whether or not the algorithms are accurate or practical because everything is closed.

***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 noticed that the team explicitly mentioned the limited validation of the standalone tools but was surprised not to see more discussion of completed or planned validation of the workflow. The reviewer was also glad to hear that the team is starting to tackle more automated connections between the various model components. Overcoming this limitation will be important toward final deployment.

Reviewer 2:

From what this reviewer can see, running POLARIS is a very involved process and requires a diverse set of inputs. Setting up a POLARIS model for a region is a months-long endeavor. In order for POLARIS to be more effective, a few things have to happen—it has to run faster and produce results quicker, and more importantly, it should be quicker to set up the models themselves. These points have been/are being addressed in the work that has been done to date on the project.

Reviewer 3:

This reviewer noted the content on Slide 22 was too high level. The real output was difficult for this reviewer to confidently understand; for example, the reviewer was unsure if the model considers consumption that happens in days, weeks, or months later. The reviewer stated that the predictive models seem to be conflated with scenario analysis, and highlighted that scenarios are not predictions.

Regarding Slide 23, the reviewer indicated that results seem to be mixing existing and under-development content. There is enough work to focus on what has been done, not what will or might be done. If the under-development content is relevant, then the reviewer asked the team to provide sufficient details on why and what has been learned and accomplished to date. This extends to other work like the new API design on Slide 25.

A prior review noted a lack of performance indicators, which remains the case. A lack of clear indicators and metrics made it difficult for this reviewer to fully assess the accomplishments.

Reviewer 4:

Although the project seemed to have made decent progress, there was no way for the reviewer to really know. There are not enough peer-reviewed articles on modeling details.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The stakeholder group that the research team has assembled is impressive. The reviewer appreciated the increased participation of MPOs in the stakeholder engagement groups. The reviewer thought that it will make the end product much more usable to engage end-users this early in the process.



Reviewer 2:

The reviewer remarked that the project team seems to be collaborating well.

Reviewer 3:

The reviewer reported that the team has involved a very large number of partners, including some outside of the United States. The very diverse set of viewpoints should improve the project outcome significantly.

Reviewer 4:

The stakeholders guided the study design. As described, more active engagement in the creation and execution of the study may help improve the work. It seemed to the reviewer that the researchers are aware of this need based on the response to prior years' comments. However, there appears to be additional room for improvement.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer indicated that proposed research continues to address improvements in process flow while also putting the model to work by looking at several new and different scenarios. This reviewer looked forward to results of the new studies.

Reviewer 2:

The reviewer stated that the proposed future research is an expansive coverage of relevant topics but lacks detail to evaluate the merits and consider them in the context of alternative options and ongoing work.

Reviewer 3:

The only piece of constructive feedback that the reviewer had for the POLARIS team at this point is to start thinking about technology transfer sooner rather than later. The reviewer thought that the work POLARIS is doing is incredible and will enable planners to answer a lot of new and important questions. However, the reviewer wanted to know if the team is thinking about how to transfer the final model to an MPO planner. Will the MPO planner require additional skillsets or training? What is the POLARIS development team doing to ensure that once the model is developed, it can be easily deployed? This model is so powerful (and complex) that the reviewer was concerned about MPOs having the necessary skillsets to be in control of this model once it is ready for deployment.

Reviewer 4:

The direction of proposed future research is good. However, the reviewer emphasized that the model should be open source if DOE HQ is serious about advancing the field. Transportation is a public good. Transportation agencies are public agencies. It does not make sense to require that public agencies should use taxpayer money to license a laboratory-developed technology that is also funded by taxpayer money.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer asserted that, of course, this project supports the overall DOE objectives.

Reviewer 2:

The reviewer affirmed, yes, but to answer the larger questions of interest to DOE, more complex models are necessary.

Reviewer 3:

The reviewer opined that the project is relevant to DOE objectives but not if the model continues to be closed.

Reviewer 4:

The reviewer responded affirmatively that, yes, it does, but the presenters did not sufficiently address how. It requires familiarity with the work over the years to understand why.

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

Reviewer 1:

The resources appeared sufficient to this reviewer.

Reviewer 2:

Without specificity of the future work, the reviewer asserted that it is hard to justify this much open-ended funding.

Reviewer 3:

The funding level seemed extremely excessive to the reviewer.

Reviewer 4:

Not applicable was indicated by this reviewer.

**Presentation Number: eems094**  
**Presentation Title: Development and Validation of Intelligent CAV Controls for Energy-Efficiency**  
**Principal Investigator: Dominik Karbowski (Argonne National Laboratory)**

**Presenter**

Dominik Karbowski, Argonne National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

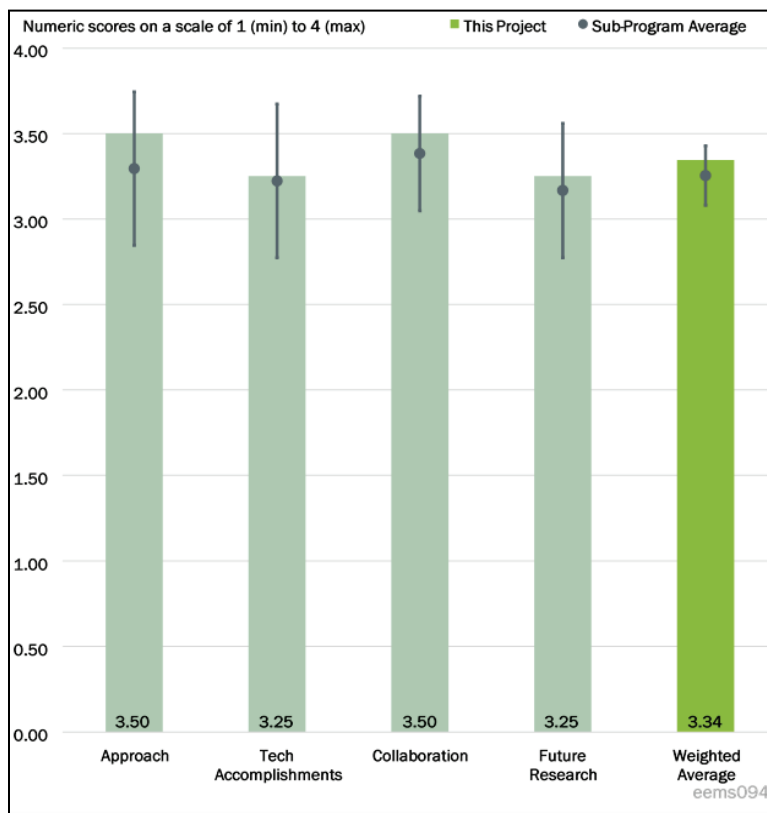


Figure 3-18 - Presentation Number: eems094 Presentation Title: Development and Validation of Intelligent CAV Controls for Energy-Efficiency Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

**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 described the dynamometer track testing sequence as well thought out and the overall project approach as solid.

Reviewer 2:

The reviewer commented that the research team has excellent methods and an execution plan to obtain answers to questions related to CAV technology when true CAVs are not readily available for testing and researchers do not have access to OEM proprietary control systems.

Reviewer 3:

Although this reviewer agreed with the statement that development of AVs has not been driven by energy efficiency, there are energy consumption benefits to be had, and this project aims to quantify those benefits that may be achieved by using appropriate controls. The reviewer explained that there is vehicle-to-vehicle variation when it comes to propulsion system efficiency (as in any product that is produced in volume), and this variation would be higher in conventional (ICE) powertrains compared to EV powertrains. It may, perhaps, be worth looking at these variations in efficiency and evaluating whether the developed controls and calibrations have a measurable effect on energy efficiency.

Reviewer 4:

This reviewer stated that the overall project approach appears to represent a strong mix of simulation, laboratory, and on-track development, which should be a promising approach for robust and realistic controls and insight creation. The presenters stated that the inclusion of realistic traffic conditions will be a key component for continued development as it is imperative to include this analysis for the realistic assessment of CAV strategies. As the project has just begun, it was not expected for this presentation, but later discussions would benefit from more detail about how the GM-provided, real-world data will be used within the overall project. Additionally, it would be helpful to the reviewer to understand how some of the evaluation cycles and scenarios were determined and if these will be updated as more real-world data are obtained and when validation challenges are highlighted from laboratory and track testing. As mentioned earlier, the sensitivity of the expected 6% gain within the context of an overall scenario with realistic traffic would be of great interest in this project and DOE's research goals. For the energy benefits shown, it would also be helpful to highlight the powertrain type used to estimate these benefits and if this would be expected across different powertrain types.

***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 research team has made great progress and accomplishments appear to be somewhat ahead of plan. V2V and vehicle-to-infrastructure (V2I) control simulations coupled with VIL validation tests are great examples of what can be done.

Reviewer 2:

The research team has shown strong preliminary accomplishments across multiple project focus areas, with a clear indication that the project is on track and already producing insights and progress. While timing may slow as experimental and integration issues arise, tasks are clearly progressing well with an emphasis on continued development and creation of research insights. The detailed Future Work slide is also helpful to clarify for the reviewer what items are being executed within the overall project timeline, strengthening the impression that the project is moving along smoothly with objectives.

Reviewer 3:

The project seems to be progressing well, and the reviewer was looking forward to learning about the energy benefits.

Reviewer 4:

The results shown with various scenarios (V2V, V2I, multi-light versus single light) were very interesting to this reviewer. Is the 6% improvement in energy savings the results of 100% CAV penetration or lower? Also, are all vehicles controlled by the same algorithm? In reality, the reviewer explained that vehicles from different manufacturers will likely have different control strategies. Is there a possibility that this could reduce the achievable benefit? Are there scenarios where this could possibly worsen the outcome?

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer noted that there is excellent collaboration between the software and hardware teams to achieve these results. It is good that the project has a source of OEM real-world data to study.

Reviewer 2:

At this early stage in the project, the collaborator roles appear to be sufficiently defined and detailed. Inclusion of other relevant DOE research projects is helpful to better understand how this project supports and is supported by multiple research projects, highlighting additional collaboration and integration with the overall

EEMS research portfolio. As the project transitions to more experimental and validation efforts, these roles may need to be detailed to a greater degree, but, for early-stage project development, the roles for various collaborators seemed adequate to the reviewer.

Reviewer 3:

The reviewer said that the project team seems to be collaborating well.

Reviewer 4:

The reviewer remarked that validation data from GM with supercruise should help improve model quality. Are there plans to include data from vehicles with higher levels of autonomy in the validation process? Also, would the work-at-home due to the pandemic adversely impact the amount of driving data that would be available?

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The proposed future research clearly outlines next steps for the project across all phases and subcomponents. It was clear to the reviewer where the project is headed, and, at this time, the future research clearly aligns with the stated overall project objectives.

Reviewer 2:

Proposed research looks good and is a full slate.

Reviewer 3:

The next steps are appropriate extensions of the current work done so far. The reviewer looked forward to more results from this project.

Reviewer 4:

The reviewer stated that proposed future research is reasonable and appeared to be in line with the original project scope.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer indicated that the way AVs are controlled can potentially improve energy efficiency significantly. Understanding the impact of controls on energy efficiency directly supports the DOE objective of improving energy efficiency.

Reviewer 2:

According to the reviewer, the stated project objectives of developing, refining, and demonstrating CAV strategies are strongly in support of overall DOE research goals. The later project objective of integrating these controls into realistic traffic scenarios is also important to further refine and validate developed controls to ensure overall system improvements and avoid unexpected system-level complications.

Reviewer 3:

The reviewer said that the project demonstrates reduction to practical implementation of ideas for improved mobility system efficiency (e.g., energy and congestion reduction) when CAVs are considered in it.

Reviewer 4:

The reviewer noted that the project supports overall DOE objectives by adding energy efficiency considerations to CAV controls.

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

Reviewer 1:

The project is operating well with the available resources. The reviewer had no indication that some tasks cannot be completed with the current allocations.

Reviewer 2:

The budget appeared adequate to the reviewer as the project integrates additional effort from several other DOE research efforts and projects.

Reviewer 3:

Resources appeared sufficient to the reviewer.

Reviewer 4:

Sufficient resources were noted by this reviewer.

**Presentation Number:** eems095  
**Presentation Title:** Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use  
**Principal Investigator:** Timothy Laclair (Oak Ridge National Laboratory)

**Presenter**

Timothy Laclair, Oak Ridge National Laboratory

**Reviewer Sample Size**

A total of three reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

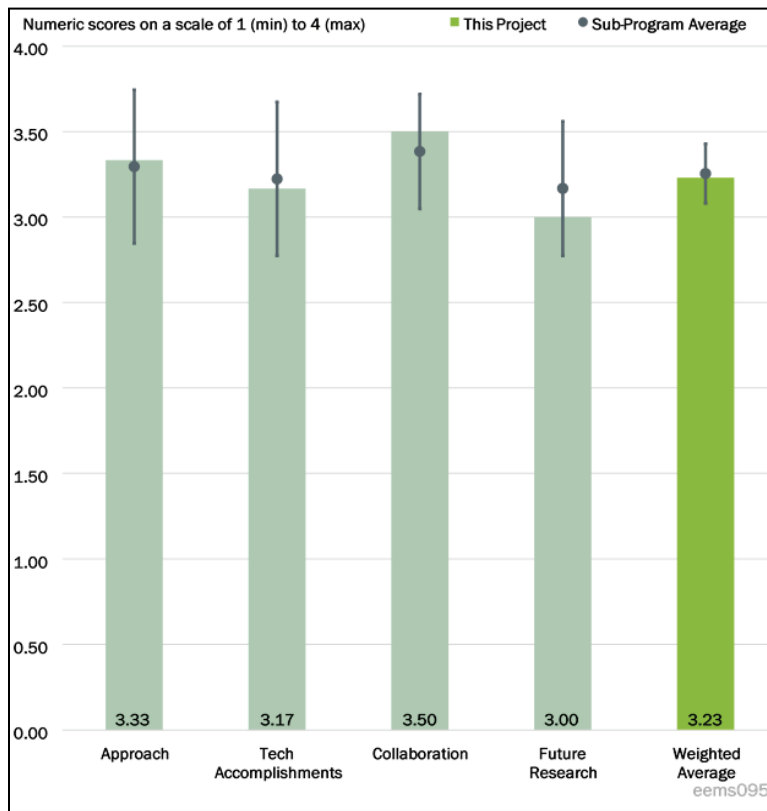


Figure 3-19 - Presentation Number: eems095 Presentation Title: Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use Principal Investigator: Timothy Laclair (Oak Ridge National Laboratory)

**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 project approach is solid. The reviewer suggested that the team should place less emphasis on Vissim simulation and more emphasis on on-road field evaluations.

Reviewer 2:

The reviewer commented that the overall project approach seemed to be very strong, with a mix of partners and parallel project development tasks. Integrating both vehicle and infrastructure controls within a realistic environment is a strong overall direction for this project. Integration of a spectrum across simulation, laboratory, and in-field work shows promise for strong conclusions and support for the project’s stated objectives of understanding CAV technologies in real-world operation. Project partners also provide a strong avenue for implementation of development insights and controls as the project includes both a vehicle OEM, infrastructure provider, and department of transportation. Work is set to address the challenges highlighted in the discussion, but it remains to be seen how difficult these actual implementation challenges will be within a real-world set of conditions.

Reviewer 3:

While this project has similar objectives to several other projects that address CAV benefits, it appeared to the reviewer that it achieves the objective differently—by controlling traffic signals. The targets for energy/fuel

savings would actually depend on how efficient the vehicles are in the first place, and this reviewer did not necessarily agree with the hard targets such as 15% or 0.09 L of fuel, without specifying the reference vehicle. Obviously, a Toyota Prius would not achieve the same reduction in fuel consumption as a Dodge Ram 3500 truck.

***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:

This reviewer stated that the project appears to be on schedule and several accomplishments have been provided at this early stage within the project. Parallel and later tasks appear to be progressing well.

Reviewer 2:

Although the project has been underway for a short time only, this reviewer stated that good progress appears to be made with the traffic signal control algorithm. Presumably, this is specific to the particular stretch of road under consideration, and would have to be developed separately for a different stretch of road.

Reviewer 3:

The project appeared to be progressing well from this reviewer's perspective.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The project has a very strong set of collaborators, and roles and responsibilities appear to be well defined during these early phases of project execution. As the project progresses, the reviewer noted that it will be interesting to understand how the different groups interact for decisions and engineering that crosses into multiple domains, such as integrated vehicle and traffic control. At this point, the roles seem well defined and matched to contributors' strengths.

Reviewer 2:

A good mix of companies/organizations in the team was noted by this reviewer. Because there are other, similar projects underway at other labs, the data that is collected/generated in this project may be used for those other projects as well.

Reviewer 3:

The team has a clear delineation of tasks for each organization. The reviewer remarked that the collaboration and coordination seem to be going well.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The proposed plan looked good to this reviewer.

Reviewer 2:

The reviewer indicated that, at this point, future research and highlighted challenges seemed adequate to address future project execution and plans discussed in the initial Approach slide, but current discussion appears more focused on the development of the controls and simulation efforts. While it is likely already planned, a detailed set of gate and debugging phases for the transition from simulation to hardware development and in-field execution would be helpful to highlight how some of the difficult implementation challenges will be addressed without delaying the project significantly if any sizable issues arise. The CAVE Laboratory is likely an avenue for the vehicle side of these efforts, but it would be helpful to see some possible



steps within the corridor discussion as well since it does begin within the discussed timeframe. Items mentioned for the controls development and Real-Time Mobility Communications and Control System (RyThMiCCS) preparation appear to support overall simulation project goals.

Reviewer 3:

The proposed future research appeared to be reasonable to the reviewer. As mentioned above, it would be nice to see more field evaluation than the Vissim simulation.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

Research efforts for understanding, developing, and validating CAV-enabled strategies within realistic operating scenarios and traffic conditions are directly applicable to DOE objectives. The inclusion of both vehicle and infrastructure systems is also highly relevant to DOE objectives as the project team works toward an overall systems approach for energy savings. The reviewer noted that identifying and addressing the practical challenges associated with CAV strategies is of great importance to both the research and industrial communities.

Reviewer 2:

According to the reviewer, CAV controls for energy efficiency are relevant to DOE's overall objectives.

Reviewer 3:

As with several other CAV projects, the reviewer indicated that this can contribute directly to improving energy efficiency.

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

Reviewer 1:

Resources seemed adequate to the reviewer for a large and multi-faceted project. The cost share also shows a strong interest from industry that this is a relevant and important project. As in-field testing progresses, unexpected costs may arise, but integration with the CAVE facility and other related projects may help offset expected budget issues without significantly reducing research outcomes by balancing simulation, laboratory, and in-field efforts.

Reviewer 2:

This reviewer described resources as sufficient.

Reviewer 3:

The reviewer said that resources are sufficient.

**Presentation Number: eems096**  
**Presentation Title: Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies, Sensors, and Connectivity**  
**Principal Investigator: Thomas Wallner (Argonne National Laboratory)**

**Presenter**

Thomas Wallner, Argonne National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

**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 is well designed to obtain the necessary data, given the limitations on availability of vehicles with the CAV technology to be studied. The reviewer stated that the project also overcomes the accessibility of information in vehicles with CAV-related technologies.

Reviewer 2:

The reviewer explained that this project is somewhat similar in scope to some of the other projects involving CAVs/AVs, and addresses the aspect of improving existing models with data available for production CAVs. One interesting aspect of this project is that it utilizes a Tesla Model 3 Autopilot, which perhaps has a higher automation level than vehicles that some of the other projects propose to use. The reviewer indicated that the data obtained here (with Tesla and the Cadillac CT6) could be very valuable for several other projects that are looking to evaluate energy efficiency benefits of CAVs, or are trying to develop better CAV/AV models for use in the SMART workflow.

Reviewer 3:

The reviewer noted that the overall approach is good and seeks to address barriers in the real-world use of CAV technologies. This research is timely because of the rapid advancements in CAV deployment and interest

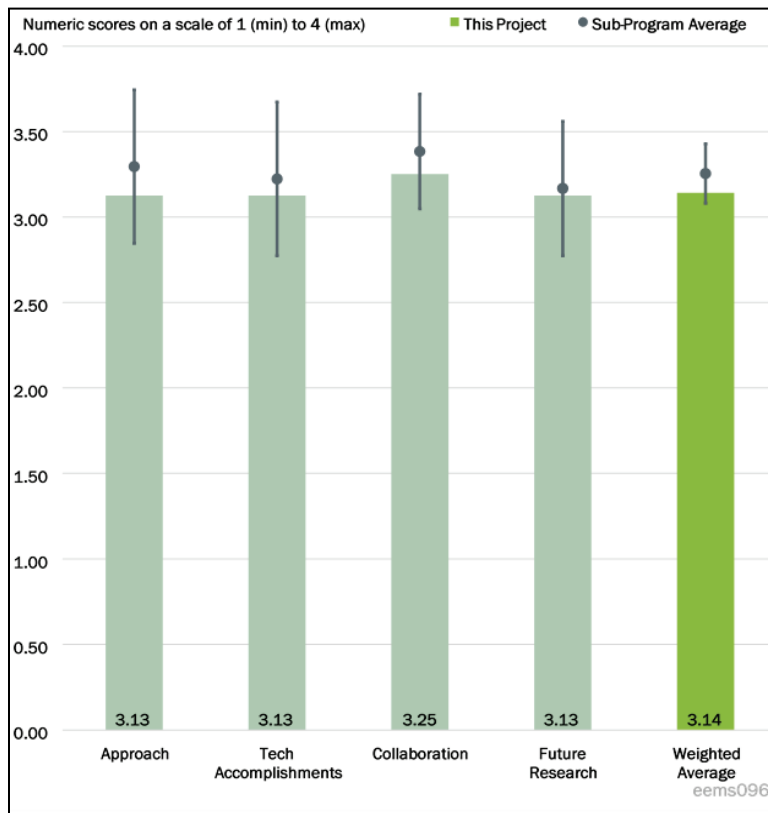


Figure 3-20 - Presentation Number: eems096 Presentation Title: Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies, Sensors, and Connectivity Principal Investigator: Thomas Wallner (Argonne National Laboratory)

in the technologies. The reviewer appreciated centering the voice of the customer in the project design, which will help with scaling up the research and deployment.

With rapidly expanding CAV technologies from OEMs like Tesla, this reviewer asked how the project team will incorporate software updates and advancements in on-board technologies.

Does the scope of the project become too large with factoring in available CAV technologies for light-duty vehicles (LDVs) versus available CAV technologies for medium-duty vehicles (MDVs) and heavy-duty vehicles (HDVs)? In addition, does the project team expect to test on-road MDV and HDV CAV technologies?

What metrics will be used to define success or progression on the project? Understanding the identified key metrics may help with finding the sweet spot for balancing data collection and management.

Reviewer 4:

Although the approach is reasonable, the reviewer wondered how representative the project findings will be of the wider range of available technologies.

***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 opined that great progress has been made on identifying the data that need to be collected, developing a means to collect those data, and adding sensors to get data (e.g., light detection and ranging [LIDAR]) where data are not readily available.

Reviewer 2:

The reviewer commented that the project as described is on track and hitting milestones. Results of the industry and stakeholder CAV status and research survey were fascinating and eye opening. Some of the feedback is behavioral, and the reviewer asked how the project team will incorporate these findings into the overall research. The reviewer also asked what the project team will be using to measure energy efficiency and energy savings for the project.

Expanding on the MDV and HDV research for on-road and lab studies will be helpful as the project continues moving forward. The reviewer understood that agreements were being negotiated at the time of the presentation submission.

Reviewer 3:

The reviewer indicated that the project appeared to be progressing well.

Reviewer 4:

Although the project is relatively new, this reviewer noted that the completed survey shows some interesting results on CAV adoption. Test results of the CAV sensors should be compared with the claims of the manufacturers.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer observed excellent collaboration with the Society of Automotive Engineers (SAE) and other laboratories that would utilize the data collected.

Reviewer 2:

This reviewer observed good collaboration with other labs, SAE, and other organizations.

Reviewer 3:

The collaboration between the labs is coordinated and moving forward. However, with the challenges and barriers identified in the survey, additional industry and fleet partners may strengthen the overall outcomes, especially for getting fleet and driver acceptance on wider scale deployment of CAV technologies.

Reviewer 4:

The reviewer did not see any issues with collaboration or coordination.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The proposed future research is defined and seeks to address challenges that have been identified, especially with MDVs and HDVs. It was encouraging for the reviewer to hear that the agreement with Cummins and the Colorado DOT has been executed and work will begin with those two entities.

Reviewer 2:

Proposed future research looked good to this reviewer, who indicated that there is ample opportunity to provide valuable data to several other DOE-funded projects with the proposed research.

Reviewer 3:

The reviewer commented that the next steps are a logical extension of the current work.

Reviewer 4:

Proposed future research appears to be in line with the remainder of the project scope. As mentioned above, the reviewer would have liked to see the team address the sample representation question in the remainder of the project. What can the broader community learn and generalize from the findings of this study?

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer stated that CAV technologies are being developed and adopted at increasing rates. This project seeks to narrow assumptions and uncertainties from existing and theoretical data. This is aligned with DOE and EEMS objectives of data sharing, increasing understanding of new and innovative technologies in transportation, and understanding the transformations in this technology.

Reviewer 2:

Data collection on CAV technologies that is not proprietary to OEMs allows DOE to study technology without constraints. The reviewer noted that this is valuable for ongoing DOE studies involving CAVs.

Reviewer 3:

The reviewer commented that results of this project could provide valuable information to other projects that are working to understand the energy efficiency benefits of CAVs/AVs.

Reviewer 4:

According to the reviewer, the energy consumption characteristics learned from this project are relevant to DOE's overall objectives.

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

Reviewer 1:

Resources appeared adequate to the reviewer. The team has done a good job considering this information is not readily obtainable.

Reviewer 2:

Resources appeared to be aligned with the project scope from this reviewer's perspective.

Reviewer 3:

The reviewer said that resources are sufficient.

Reviewer 4:

Resources were sufficient to this reviewer.

**Presentation Number:** eems097  
**Presentation Title:** Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE)  
**Principal Investigator:** Andrew Duvall (National Renewable Energy Laboratory)

**Presenter**

Andrew Duvall, National Renewable Energy Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

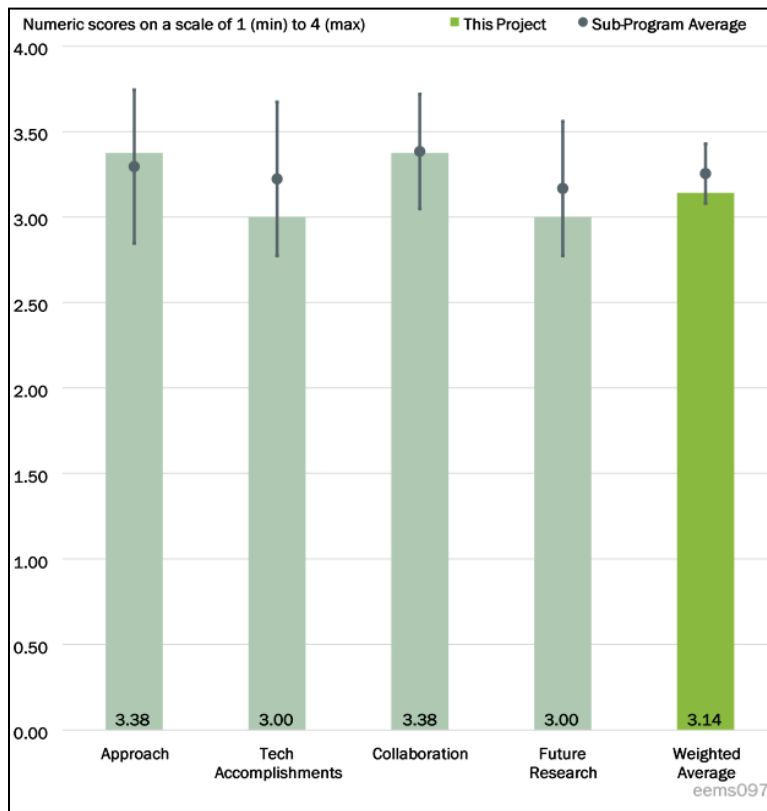


Figure 3-21 - Presentation Number: eems097 Presentation Title: Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE) Principal Investigator: Andrew Duvall (National Renewable Energy Laboratory)

**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 liked this research topic and approach and thought that it will be important to get the overall energy usage quantified for these micromobility modes. Those data could also be used to anchor some of the energy costs in the business models to determine viability. There has been some consolidation and turnover in some of the commercial entities so that could help to stabilize some of the operations.

Reviewer 2:

According to the reviewer, the researchers have a good approach to addressing a complicated issue in which there are generally limited data. The first stage of this work is nearly completed, with the important next stage of model development ongoing.

Reviewer 3:

The approach focuses on areas of micromobility that are not yet well understood, such as energy use, integration with transit, energy optimization, and micro-freight. The reviewer asserted that integration of findings with SMART Mobility Comprehensive Regional Evaluator (CORE) tools will enhance workflow models, add micro freight, and impact on curb space.

Reviewer 4:

The approach indicates thoughtful design of scenarios and an overall analytic process that is designed to provide data for the MEP metric. The reviewer suggested that an additional design aid may be to show how the selected scenario parameter bounds generate variability and sensitivity in the MEP metric and the degree to which the potential MEP parameter is addressed by the scenario parameters chosen.

***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:

While this project was just started in FY 2021, the reviewer said that good progress has been made in all five tasks, including literature review, sample vehicle instrumentation, industry stakeholder connections for freight micromobility data collection, and analysis of trip-level micromobility data from a dozen cities.

Reviewer 2:

It appeared to the reviewer that the research has made good progress in gathering baseline data and developing a model framework in an area where information is limited to date. The project team has already developed a number of publications and presentations on this research that supports that the work is being accepted as relevant within the technical community.

Reviewer 3:

The reviewer stated observed that this project is really just getting started. Completing the literature survey was good before getting to the rest of the program elements.

Reviewer 4:

It may be useful to add an analysis of the possible correlation, dependencies, and orthogonality relationships of the scenario independent variables. Micromobility may be significantly affected by the seasons and weather events. The reviewer suggested that scenarios designers may want to consider adding weather parameters as independent variables.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer remarked that collaboration is well covered and includes co-PIs from LBNL and ANL as well as complimentary research from PNNL. Collaboration also includes two universities (Colorado and Massachusetts Institute of Technology [MIT]) and EPA as well as nearly a dozen industry stakeholders that help inform the approach, contribute data, and provide valuable insights on this fast-changing industry.

Reviewer 2:

The team incorporates a good group of researchers, and they have built solid collaborations with a number of cities and other stakeholders. It will be exciting for the reviewer to see how the model can be integrated into city planning as it continues to develop.

Reviewer 3:

According to the reviewer, there is a good and wide diversity of partners and data sources that will lead to more robust modeling.

Reviewer 4:

The reviewer commented that the project stakeholders that are providing insights and data appear to be a diverse group.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

Future research areas are well laid out but the challenge, as acknowledged, will be collecting detailed trip data from ongoing micromobility operations due to the business sensitive nature of the information. Additionally, the micromobility industry is evolving very rapidly and it is important to stay on top of the latest trends (i.e., complete shift from docked bicycles to dockless electric scooters in less than 3 years). Nevertheless, the reviewer asserted that the data planned to be collected over the next 2 years of this project will provide great insights for modeling and the different micromobility scenarios for the BEAM CORE tools.

Reviewer 2:

It looked to the reviewer as if the researchers have made good progress toward developing a modeling framework and preparing for the initial scenarios for micromobility. It will be interesting to see how far the researchers will get with the model framework over the next year, which will feature some of the key milestones in the project. It will also be interesting to see the extent to which the model can be expanded in Year 3.

Reviewer 3:

The reviewer recommended that the research team approaches some of the corporate partners to develop a cell-phone based market survey that could help support some of the Fundamental Influencing Factor (FIF) data. The application could pop up at the end of a ride or usage and help get more customer input on the mode selection.

Reviewer 4:

The reviewer found that the proposed future work is logical for contributing to the overall project objectives.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer believed that these are important and new transportation options for urban and suburban applications. More research in this area is very relevant. Research in this area appears to just be getting started and understanding the energy picture and decision-making on what influences mode selection will be important to help these new transportation modes migrate to other cities and communities.

Reviewer 2:

The area of micromobility is going to be an important piece of developing an overall strategy for improving mobility options going into the future. There are still limited data, but these data will be important for developing strategies around FMLM solutions for bus and rail transport users. This project should provide some important information on filling the gaps on micromobility.

Reviewer 3:

According to the reviewer, this project supports energy efficient systems modeling by collecting and studying data of micromobility modes whose energy impacts have not been well understood. Indirectly, the findings of this research will contribute to reduced energy use, increased energy security, and use of clean energy to move people and goods.

Reviewer 4:

The reviewer said that this project supports DOE's objectives to explore potential energy characteristics and impacts associated with advanced mobility concepts.



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

Reviewer 1:

The project has an annual budget of nearly \$1 million, which seemed appropriate to the reviewer and given the importance and breath of scope as well as multi-partner collaboration and coordination.

Reviewer 2:

The researchers appear to have made good progress toward data collection and the micromobility area where limited data are available. The reviewer stated that the researchers have used an appropriate share of the funds during the first year to allow for a successful completion of the project.

Reviewer 3:

The reviewer asserted that the project has been productive in producing scenario parameters with the resources provided.

Reviewer 4:

The reviewer did not have a good feel for the resources needed on this project in order to provide any objective comments. Being that this is fairly early in the project cycle, the reviewer rated resources as being sufficient without much knowledge.

**Presentation Number: eems098**  
**Presentation Title: Optimizing Drone Deployment for More Effective Movement of Goods**  
**Principal Investigator: Victor Walker (Idaho National Laboratory)**

**Presenter**

Victor Walker, Idaho National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 75% of reviewers felt that the resources were sufficient, 25% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

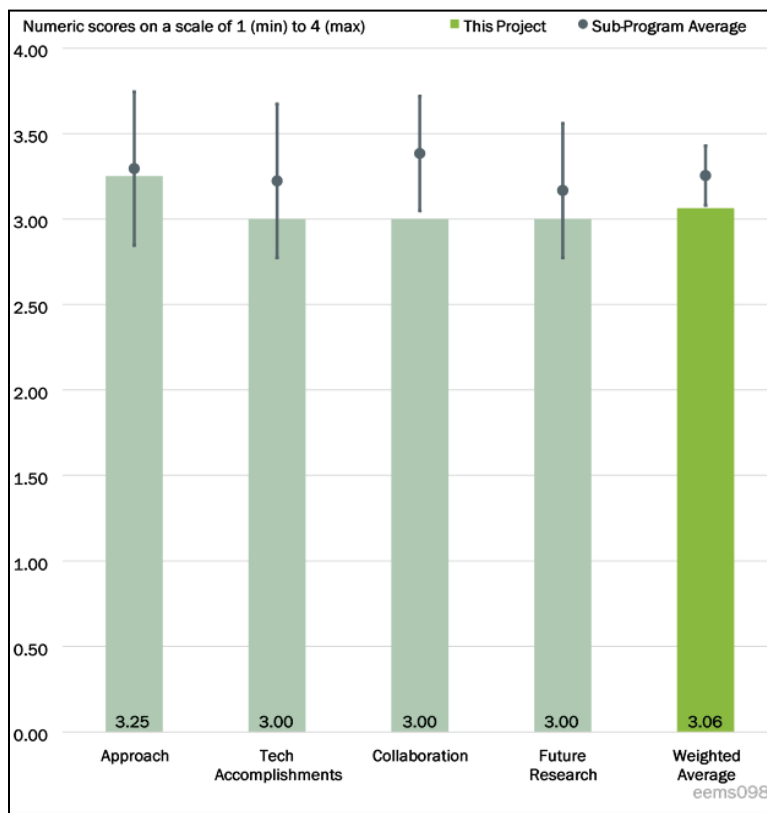


Figure 3-22 - Presentation Number: eems098 Presentation Title: Optimizing Drone Deployment for More Effective Movement of Goods Principal Investigator: Victor Walker (Idaho National Laboratory)

**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:

This reviewer stated that the research is timely and needed in understanding goods movement using drones. The reviewer appreciated the timeliness of seeking to understand the need for open data and an understanding of the most energy efficient way to manage and deploy drones for goods movement. This information and research will assist in making regulations and understanding the total impacts of this technology. The reviewer wanted to know what metrics the research team will be using to understand total energy usage for drone delivery scenarios and asked whether these metrics will be built out with industry input.

Reviewer 2:

Subject to availability of additional industry partners, the reviewer noted that work detailed in the presentation matches the stated project goals well. The integration of both laboratory and in-field work should provide a unique and robust set of data not typically offered for these types of systems. While not entirely clear from the presentation, the optimization work should also benefit from the ability to validate and iterate upon real and emulated scenarios. One area for additional development and reporting would be the techniques expected to be used for the drone simulation itself, as it was not entirely clear to the reviewer how this will be handled within this project. This detail will likely be refined in future presentations as work continues, so at this early stage of project execution this is acceptable as an initial overview. The selection of future airframes and mission profiles to support industry and researcher-centric questions will be important going forward to ensure that the

developed data and insights are most applicable to solving the project objectives of available data, uncertainty reduction, and risk mitigation.

Reviewer 3:

Although the project intent has merit, the reviewer noted the number of independent variables in real-world operations is too large, given the available resources. The reviewer suggested that the project team should consider rescoping to focus on calibrating a suite of sensors with a drone and validating a smaller set of energy consumption models and algorithms in a wind tunnel environment where variables can be accurately measured and controlled. After the wind tunnel phase is completed, the project team could consider moving to uncontrolled and real-world environments.

Reviewer 4:

The reviewer said that this is a good approach for the specific drone freight movement needs.

***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 team is clearly making progress in performing work on the stated plan. In doing the work, the reviewer opined that the team is discovering the significant complexities associated with the experiments.

Reviewer 2:

Progress to date is good, but there were challenges with the drones and components. It was clear to the reviewer that the challenges with the drones and equipment were causing some delays in the drone testing. In addition, limited industry engagement was flagged (e.g., Kroger and Walmart) as a barrier that would need to be addressed.

Additional information on battery cycling and performance may be helpful for decision-making, especially over varied geographies and terrains.

Reviewer 3:

The reviewer indicated that the project has just started, objectives and progress seem to be on track as experimental work has begun. Based on the presentation, it was not entirely clear to the reviewer how far along the individual experimental pieces are in the debugging, experimental development, or execution phases. For the optimization portion of the work, it is not clear if this is just beginning or waiting for input from the experimental results to begin development. Although the presentation mentioned specific scenarios of interest and that energy is impacted for the scenarios, the reviewer was unclear if this has been estimated through the optimization work or if it represents expected performance to be validated later.

Reviewer 4:

In the past few years, the reviewer has seen a decrease in evidence presented in these AMR reviews to confidently share that technical accomplishments have been made. Specifically, more metrics on efficiency are needed. The reviewer liked the suggestion for freight efficiency, which was kilowatt-hours per pound (kWh/lb).

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer opined that additional collaboration with industry partners will be helpful and necessary as the project moves forward, especially as the team begins to consider delivery routes and options. Feedback from vendors (e.g., Kroger, Walmart, Amazon, etc.) will be helpful as they will have inputs on business models related to the three major scenarios for deliveries.

The PI did mention several barriers with current regulations related to the Federal Aviation Administration (FAA) and that may be one of the biggest challenges to wider scale development and future research. The reviewer indicated that it may be beneficial to include more coordination and collaboration with the FAA to address the regulatory and policy challenges as this project moves forward.

Reviewer 2:

The plan to coordinate the work of the partners appears to be balanced throughout the project. The reviewer suggested that the project may want to introduce another partner with extensive aerodynamics testing experience as an advisory consultant.

Reviewer 3:

While the multi-laboratory approach appears promising, more detail about Carnegie Mellon University's (CMU) role in the overall project would be helpful. Also, additional collaborators from delivery operators or industry would help highlight any relevant items and considerations that may need to be updated or refined within the later experiments. The presenter mentioned challenges with obtaining industry collaborators and input, but the reviewer stated that this is likely an area for continued effort as it would add strong additional inputs to the research team. It would be helpful to also highlight if and how these efforts will inform other ongoing DOE drone efforts and projects.

Reviewer 4:

There seems to be little evidence to the claims made concerning industry engagement outside of the specific partners that are funded. The reviewer believed there should be more effort on fleet and other engagements in these 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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer said that the team has good plans.

Reviewer 2:

This reviewer commented that proposed future work may have merit after a more structured set of experiments and model validations have been accomplished.

Reviewer 3:

The proposed future research is targeted at overcoming identified challenges. The reviewer appreciated that this project will build a foundation for developing drone regulations, understanding drone energy usage, and identifying data for industry needs. The reviewer asserted that one area that needs strengthening is inclusion of more industry partners and collaboration with the FAA on regulations. These partnerships and collaboration will assist in moving this project from the laboratory to real-world deployment.

Reviewer 4:

As the project is just beginning, areas of future research are still developing; areas highlighted for emphasis include more industry collaboration and additional airframes, which seemed reasonable to the reviewer. In future years, it would be desirable to highlight areas of the most energy uncertainty and where the DOE research investment might aid in reducing the largest degree of uncertainty relative to drone delivery and related maneuvers. While difficult, more industry participation would likely strengthen the identification of additional research needs as well. In future presentations, more detail regarding the next steps would be helpful

within the discussion as the current future topics are a bit open ended. For example, aside from just the topic title, the optimization side of the project is not directly mentioned within the Future Work slide or discussion.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The timeliness of this project is aligned with the DOE objectives of accelerating the development and deployment of advanced technologies. In addition, the research is focused on optimizing routes and energy for goods movement, which is aligned with DOE objectives and goals. The reviewer praised the work as well done.

Reviewer 2:

According to the reviewer, this project has the potential to be very relevant to achieving the DOE objectives of characterizing the energy consumption characteristics of advanced mobility concepts (e.g., commercial drone deliveries). The project's objective of performing experiments to inform energy consumption models is relevant to achieving DOE's overall goals.

Reviewer 3:

The project supports the increasing need for accurate data and characterization of drone operation to enable an accurate and robust assessment of the energy implications of drone delivery within the context of an overall transportation system. While it was unclear to the reviewer if providers of drone delivery will consider the energy implications of drone delivery (versus speed, cost, etc.), this is an important item for DOE to understand and provide research upon.

Reviewer 4:

The reviewer affirmed that, yes, the project supports 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 found that project resources are sufficient.

Reviewer 2:

The resources are sufficient to achieve the scope of the project and the milestones outlined in the 2-year project. The reviewer said that further research or continuation of this project will need to be addressed.

Reviewer 3:

Resources seemed appropriate to the reviewer for current research directions discussed in the presentation. As additional, larger air frames begin to be considered, the overall cost of obtaining new and relevant airframes may begin to pressure some of the overall budget depending on the desired directions.

Reviewer 4:

The reviewer remarked that additional resources are needed to successfully achieve the stated objectives of the project. As stated earlier, the complexity of the field of study and the large number of independent variables requires more structured experiments and model development than current funding levels afford.

**Presentation Number:** eems099  
**Presentation Title:** Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems  
**Principal Investigator:** Venu Garikapati (National Renewable Energy Laboratory)

**Presenter**

Venu Garikapati, National Renewable Energy Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

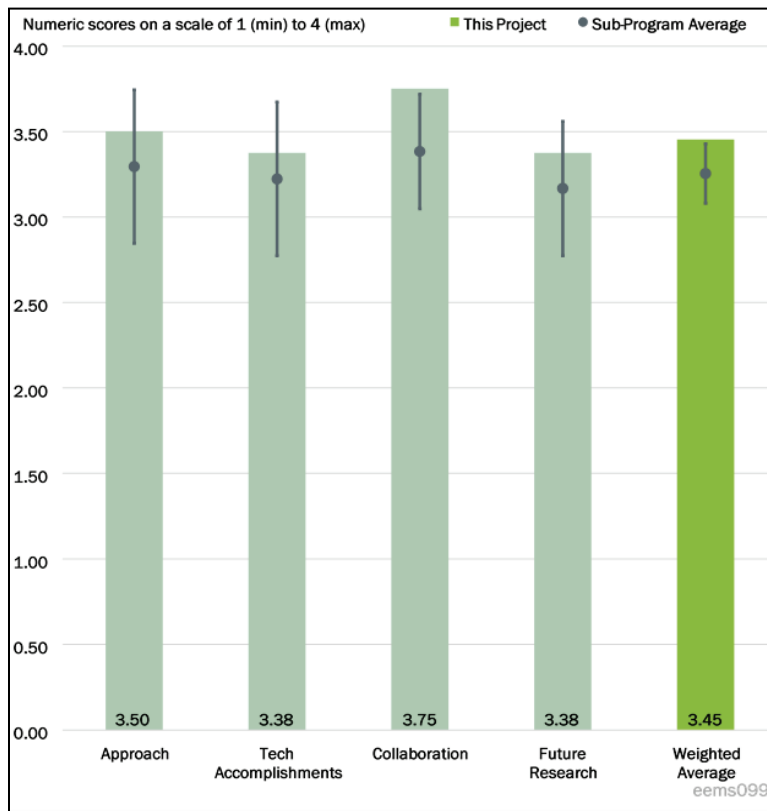


Figure 3-23 - Presentation Number: eems099 Presentation Title: Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems Principal Investigator: Venu Garikapati (National Renewable Energy Laboratory)

**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 applauded the project’s approach for this period of performance as excellent because it addresses cohort-specific preferences and utility functions when calculating the MEP metric. This approach adds a new level of sophistication to the MEP metric analysis.

Reviewer 2:

MEP provides a unified framework for quantifying the mobility and energy impacts of transportation investments and technologies. The reviewer opined that the new, person-based Individual Experience Utility-based Synthesis (INEXUS) metric is an interesting concept that seems to complement the location-based MEP metric well.

Reviewer 3:

The researchers seem to have a thoughtful approach to performing the work and have made good progress on gathering data to allow for the development of the calculations. The reviewer stated that this data analysis is worthwhile in breaking down technical barriers in understanding questions related to mobility.

Reviewer 4:

This project seemed adequate for the research from this reviewer’s perspective. With the organizations that are lining up to use the MEP metric, it will be important to evaluate the application in a wide enough set of cities and mobility situations to create a robust model that can be of value across the nation, etc.

***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 team has been making several enhancements to the MEP metric. The calibration of travel time coefficients for different trip purposes and travel modes seems like a step in the right direction. The reviewer looked forward to seeing the results of further enhancement from calibrating travel time coefficients for travelers with different sociodemographic characteristics or different values of time.

Reviewer 2:

The presentation provides clear explanations of theory and examples of analyses results. The reviewer commented that the results reflect significant progress and accomplishments toward the project objectives.

Reviewer 3:

It appeared to the reviewer that the performance metrics have been met for this project or are on track to be met. The completion of the activities for the first year should provide a good foundation for further development and enhancement of the methodology going into the second and third years.

Reviewer 4:

According to the reviewer, this seems like a good project that appears to be just getting started.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

There are collaborations with organizations both inside and outside the SMART Mobility Consortium. The outside collaborations span across multiple types of organization (e.g., government, non-profit, university, and industry). The reviewer found the extent of some of the collaborations to be impressive.

Reviewer 2:

The reviewer observed an excellent set of partners on the project. As previously mentioned, having many of the American Council for an Energy-Efficient Economy (ACEEE) and other organizations wanting to use this metric is good for technology transfer and creating a market pull, which puts more value on this research.

Reviewer 3:

According to the reviewer, the examples of the collaboration with institutions indicate that this project is having a significant impact on mobility science in multiple parts of the United States.

Reviewer 4:

The team has good coordination and cross collaboration. It will be interesting to the reviewer if the researchers can look to continue widening partnerships with other DOTs and universities as the project evolves.

***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. Note: if the project has ended, please state project ended.***

Reviewer 1:

Several enhancements to MEP are planned, which will lead to more refined and useful metrics. As the metrics grow more complex with additional factors (e.g., safety and infrastructure quality) taken into account, the



reviewer asserted that it is important to ensure that the resulting metrics are meaningful and can be understood by policymakers.

Reviewer 2:

The reviewer commented that the researchers seem to have a good plan for moving forward with the work to an individual-level MEP metric and enhancements on emissions and safety.

Reviewer 3:

Although the reviewer did not have too much to say regarding proposed future research, it looks like it is on a fast track for adoption. As the reviewer stated previously, it would be good to evaluate a wide array of cities and transportation variables to make this into a robust model that will work wherever it is applied in the future.

Reviewer 4:

The future work proposed addresses additional MEP factors that include “common sense” attributes that resonate with real-world experience, according to the reviewer.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer remarked 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 technologies. In addition, MEP has been a key metric used in projects within the EEMS program.

Reviewer 2:

Overall, it appeared to the reviewer that this metric is getting exposure and making a useful impact on characterizing mobility. Given the importance of understanding mobility in changing the landscape of transportation options through the country, this work appears to be well positioned to support DOE’s overall objectives.

Reviewer 3:

This reviewer explained that having metrics allowing comparisons between different transportation modes, situations, and options seemed like exactly what is needed to help transportation planners make relatively objective decisions.

Reviewer 4:

The reviewer said that this project directly supports DOE’s objectives to assess the energy characteristics and impacts of advanced modes of mobility.

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

Reviewer 1:

The project results presented are significant and reflect an efficient and productive use of resources, according to the reviewer.

Reviewer 2:

It appeared to the reviewer that the researchers have made good progress in the first year of the project with the allocated project funds.

Reviewer 3:

The reviewer found that the level of project funding is reasonable.



Reviewer 4:

The reviewer was not too familiar with this modeling and, given that this project is just getting started, the reviewer rated the resources as sufficient for now.

**Presentation Number: eems100**  
**Presentation Title: Dynamic Curb Allocation**  
**Principal Investigator: Chase Dowling (Pacific Northwest National Laboratory)**

**Presenter**

Chase Dowling, Pacific Northwest National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

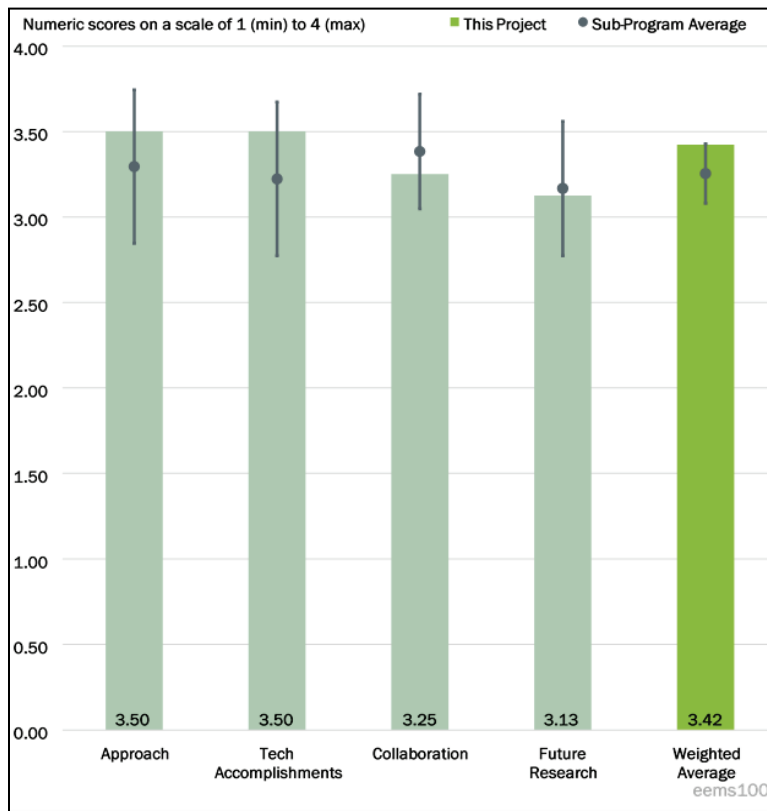


Figure 3-24 - Presentation Number: eems100 Presentation Title: Dynamic Curb Allocation Principal Investigator: Chase Dowling (Pacific Northwest National Laboratory)

**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 described the presentation as well done and great. The reviewer appreciated the level of detail and the attention to curb metrics for internal and external user utility. This project seeks to address increasing complexities of curb usage in the United States and the impacts of energy usage and congestion and, as well as understand how curb utility can be translated across the country. The project team is making good progress on the development of the scope and simulation.

The reviewer wanted to know if the project team will be developing metrics for energy efficiency between different vehicle fuel types. Will the team be building in metrics for cost and time savings? Is the project team considering energy savings and use between an LDV, MDV, and HDV, and how will the curb zoning be used? It seems that measuring changing curb dynamics throughout the day, vehicle types, vehicle flow, and other factors could create a large amount of data to process. Has the team considered this? If this is determined to be a challenge, how will the team address finding the right amount of data for processing?

Reviewer 2:

According to the reviewer, the researcher laid out a thoughtful research plan for addressing technical barriers and issues associated with curb space management and its impacts on traffic flow and energy use. The approach utilizes previously developed performance metrics for defining optimal curb zoning, developing a microscale simulator for assessing fundamental diagrams associated with various curb configurations, and

using an existing tool (BEAM) for assessing broader system-level impacts. Later phases of the project will involve stakeholder input (municipal and commercial partners) to test simulations of optimal curb space allocations. The approach includes reasonable milestones for meeting overall project objectives.

Reviewer 3:

The reviewer enjoyed seeing the team’s approach to the work and liked how the team outlined the approach on each page, making it very easy to follow.

Reviewer 4:

The reviewer commented that the research team has a good overall approach to implementing the microsimulation tool. The approach includes the development of the microsimulation, its validation, integration into BEAM, and then the partner engagements. It seemed that the researchers will go full circle by the completion of this effort.

***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 team has made excellent progress on the project. The presentation covered the development and deployment of the microscale simulator, which has yielded interesting data. The reviewer also appreciated the progress and explanation of the net user utility from the system and user perspective. For the project being in its first year, great progress has been achieved to this point.

Reviewer 2:

The research seems to have made good progress in the first year of the study with the development of the microsimulation tools. The researchers were able to provide a visual aid for the work, which the reviewer found useful. The presentation did include a lot of mathematical terms that might not necessarily be common knowledge to a broader audience, so that might be something to consider in the presentation for next year.

Reviewer 3:

The team has an interesting approach on modeling. The reviewer had not thought about this problem before, but can see how this “change in business approach with deliveries” can truly impact fuel usage, EV charging, pollution, DOT issues, etc.

Reviewer 4:

The reviewer noted that the research team has made reasonable technical progress to date as related to project milestones. The team reported completion of two milestones to date, including the selection of the microsimulation tool and development of microsimulation results by vehicle type. The team is also currently planning and scoping the validation process and has initiated the integration of the microscale simulation outputs into the BEAM tool, which will serve as the primary go/no-go activity for the project. The researcher estimated that about 25% of the project effort has been completed thus far, which is generally in line with a project completion of September 2023.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The research team exhibited excellent and well-coordinated collaboration involving other national laboratories, a university, and an urban mobility data company. The reviewer stated that the roles of each partner were well defined and integrated into the research plan for providing services, tools, and data for supporting project objectives.

## Reviewer 2:

The reviewer thought that cooperation and collaboration are a good place to start. The reviewer was familiar with the streets of Seattle, making it easy to understand.

## Reviewer 3:

This project has good collaborations between national laboratories and other partners (about 35%) and a strong team. The reviewer suggested that the researchers could emphasize some of the collaborations with cities, such as Seattle and Bellevue, as well as mentioning Miami during the presentation. It will be interesting to see if the number of cities can be expanded over the next few years as the work develops and as city and commercial partner engagements are expected to be expanded.

## Reviewer 4:

The collaboration and coordination between the team is good, but there may be room for additional collaboration between users (delivery companies, transportation network companies [TNCs], etc.) to understand the need and use of curbs throughout a given timeframe. The reviewer understood that Bellevue and Seattle are the two target cities but wanted to know if there are other cities that will be included in the study in other states. How will these stakeholders be engaged to account for different laws and regulations that dictate curb usage?

***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. Note: if the project has ended, please state project ended.***

## Reviewer 1:

Overall, the reviewer noted that researchers have made good progress in the microsimulation development that will allow its refinement and broader implementation going into the future. The researchers appeared to have a well-thought-out plan on how the microsimulation validation will be carried out, as well as the integration into BEAM. Finally, the researchers have incorporated engagements with city and commercial partners as well as test simulations for curb allocation policies into the planning, which could allow for the implementation of this microsimulation upon the completion of the program.

## Reviewer 2:

The reviewer commented that the future research plan included appropriate milestones that build off previous work as well as a go/no-go decision point. The project team has attempted to address remaining challenges in its research plan. To maximize the transferability of stateful fundamental diagrams (FDs), the team is considering effective sampling strategies or a more general governing function. To complete validation efforts in Milestone 3, the researchers are collaborating with stakeholders to gain access to specialized data. To facilitate achievement of Milestone 4, the team will be garnering input from municipal stakeholders. The researchers may also incorporate other exogenous factors like weather, topography, and vehicle mix into future research plans.

## Reviewer 3:

According to the reviewer, the project team has identified future research and how to build on the findings from this project.

## Reviewer 4:

The reviewer opined that the proposed future research is satisfactory and needs more thought, especially with V2I at both the “V” and “I,” in terms of sensors, standardization of sensors, non-hackable sensors, etc. This could be an interesting boundary diagram.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

Although this might be a newer area, curb allocation can be an important issue in bigger cities where there are many competing interests for curb space. As the scope of mobility expands going into the future, the reviewer said that this project will generate important information that can be used in conjunction with other mobility modeling tools to provide a comprehensive assessment of how mobility options can be improved going into the future.

Reviewer 2:

According to the reviewer, this project is aligned with EEMS and DOT objectives by understanding how curb usage impacts congestion and energy usage in the transportation sector. The findings from this project will help understand how changing regulations and policies along curbs can impact the transportation system.

Reviewer 3:

Curb space management is a critical element of traffic flow management in congested urban settings. The reviewer said that effective curb space use can have significant impacts on traffic-associated energy use and mobility efficiency.

Reviewer 4:

The reviewer affirmed that, yes, this is relevant and quite interesting as deliveries increase. The reviewer commented it would be nice to see an overall slide on delivery increases.

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

Reviewer 1:

Resources appeared to be sufficient to the reviewer for achieving the stated objectives and milestones of the project. The research team estimates it has completed about 25% of the project to date (June 2021). The remaining budget for FY 2022 and FY 2023 activities will be about 62%.

Reviewer 2:

Based on the presentation, it was not totally clear to the reviewer how the funds have been spent. It looks like about \$1 million of the total funds has been spent in FY 2020 and FY 2021. It does appear that the researchers have made good progress for approximately one-third of the budget and should be able to complete the objectives within the scope of work.

Reviewer 3:

This reviewer asserted that the project appears to be sufficiently funded.

Reviewer 4:

The reviewer said that the resources are good to start.

**Presentation Number: eems101**  
**Presentation Title: RealSim**  
**Principal Investigator: Dean Deter**  
**(Oak Ridge National Laboratory)**

**Presenter**

Dean Deter, Oak Ridge National Laboratory

**Reviewer Sample Size**

A total of four reviewers evaluated this project.

**Project Relevance and Resources**

100% of reviewers felt that the project was relevant to current DOE objectives, 0% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 100% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 0% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

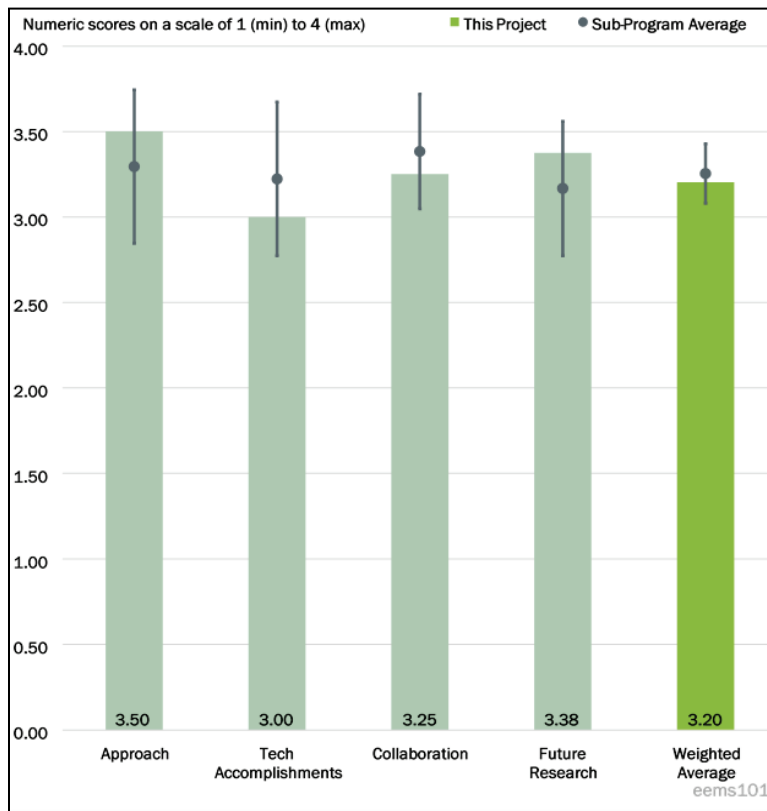


Figure 3-25 - Presentation Number: eems101 Presentation Title: RealSim Principal Investigator: Dean Deter (Oak Ridge National Laboratory)

**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:

This project aims to create and assemble the building blocks of a system of systems for studying and simulating an ADAS and CAV systems. The approach of progressively building up these features in existing software simulation systems is a sound one, according to the reviewer.

Reviewer 2:

This reviewer asserted that the need identified by the ORNL team is real and successful completion of this project should help provide validation for several other projects involving CAVs and AVs.

Reviewer 3:

The reviewer found that the project approach is sound, and the technical barriers are being addressed. However, as discussed during the presentation, some of the technical barriers will continue to be challenging for the project time, such as working with various beta and prototype software and components and the computational requirements and complexity of the interconnected system of simulated environments.

Reviewer 4:

The reviewer suggested that the researchers might want to reconsider the DSRC environmental data usage in light of the November 2020 FCC decision to reallocate all of DSRC’s spectrum for uses other than vehicle transportation.

***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 technical progress is solid. The first deliverable involving the integration of sensor simulation into the perception stack is complete. The second deliverable requiring the demonstration of micro-traffic simulation functionality into Real-Sim is delayed due to COVID-19 (understandable). The third deliverable, which is a prototype platform with vehicle and infrastructure components, is on track.

Reviewer 2:

The project is relatively new, but this reviewer indicated that the team has done a good job of communicating requirements to the IPG Carmaker team and working with them to implement all improvements needed.

Reviewer 3:

Progress has been made despite limited access related to COVID-19 restrictions. The reviewer remarked that two of the three upcoming milestones are still on schedule.

Reviewer 4:

Not applicable was indicated by this reviewer.

***Question 3: Collaboration and Coordination Across Project Team.***

Reviewer 1:

The reviewer asserted that there is excellent coordination and collaboration between ORNL, ANL, ACM, and IPG CarMaker.

Reviewer 2:

According to the reviewer, a major strength to this project is the coordination with several other EEMS projects, such as EEMS096, EEMS095, EEMS067, EEMS061, and EEMS082.

Reviewer 3:

Good collaboration with the IPG team was noted by this reviewer. Working with ANL should also help provide the ANL teams with validation data in the future to validate the CAV/AV controls. Data collected at ANL on some of the other projects could also provide ORNL with potential test scenarios, etc. The reviewer further suggested that including an OEM as a partner could benefit the project by better defining OEM needs; while the primary purpose is not to meet OEM needs, it could provide valuable insight to the ORNL team.

Reviewer 4:

Not applicable was indicated by this 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. Note: if the project has ended, please state project ended.***

Reviewer 1:

The reviewer praised the future plans as excellent. They involve continued work on sensor simulation and data stream emulation, the ANL prototype demonstration, deployment of field components, construction of the digital twin, and the design of appropriate scenarios for simulation and experimental correlation.

Reviewer 2:

Predictive roadway traffic conditions and environmental data are being adopted in the vehicle routing decision-making process. The reviewer suggested that considering this predictive aspect in addition to the existing setup that is based on real-time data might offer further capabilities.

Reviewer 3:

The proposed project plan looked good to this reviewer, and as previously indicated, perhaps an automotive OEM should be included among the collaborators to understand their perspective.

Reviewer 4:

The reviewer said that future work as described for the remainder of FY 2021 and FY 2022–FY 2023 is appropriate.

***Question 5: Relevance—Does this project support the overall DOE objectives? Why or why not?***

Reviewer 1:

The reviewer found that this project is very relevant as it is building the test and evaluation environment necessary for assessing the potential energy savings of CAVs in a cost-effective manner.

Reviewer 2:

The coordination of ADAS systems with CAVs will bring increased efficiencies to transportation and yield further reductions in energy use, according to the reviewer.

Reviewer 3:

This reviewer stated that the project can provide validation to a number of other DOE funded projects that are aiming to understand the potential energy efficiency benefits of CAVs/AVs.

Reviewer 4:

Not applicable was indicated by this 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 commented that the budget of \$3.58 million over 3 years is adequate for the planned tool development and experimental correlation.

Reviewer 2:

The resources appeared sufficient to achieve the milestones from this reviewer’s perspective. However, given that this project is on the “bleeding edge” of research, there is the potential for unforeseen challenges that could lead to the need for additional funding.

Reviewer 3:

This reviewer remarked that resources are sufficient.

Reviewer 4:

Not applicable was indicated by this reviewer.



## Acronyms and Abbreviations

ACEEE	America Council for an Energy-Efficient Economy
ACM	American Center for Mobility
ACT	Applications and Collaboration Tool
ADAS	Advanced driver-assisted system
AI	Artificial intelligence
AIMSUN	Advanced Interactive Microscopic Simulator for Urban and Non-Urban Networks
AMBER	Advanced Model Based Engineering Resource
AMR	Annual Merit Review
ANL	Argonne National Laboratory
API	Application performance interface
APTA	American Public Transportation Association
ATCS	Adaptive traffic control system
AV	Autonomous vehicle
BEAM CORE	Behavior, Energy, Autonomy, and Mobility Comprehensive Regional Evaluator
BEAM	Behavior, Energy, Autonomy, and Mobility
CARLA	Computer-Assisted Related Language Adaptation
CAV	Connected and automated vehicle
CAVE	Connected and Automated Vehicle Environment
CDOT	Chicago Department of Transportation
CMU	Carnegie Mellon University
CO <sub>2</sub>	Carbon dioxide
CORE	Comprehensive Regional Evaluator
COVID-19	Coronavirus disease 2019
CTA	Chicago Transit Authority
CV	Connected vehicle
C-V2X	Cellular vehicle-to-everything
DCRNN	Diffusion Convolutional Recurrent Neural Network
DOE	U.S. Department of Energy
DOT	[state or city] Department of Transportation
DOT	U.S. Department of Transportation
DSRC	Dedicated short-range communication

EcoCAR	EcoCAR Mobility Challenge Advanced Vehicle Technology Competition
EEMS	Energy Efficient Mobility Systems program
EPA	U.S. Environmental Protection Agency
EV	Electric vehicle
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FD	Fundamental diagram
FIF	Fundamental Influencing Factor
FMLM	First-mile and last-mile
FY	Fiscal Year
GM	General Motors
HDV	Heavy-duty vehicle
HPC	High-performance computing
HQ	Headquarters
INEXUS	Individual Experienced Utility-based Synthesis
INL	Idaho National Laboratory
IRB	Institutional Review Board
ITS	Intelligent Transportation Systems
kW	Kilowatt
kWh/lb	Kilowatt-hour/pound
LBNL	Lawrence Berkeley National Laboratory
LDV	Light-duty vehicle
LIDAR	Light detection and ranging
LoOP	Local outlier probability
MDV	Medium-duty vehicle
MEP	Mobility Energy Productivity
MFA	Multi-factor authentication
MIB	Management Information Base
MIT	Massachusetts Institute of Technology
ML	Machine learning
mph	Miles per hour
MPO	Metropolitan planning organization

NDA	Non-disclosure agreement
NGO	Non-governmental organization
NHTSA	National Highway Traffic Safety Administration
NREL	National Renewable Energy Laboratory
NTCIP	National Transportation Communications for Intelligent Transportation Systems Protocol
NVBL	National Virtual Biotechnology Laboratory
OEM	Original equipment manufacturer
ORNL	Oak Ridge National Laboratory
PATH	Partners for Advanced Transportation Technology
PF	Proportionally fair
Ph.D.	Doctor of Philosophy
PI	Principal Investigator
PNNL	Pacific Northwest National Laboratory
POLARIS	Planning and Operations Language for Agent-based Regional Integrated Simulation
Q	Quarter
Q&A	Question and answer
QDTA	Quasi-dynamic traffic assignment
R&D	Research and development
RDD&D	Research, development, deployment, and demonstration
RL	Reinforcement learning
RyThMiCCS	Real-Time Mobility Communications and Control System
SAE	Society of Automotive Engineers
SIL	Software-in-the-loop
SMART	Systems and Modeling for Accelerated Research in Transportation
SOF	System optimal fuel use
SOT	System optimal travel time
STA	Static traffic assignment
SUMO	Simulation of Urban Mobility
SVTRIP	Stochastic vehicle trip prediction
SwRI	Southwest Research Institute
TCF	Technology Commercialization Fund

TDOT	Tennessee Department of Transportation
TI	Technology Integration program
TNC	Transportation network companies
U.S. DRIVE	United States Driving Research and Innovation for Vehicle efficiency and Energy sustainability
UET	User equilibrium travel time
UIC	University of Illinois at Chicago
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
V2X	Vehicle-to-anything
VAN	Vehicle Analysis program
VIL	Vehicle-in-the-loop
VPPG	Virtual physical proving ground
VTO	Vehicle Technologies Office
XIL	Anything-in-the-loop