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 and 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 (MEP) for individuals and businesses when adopted at scale. The EEMS subprogram has developed a quantitative metric for MEP, 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% improvement in MEP 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	Argonne National Laboratory Core Tools-Simulation	Phil Sharer (Argonne National Laboratory)	3-8	3.63	3.50	3.50	3.25	3.50
eems037	Big Data Solutions for Mobility	Jane Macfarlane (LBNL)	3-12	3.50	3.50	3.25	3.25	3.44
eems041	ANL Everything-in-the-loop (XIL) Capabilities	Kevin Stutenberg (Argonne National Laboratory)	3-16	3.25	3.42	3.25	3.08	3.31
eems061	Scaling up the Realtime Data, Simulation and Artificial Intelligence (AI) and Control for Optimizing Regional Mobility	Jiboananda Sanyal (Oak Ridge National Laboratory)	3-22	3.00	3.25	3.50	2.50	3.13
eems066	Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing	Lauren Spath-Luhring (National Renewable Energy Laboratory)	3-26	3.25	3.13	2.88	3.00	3.11

eems067	Virtual and Physical Proving Ground (VPPG) for Development and Validation of Future Mobility Technologies	Dean Deter (Oak Ridge National Laboratory)	3-30	3.50	3.50	3.63	3.33	3.49
eems082	Validation of Connected and Automated Mobility System Modeling and Simulation	Dhiren Verma (American Center for Mobility)	3-34	3.30	3.10	3.40	3.20	3.20
eems083	CIRCLES: Congestion Impact Reduction via Connected and Automated Vehicle (CAV)-in-the-Loop Lagrangian Energy Smoothing	Alexandre Bayen (University of California at Berkeley)	3-39	3.50	3.63	3.75	3.50	3.59
eems084	Energy-Efficient Maneuvering of Connected and Automated Vehicles (CAVs) with Situational Awareness at Intersections	Sankar Rengarajan (Southwest Research Institute)	3-43	3.13	3.50	3.38	3.25	3.36
eems089	Energy Efficient Connected and Automated Vehicles (CAVs), Workflow Development and Deployment	Dominik Karbowski (Argonne National Laboratory)	3-47	3.13	3.50	3.50	3.38	3.39
eems090	Applying Artificial Intelligence (AI) Based Signal Coordination and Controls for Optimized Mobility for the Nimitz Highway	Hong Wang (Oak Ridge National Laboratory)	3-51	3.17	3.33	3.50	3.33	3.31

eems092	Behavior, Energy, Autonomy, Mobility (BEAM) CORE	Anna Spurlock (Lawrence Berkeley National Laboratory)	3-55	3.50	3.50	3.50	3.25	3.47
eems093	Transportation System Impact: POLARIS Workflow Development, Implementation and Deployment	Joshua Auld (Argonne National Laboratory)	3-59	3.50	3.63	3.63	3.25	3.55
eems094	Development and Validation of Intelligent Connected and Automated Vehicle (CAV) Controls for Energy-Efficiency	Dominik Karbowski (Argonne National Laboratory)	3-63	3.25	3.50	3.50	3.50	3.44
eems095	Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use	Timothy Laclair (Oak Ridge National Laboratory)	3-67	3.50	3.17	3.33	3.17	3.27
eems096	Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies, Sensors, and Connectivity	Thomas Wallner (Argonne National Laboratory)	3-70	3.33	3.67	3.17	3.00	3.44
eems097	Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE)	Andrew Duvall (National Renewable Energy Laboratory)	3-74	3.25	3.38	3.38	3.25	3.33
eems098	Optimizing Drone Deployment for More Effective Movement of Goods	Victor Walker (Idaho National Laboratory)	3-78	3.33	3.33	3.17	3.33	3.31

eems099	Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems	Venu Garikapati (National Renewable Energy Laboratory)	3-81	3.50	3.50	3.63	3.38	3.50
eems100	Dynamic Curb Allocation	Chase Dowling (Pacific Northwest National Laboratory)	3-85	3.17	3.17	3.33	2.83	3.15
eems101	RealSim, An Anything-in-the-loop Platform for Mobility Technologies	Dean Deter (Oak Ridge National Laboratory)	3-88	3.30	3.30	3.40	3.10	3.29
eems102	AI-Engine for Optimizing Integrated Service in Mixed Fleet Transit Operations	Philip Pugliese (Go Carta)	3-93	3.25	3.25	3.25	3.00	3.22
eems103	Transit-Centric Smart Mobility System for High-Growth Urban Activity Centers: Improving Energy Efficiency through Machine Learning	Jinhua Zhao (Massachusetts Institute of Technology)	3-96	3.00	4.00	2.50	3.00	3.44
eems104	Increasing Affordability, Energy Efficiency, and Ridership of Transit Bus Systems through Large-Scale Electrification	Ziqi Song (Utah State University)	3-98	3.00	3.50	3.50	3.00	3.31

eems105	Energy Optimization of Light and Heavy Duty Vehicle Cohorts of Mixed Connectivity: Automation and Propulsion System Capabilities via Meshed Vehicle-to-Vehicle (V2V)-Vehicle-to-Infrastructure (V2I) and Expanded Data Sharing	Darrell Robinette (Michigan Technological University)	3-100	3.33	3.50	3.58	3.25	3.44
eems106	Developing an Energy-Conscious Traffic Signal Control System for Optimized Fuel Consumption in Connected Vehicle Environments	Mina Sartipi (University of Tennessee)	3-106	3.50	3.25	3.50	3.38	3.36
eems107	Improving network-wide fuel economy and enabling traffic signal optimization using infrastructure and vehicle-based sensing and connectivity	Joshua Bittle (University of Alabama)	3-110	3.17	3.25	3.25	3.17	3.22
eems108	Co-Optimization of Vehicles and Routes	Jack Schneider (PACCAR)	3-116	3.17	3.00	3.00	2.50	2.98
eems109	Connected and Learning Based Optimal Freight Management for Efficiency	Ali Borhan (Cummins)	3-119	3.17	3.33	3.50	3.17	3.29

eems110	Human Factors and Technologies Design to Improve User Acceptance of Pooled Rideshare (PR) for Increasing Transportation System Energy Efficiency	Yunyi Jia (Clemson University)	3-122	3.00	3.00	3.13	2.75	2.98
eems111	Contextual Predictions and Eco Services for Electrified Vehicles	Jacopo Guanetti (AV-Connect, Inc.)	3-127	3.00	3.17	3.17	2.83	3.08
eems112	National Renewable Energy Laboratory Core Modeling & Decision Support Capabilities, Route Energy Prediction Model (RouteE), Future Automotive Systems Technology Simulator (FASTSim), OpenPATH, and Transportation Technology Total Cost of Ownership (T3CO)	Jeff Gonder (National Renewable Energy Laboratory)	3-130	3.00	3.17	3.00	3.33	3.13
Overall Average				**3.29**	**3.36**	**3.37**	**3.17**	**3.32**

Presentation Number: eems013
Presentation Title: Argonne National Laboratory Core Tools-Simulation
Principal Investigator: Phil Sharer, Argonne National Laboratory

Presenter

Phil Sharer, ANL

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.

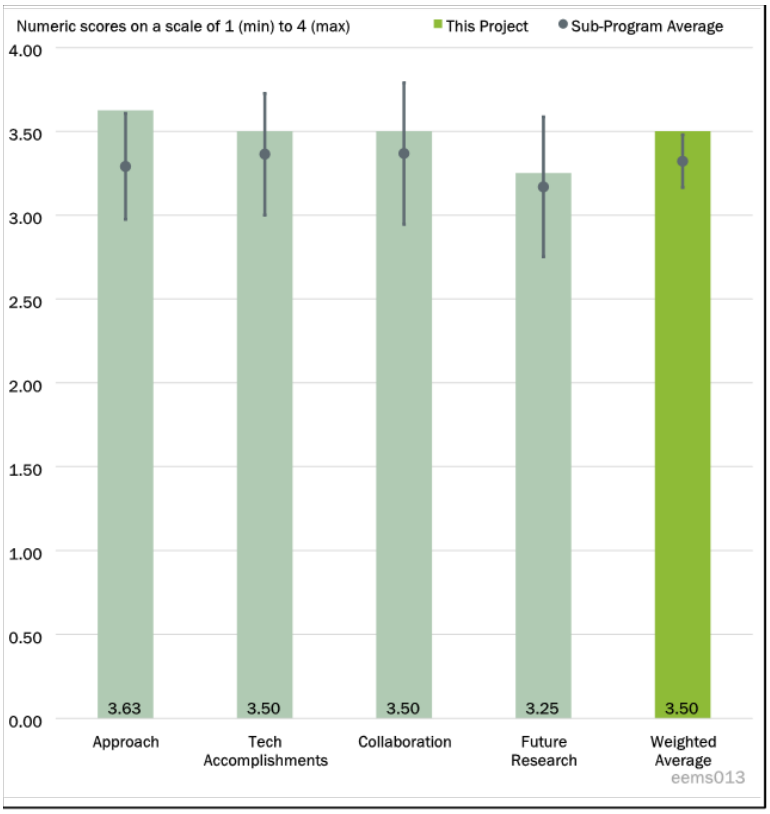

Figure 3-1 - Presentation Number: eems013 Presentation Title: Argonne National Laboratory Core Tools-Simulation Principal Investigator: Phil Sharer, Argonne National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer noted that there are no flaws in the overall approach, but there are misgivings about the nature of the research, i.e., software development. There are no commercial software available that can do a similar job, which eases but does not entirely eliminate these misgivings . The list of contributors to the project on the title page numbers 13 is impressive.

Reviewer 2

The reviewer expressed that the barriers being addressed by this project are very important and the overall scope and design of the project help to support and streamline the efforts of many downstream efforts.

Reviewer 3

The reviewer felt that the project is focused on development of core simulation tools, supporting many other projects in the EEMS program. The technical barriers will be addressed because the project relies on further development of the AUTONOMIE model which is very popular across original equipment manufacturers (OEMs), and automotive R&D institutions. Moreover, the proposed, computationally efficient version of AUTONOMIE, which will be less dependent on other software modules, is very important for stakeholders addressing the listed technical barriers.

Reviewer 4

The reviewer commented that the project approach is sound. The AMBER framework is designed to support model-based systems engineering simulation workflows. AUTONOMIE continuously collects data and inputs from public and private sources.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer said that developing Autonomie Lite and Autonomie Express is a great idea, and could perhaps result in the adoption of the tool by a much larger audience, resulting in greater feedback and ideas for further improvement.

Reviewer 2

The reviewer stated that the conglomeration of many different tools in the project is very impressive. Given the presentation, the project team seems to be making technical progress across each of the tools described. The reviewer especially appreciated the explicit inclusion of improvements to the workflow that is directed at stakeholders.

Reviewer 3

The reviewer stated that the technical progress is impressive and well planned, as evident in development of Autonomie Lite and Autonomie Express. The team targets two releases per year, while maintaining an increasing number of models and interfaces. The team uses best practices for software development and testing, while listening and taking into account stakeholder input.

Reviewer 4

The reviewer commented that three new Autonomie packages were introduced (Lite, Express, and AI). Autonomie was updated to support VTO studies on new and emerging technologies.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer expressed that the large number of DOE projects that rely on this project is proof that there is outstanding collaboration and relevance to the DOE objectives.

Reviewer 2

The reviewer stated that the project team does a nice job of showing the use of the core models and tools across stakeholders in Slides 21 and 22. However, it would also be useful to see an explicit description of the collaboration between developers of the various modeling tools themselves, and steps the project team is taking to help streamline the integration of different models. Lastly, it would be good to see the iterative feedback process among users of the models (especially at the national labs) that may lead to better streamlining or improvements to tools developed by the project team.

Reviewer 3

The reviewer stared that the core tools are well-integrated across multiple projects and government agencies; therefore, the reviewer views the collaboration and coordination within the team as good.

Reviewer 4

The reviewer observed that the project team demonstrates a very broad span of collaboration with numerous government and private partners (too numerous to list here) for model development, simulation, workflows and database creation.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated that the proposed future research is designed to improve the tool chain and processes.

Reviewer 2

The reviewer noted that improvement of future technical work is laid out nicely in Slide 23. However, as these models become increasingly popular among external stakeholders, the team should begin putting explicit emphasis on accessibility. The team mentions licensing, documentation, and training, which will all contribute to accessibility, but other issues as identified in the session such as open-access (e.g., over licensed back-end features such as MATLAB) would be very helpful as well.

Reviewer 3

The reviewer expressed that the proposed next steps are articulated in detail with high likelihood of achieving the targets. The development of AI is of special interest as it promises to decrease computational complexity while maintaining simulation fidelity through data-driven methods.

Reviewer 4

The reviewer found that the proposed future work on Aeronomie development, as well as further development on the Autonomie model and diverse workflows, is well-motivated and will be immensely useful.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

In referencing the response to the previous Collaboration and Coordination question, the reviewer reiterated that the large number of DOE projects that rely on this project is proof that there is outstanding collaboration and relevance to the DOE objectives.

Reviewer 2

The reviewer expressed that the project aligns with VTO objectives.

Reviewer 3

The reviewer noted the clear relevance of this project to the overall VTO subprogram objectives as project goals are defined in the development of core tools. The reviewer had no further comments.

Reviewer 4

The reviewer stated that the project supports the overall VTO subprogram objectives by creating a versatile suite of modeling tools and databases that support stakeholder engagement, large scale vehicle studies, diverse vehicle types, and evaluation/assessment of new vehicle technologies.

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

Reviewer 1

The reviewer commented that there is a lot more to be done in this area, and as a result, it could be stated that the resources are insufficient. However, the reviewer has seen some of the work that has been done for U.S.

DRIVE (Vehicle-Mobility Systems Analysis Technical Team) and the results of those simulation are providing very interesting insights into future mobility. The reviewer further observed that these processes and the toolchain can go a long way in helping understand the issues and ramifications of mobility choices.

Reviewer 2

The reviewer determined that the amount of funding seems reasonable for the scope and size of the project.

Reviewer 3

The reviewer felt that the project has sufficient resources to achieve its goals. The project team illustrated how it supports a number of important projects as listed.

Reviewer 4

The reviewer commented that the approved funding for the three year project is appropriate for this effort.

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

Presenter

Jane Macfarlane, LBNL

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, 0% of reviewers felt that the resources were insufficient, 25% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

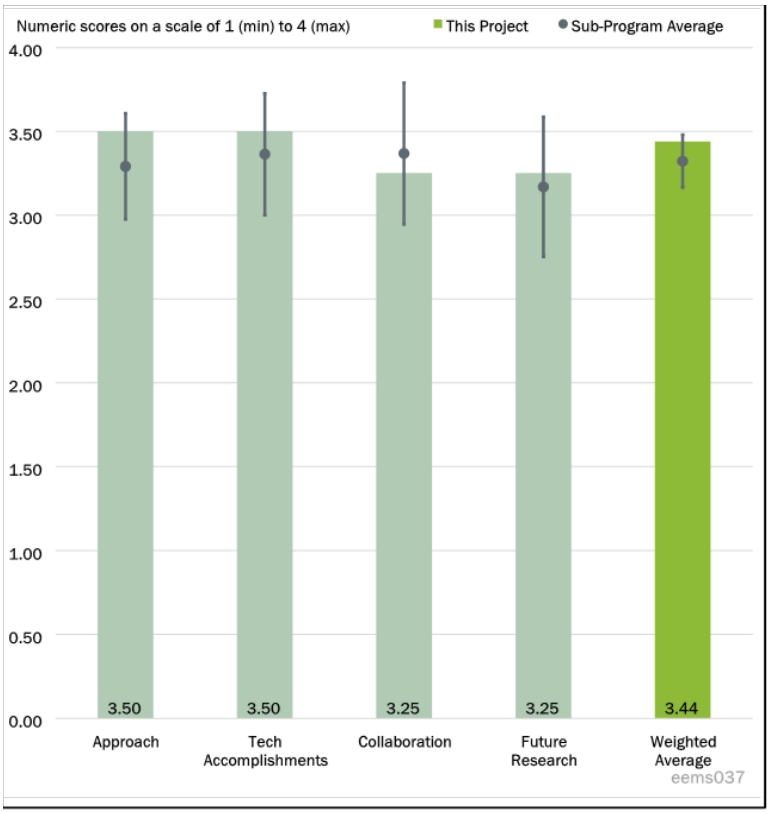

Figure 3-2 - Presentation Number: eems037 Presentation Title: Big Data Solutions for Mobility Principal Investigator: Jane Macfarlane, Lawrence Berkeley National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer determined that the barriers laid out in Slide 2 are definitely an important issue facing planners and operators of transportation systems. If generalizable, this project has the potential to help improve the transportation system in a variety of ways.

Reviewer 2

The reviewer responded that the approach is addressing technical barriers related to the ability to conduct realistic metropolitan level transportation modeling in a timely manner so that a variety of scenarios can be studied. The technical barrier of making a more simplistic and computationally less sophisticated version of the tool for transportation planning practitioners is also being addressed. This is important since it is unrealistic for transportation planning agencies to have the resources available for supercomputers.

Reviewer 3

The reviewer asserted that the approach of using the origin-destination data from a transportation planning organization to start the model and then calibrate it using Wejo is a manageable approach when working on regional-scale projects. This can potentially be applied to other cities, as was mentioned in the presentation for San Francisco to Sacramento and Los Angeles to the border.

Reviewer 4

This reviewer commented that the project addresses large-scale regional traffic dynamics with the design of active control strategies for managing regional movement. In designing these strategies, the project team aims to be socially aware on metrics for transportation, and to understand how signal control variations and timings will enable greater impact.

The approaches are to extend and improve Mobiliti (a transportation modeling platform), use AI to build transferable models after their creation on a high-performance computer and provide to organizations that do not have high-performance computing (HPC) access, and enable practitioners to run these reduced models to develop new kinds of control and planning solutions.

The barriers include the increased complexity of city-level transportation to model at scale in reasonable time, challenges to acquiring sensor data, and the difficulties in optimization to scale. By aiming to model cities at scale with HPCs and search for reduced order models, these barriers are effectively addressed. There may be additional challenges remaining in understanding under what circumstances the models can be reapplied and how they may be used in other simulation environments.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer commented that Slide 6 provides a nice overview of the progress made in the last period of work. The accomplishments of the research team are very impressive, especially on the technical development of the model and digestion of big data.

Reviewer 2

The reviewer believed that the project team has made good progress and has successfully run the large scale HPC model of San Francisco using Mobiliti. The reviewer was not entirely clear on how close the team is to completing a successful surrogate model (Task 3). The team is, however, making progress on the traffic signal control algorithms.

Reviewer 3

The reviewer stated that the project team presented uncertainty Slides very well. The extension of the traffic controller optimization work going from one intersection, to a corridor, and to the grid is great. This is a challenging problem. It will be great to see the complexity and performance at the grid level.

The reviewer did describe a couple of concerns. First, the long term project goal is to generate surrogate models for practitioners. It was not clear to the reviewer how feasible this goal is in terms of the computational needs as well as the learning curve. Second, with Wejo having less than 2% penetration, the reviewer suggested that there needs to be a study on how accurate the calibrated model will be. The reviewer further stated that a comparison between a model calibrated using only Wejo and another model calibrated/built using other existing internet-of-things devices in San Francisco would be highly valuable

Reviewer 4

The reviewer confirmed that the technical approaches in this project reporting period are explored with tasks in: 1.) data acquisition and cleaning, 2.) uncertainty quantification, 3.) surrogate model building, 4.) design of signal controllers, and 5.) establishing city-level metrics. The city models include the Bay Area, LA Basin, and new data from Sacramento are being explored.

For the surrogate model building and data acquisition, the reviewer inquired whether the fuel estimates come from reading the vehicle data directly, or from extrapolating from the global positioning system of vehicle

motion? The researcher's Slides mention 1-5Hz, but if using vehicle data in this way, the resolution on acceleration (or even approximating acceleration/velocity from position) may not have high enough resolution to build an energy model that could be used in large-scale simulators. Additionally, such an energy model might exhibit characteristics that would encourage overfitting by model users who apply it in AI contexts.

For the fuel validation, the reviewer wondered what the error bounds are on approximation of the model, and how this compares with potential overall savings (i.e., are the potential savings much greater than the error bounds of the model)?

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer intimated that it is difficult to judge the collaboration and contributions of the partner institutions and stakeholders, since no details are provided on Slide 20. The reviewer recommended that the project team be more explicit on the tasks and accomplishments amongst the labs, and describe how they are coordinating. Additionally, it would be helpful to list the contributions/relationships of the stakeholders to understand how they are linked with the project (helping with data/modeling versus as an endpoint for information dissemination).

Reviewer 2

The reviewer stated that the project team has a large number of members; however, the roles, and collaboration and cooperation of each member is not entirely clear.

Reviewer 3

The reviewer believed that this is a great group consisting of three national labs (Lawrence Berkeley National Laboratory [LBNL], Argonne National Laboratory [ANL], and the National Renewable Energy Laboratory [NREL]) as well as public (City of San Jose) and private partners. The partnership with Siemens and Wejo are very relevant.

Reviewer 4

The reviewer commented that the project team collaboration is strong, and that project tasks are distributed among team members.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer mentioned that most of the future work focuses on the technical aspects of the modeling, but it may serve the project well to explicitly have goals on outreach and engagement with existing and new stakeholders. To that end, statements on future goals for expected outcomes in project team interactions with stakeholders would be useful as well.

Reviewer 2

The reviewer expressed that future work will include getting the surrogate model in place. Implementing the data driven energy estimates will also be included in the future work. One element that was not clear to the reviewer from the future work description is how the HPC Mobiliti model results are going to be compared with the surrogate model results. If the transportation planning organizations are supportive of the HPC

Mobiliti model as an approach, they will need to be comfortable that the surrogate model is producing consistent (although higher level, more aggregate) results.

Reviewer 3

The reviewer's only concern was that considering 70% of the project is reported to be done, and the end date is January 2023, the remaining amount of work is significant.

Reviewer 4

The reviewer mentioned that the next phase of the research is to improve the surrogate model and explore ways to perform estimates at a larger level.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer commented that the project aligns with VTO objectives.

Reviewer 2

The reviewer affirmed that this project is relevant to EEMS by developing tools for a metropolitan area to assess transportation strategies that help address energy and equity considerations.

Reviewer 3

The reviewer remarked that developing tools to model large-scale transportation networks using real-world data is relevant to the VTO objectives. While, the goal is to make the tools rapidly, the project team did not define how many resources will be required for this rapid pace. The reviewer further concluded that it would be beneficial for the researchers to mention how long it may take to build and update the model given the resources usually accessible to practioners

Reviewer 4

The reviewer observed that the project provides strong relevance for understanding energy use at large scales in mobility applications.

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

Reviewer 1

The reviewer determined that the budget of the project seems reasonable relative to the size of the project and effort required across three labs.

Reviewer 2

the reviewer concluded that the resources appear to be sufficient for the project to meet its goals.

Reviewer 3

The reviewer asserted that the project team has sufficient resources to deliver the project.

Reviewer 4

The reviewer felt that the budget is commensurate with efforts and expected results.

Presentation Number: eems041
Presentation Title: ANL Everything-in-the-loop (XIL) Capabilities
Principal Investigator: Kevin Stutenberg, Argonne National Laboratory

Presenter

Kevin Stutenberg, ANL

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.

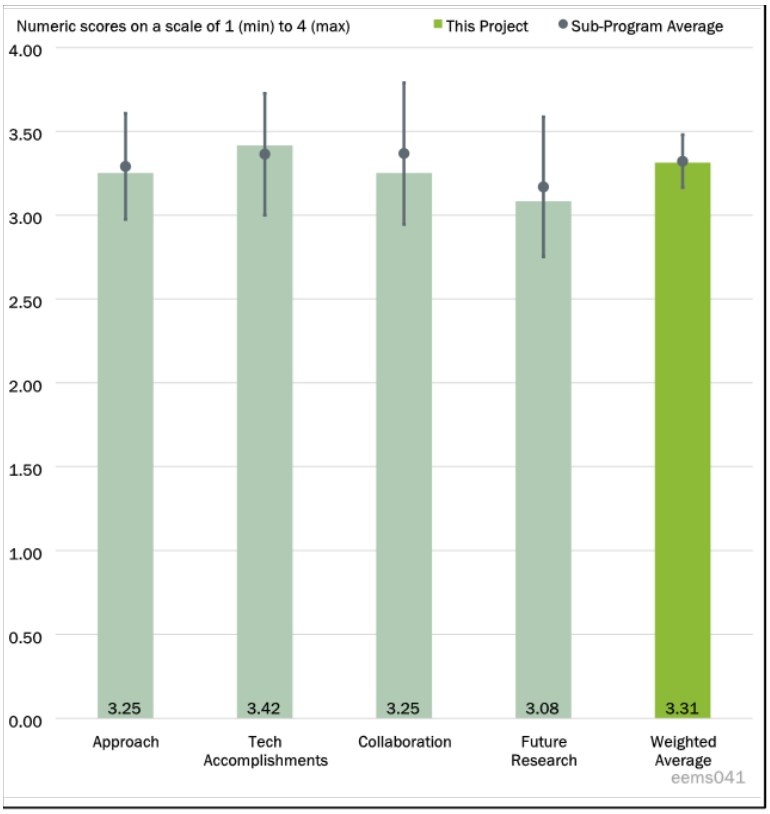

Figure 3-3 - Presentation Number: eems041 Presentation Title: ANL Everything-in-the-loop (XIL) Capabilities Principal Investigator: Kevin Stutenberg, Argonne National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer stated that the project develops key technology enablers that underlie research on connected and automated vehicles (CAVs). It does an excellent job of applying different software and hardware strategies to achieve the desired goals (data collection, controls implementation, and vehicle performance characterization).

Reviewer 2

The reviewer expressed that there are a number of pieces in this project so it is difficult to evaluate all of the technical barriers. The team has good experience and knowledge in the areas needed and this should enable the project to move forward in a timely manner. The selection of the new vehicles is good/appropriate, but bringing on three new vehicles and integrating vehicle controls is a significant challenge.

Reviewer 3

The reviewer suggested that there is a need for new testing and evaluation capabilities for connected and autonomous vehicles and the team's approach to developing next generation research platforms, expanded dyno XiL workflows and Lab2Road, is sound.

Reviewer 4

The reviewer intimated that experimental work is extremely costly and time consuming. Having the ability to put the CAV in an XiL environment to run scenarios virtually is paramount to achieving market acceptance

and validation of behaviors. This seems to be a converging approach by research labs, OEM's and tier 1 suppliers.

Reviewer 5

The reviewer determined that overall, the researchers have defined the barriers very clearly. Making the XiL work for any vehicle is challenging as stated in the presentation. Adding a variety of vehicles that the project team has access to through the U.S. Department of Transportation (DOT) helps with increasing the portfolio of vehicles implemented and tested. It is important to test both dedicated short-range communications (DSRC) and cellular vehicle-to-everything (C-V2X).

Reviewer 6

The reviewer stated that the project is a synergetic effort by different DOE laboratories (e.g., ANL, Oak Ridge National Laboratory [ORNL], LBNL) for developing advanced XiL modeling and testing platform for CAV related research. The entire project is well designed and aligns with other parallel projects. The reviewer believed that the timeline for Core2 makes sense.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer commented that a number of impressive technology demonstrations has been carried out (virtual vehicle interacting with real vehicle, etc.) under the project. The progress has been in line with the project plan, which is impressive whenever you are dealing with hardware/software implementations.

Reviewer 2

The reviewer stated that the project is on plan for development, integration, and demonstrations. The reviewer has no significant concerns at this point. The reviewer also commented that Slide 11 describes an appropriate selection of vehicles, but questioned whether every vehicle integration a one-off. Per Slide 12, the reviewer inquired how the results are being used? That is, is the project teambuilding virtual models for the latency, controller, and dynamics that then will be integrated into the vehicle models and/or used for controls development and tuning?

Reviewer 3

The reviewer felt that the team has made significant progress on the vehicle-in-the-loop (VIL) milestones, such as enabling hardware connectivity, demonstrating powertrain overrides, etc. The team has made solid progress on XiL milestones such as selection of fiscal year 22 research platforms and XiL vehicle integration on the Sonata hybrid electric vehicle (HEV).

Reviewer 4

The reviewer commented that the project seems to be on track with the operation of vehicles on the dynamometer and correlated to real world behavior. Obviously, COVID impacted nearly all projects and progress, but it appears the team has made good strides to the project plan regardless.

The reviewer felt that the acquisition of results is timely and highly relevant to other projects sponsored by DOE in the EEMS area.

Reviewer 5

The reviewer expressed that the team has accomplished quite a bit with developing and demonstrating XiL workflow.

Reviewer 6

The reviewer noted that the aerodynamic load evaluation is very interesting, which can address the existing research gaps to some degree on this effect. The results will be useful for further energy/emissions analyses. Based on the reviewer's understanding, the test was conducted for three light-duty vehicles. If so, a test plan for heavy-duty trucks would be preferable too. Just for informational reference, California Partners for Advanced Transportation Technology (PATH) used to perform some real-world truck platooning testing in Canada to evaluate the aerodynamic load effects due to different intra-platoon gaps. The reviewer did have one question about the modeling and testing capability—can the current platform conduct lateral behavior related experiments?

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated that project collaboration includes USDOT, a university, and various national labs with expertise relevant.to the project tasks. The project tasks require good intra-organizational collaboration between these entities and is working well.

Reviewer 2

The reviewer commented there is good collaboration between the modeling and hardware teams. The reviewer also stated that is good to see the partnership with GM being leveraged. The project team should continue to explore other initiatives, including those with USDOT.

Reviewer 3

The reviewer observed that the team has shown strong collaboration with the DOE national labs (ORNL and LBNL), Ecocar Challenge, as well as outside partners such as the National Highway Traffic Safety Administration (NHTSA), Virtual Open Innovation Collaborative Environment for Safety (VOICES), Illinois Institute of Technology (IIT), and University of California-Irvine.

Reviewer 4

The reviewer commented that the collaboration and integration with other federal institutions and DOE EEMS projects is strong and provides great justification for the project objectives and outcomes. The reviewer liked the usages of other EEMS projects for vehicle data for validation of modeling.

Although not explicitly stated on the slides, and not mentioned during the presentation, the reviewer stated it would be good to get the OEM's, Ford, Hyundai, etc. more involved with ANL, ORNL, and others on proprietary controlled area network (CAN) signals that aid in the collection of data and determining how the vehicle and powertrain are behaving. While much of this data are proprietary, it would certainly help reduce effort for reverse engineering the signals that occur anyway.

Reviewer 5

The reviewer stated that the team mostly consists of ANL researchers and one graduate student from IIT.

The U.S DOT NHSTA provides vehicles for the project. However, the role of VOICES cooperative automation research mobility applications (CARMA) is not clear in this project.

Reviewer 6

The reviewer observed that the coordination with other DOE national laboratory partners is well addressed in the project. It is noted that the Federal Highway Administration (FHWA) CARMA and VOICES program efforts have been recognized, which should benefit the project Core2 very well, from both the real-simulation interaction and system scalability perspectives. The team needs to consider involvement of industry.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer remarked that the next steps are appropriate extensions of the previous work. The researchers acknowledge certain difficulties (increasing over time) in implementing certain controls linkages in production vehicles.

Reviewer 2

The reviewer expressed that the progress presented in the different aspects of the project is all significant. However, the researchers will need to manage the challenges with integration. The reviewer questioned whether every vehicle integration is a one-off? Going forward the team should look for ways to commonize this or leverage other efforts.

For the aerodynamic load evaluation, the reviewer questioned whether there is plan to conduct an "extensive test matrix with different vehicle placements, vehicle configurations, speed, and gaps" within one week of testing and if so, is this reasonable, Further, the reviewer asked what the repeatability of the tests and noise factors are versus the expected road-load reduction? From these, can the team determine whether the measurements provide a relative significant difference and how many test repeats will be needed?

Reviewer 3

The reviewer believed the proposed future work, including additional XiL vehicle integration, improving and expanding XiL workflow, and the initiation of Lab2Road, is very well-motivated.

Reviewer 4

The reviewer stated the HEV and plug-in hybrid electric vehicle (PHEV) vehicle platforms seem the most likely candidates to benefit from CAV technology and XiL workflow for energy savings. Limited energy savings (in terms of real kJ) will be achieved for BEVs in most scenarios. The HEV and PHEV applications can have significant energy reductions through CAV prediction horizon forecasts. The reviewer is excited to see how the proposed platforms from battery electric vehicle (BEV) to PHEV illustrate this point.

Reviewer 5

The reviewer commented that the objective of the project is defined as: "Develop an experimental platform and processes which can quantify vehicle-level energy use impacts of connected and automated vehicles (CAVs) for use in model validation, data collection and direct analysis of future mobility technologies." The type of override that can be executed and the type of studies that can be conducted depend on the vehicles, on-board modules, and other factors. The team plans to expand the XiL research fleet. While this is a good approach, the reviewer questioned whether this will be able to cover the existing vehicles? The reviewer asked how many and how often vehicles will need to be added to the fleet?

Reviewer 6

The reviewer mentioned that most of the proposed future work makes sense. Regarding the integration of research vehicles, the team may consider other powertrains (e.g., pure electric). Also, the team could consider extension to multi-laboratory or multi-institute collaborative platforms as another major future step?

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer felt the project is highly relevant to EEMS CAV activities and the general VTO research related to improving vehicle energy efficiency.

Reviewer 2

The reviewer expressed the project contributions coupling modeling, simulation, and testing that verify energy models and energy reductions from CAV technologies are very important outcomes.

Reviewer 3

The reviewer commented that the project is relevant to VTO subprogram objectives by providing a sound experimental framework for testing and evaluating relevant technologies for CAVs.

Reviewer 4

The reviewer stated that the project supports program objectives by providing the ability to examine CAV scenarios through an XiL facility. The XiL approach enables better control of conditions and environmental boundaries for determining the effectiveness of CAV technologies at scale and real-time implementation capability.

Reviewer 5

The reviewer said this project is directly relevant. Current methods of energy consumption measurement do not apply to connected and/or automated vehicle technologies, Advanced methods for experimentation are required to directly evaluate emerging mobility technologies and enable validation of DOE simulation efforts.

Reviewer 6

The reviewer mentioned that similar to other funded projects on modeling and testing platform development, this project supports the overall VTO subprogram objectives (e.g., EEMS). The successful completion of this project leverages DOE's capability on evaluating the energy impacts of emerging transportation technologies, such as connected and automated vehicles.

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

Reviewer 1

The reviewer noted that project progress is very good and milestones appear to be on track.

Reviewer 2

The reviewer intimated that there are many different activities that need to be coordinated. As a reviewer, it is difficult to judge whether there are sufficient resources for this project.

Reviewer 3

The reviewer stated that the approved funding for 2 years is appropriate.

Reviewer 4

From what was presented, the reviewer concluded that a lack of resources is not going to be an issue for this project. Collaboration with multiple labs, federal agencies, etc., and the already existing facilities (both physical and analytical) should provide the team with continued success and momentum to accomplish the project in the proposed time frame.

Reviewer 5

The reviewer commented that ANL and this team specifically have sufficient resources to deliver the project.

Reviewer 6

The reviewer felt that the project team leverages the key resources from DOE national laboratories, which should be sufficient for project objectives. The team is encouraged to get more involved with industry and explore additional resources related to the project.

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

Presenter

Jibonanda Sanya, ORNL

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.

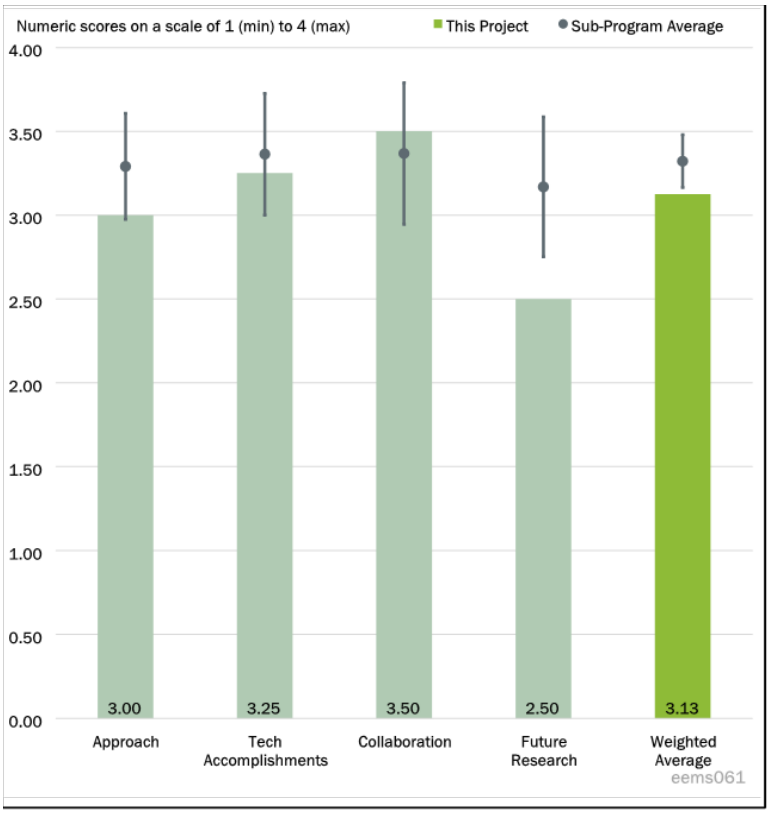

Figure 3-4 - Presentation Number: eems061 Presentation Title: Scaling up the Realtime Data, Simulation and Artificial Intelligence (AI) and Control for Optimizing Regional Mobility Principal Investigator: Jibonanda Sanya, Oak Ridge National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer cited the following statements made by the presenter: 1.) "Different controller versions are deployed throughout the city;" 2. "For all experiments to date, the intersections had Siemens m60 controllers:" and 3.) "As we scale up, many intersections have m50 controllers, with different software versions. This will require changes in communication." In reference to these statements, the reviewer commented that all of the improvements showcased by the project goals require clear communication between the different functions. Having different software versions in many data inputs/functions (e.g., different controllers) might result in a suboptimal system. The reviewer asked how could this be improved given limited resources, future expansions of these inputs, and additional potential versions?

Reviewer 2

The reviewer stated that the overall approach described in the introductory graphic is informative to understand the overall vision of the project, but some of the more detailed approach steps are a bit unclear and may be evolving as data streams and controllers are integrated into the CTwin approach. For example, quite a few traffic signal control algorithm developments are highlighted, but it is not necessarily clear if/how ramp metering and other control methods are to be integrated into the overall regional approach. The value of situational awareness is highlighted as well, but dynamic routing or other approaches are also not mentioned in significant detail. It is not clear if this is an issue of project scoping or if these strategies will be developed in the later stages of the project (or if they are even needed for the overall project goals). Any insights regarding

the balance between sensor ingestion difficulty and benefits to overall system optimization could also be a useful addition to this work as traffic engineers may struggle with trade-offs such as purchasing supplemental probe data or upgrading traffic sensing at certain intersections. It seems the simulation component of this project may also be used to help understand some of these priorities.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer said the way the data has been integrated is a great accomplishment by itself. The final reporting should include lessons learned in this process.

Reviewer 2

The reviewer expressed that the highlighted accomplishments have been provided within the separate subtasks of the project, but the pieces still feel a bit independent and not contributing to the overall 20% regional energy reduction goals stated in the introduction. While situational awareness is important, typing the awareness into more advanced controls and routing seem to be implied, but not necessarily fully implemented at this point in time. Given the ambitious scale of the data ingestion related to this project, this result may be expected, but insights related to the controls developed and validating new usage possibilities afforded by these large scale techniques should be considered equally important to the overall project scope and a completion date of December 2022. For the example results shown, it is not clear if the results shown are truly optimal, or if more improvements are expected; this is important given the disparity between the targets and current examples of energy reduction as well as the discrepancies between the average and the daily example shown. A better description of the connections between this project's situational awareness and proposed controls developed would also be helpful to understand the intended vision and progress of the overall progress. Specifically, is more situational awareness needed to get closer to the original goals, or is a scale-up of the methods a more promising direction for larger improvements? The publications and results from the AI-based signal control algorithm development are promising and support contributions from other EEMS projects. The project team may also find it beneficial to coordinate insights with the EEMS090 project team.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer observed that the project team's coordination with multiple groups and stakeholders seems to be well orchestrated and managed.

Reviewer 2

The reviewer remarked that researchers presented a strong mix of collaborators in support of this project. While more information about the specific contributions of the different project partners would be helpful, the range of strong partners is highlighted. The researchers could also describe the interface between the lab contributions in more detail, but again this is a suggestion for improving the already strong collaboration highlighted for this work.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer intimated that the proposed research seems to tackle several of the barriers; however, the reviewer also thought that a clearer mapping of these needs/barriers addressed by the future research is preferred.

Reviewer 2

The reviewer indicated that more detail would be helpful for some of the future work scale up related items. The overall number of control signals and types used for the large-scale implementation mentioned for 2022 work would be helpful to understand the size of the envisions increase in scale. The reviewer also thought it would be useful to know if this scale-up is on the order of 10s or 100s of signal controllers; further, the reviewer asked whether there are any related concerns about scalability of the chosen controls optimization approaches as the problems become increasingly large. The "deploying traffic control algorithms in the field based on available controllers and data sources covering 80% control points" would imply 100s of signals to be controlled, but that is not entirely clear from the information and discussion provided in the presentation. Ultimately, the reviewer felt it would be helpful to clarify the expected outcomes for the end-stage of this specific project effort as a 20-year timeline was verbally mentioned in the context of the project's stated 20% regional improvement goal. For the scale-up of the classification algorithms, the reviewer wondered whether this represented a larger-scale data stream for the CTwin Data Lake only, or if there are additional control strategies that are also anticipated to utilize this information for regional control. For the incident detection efforts, it may be helpful to discuss methods with the EEMS037 project team since that project's incident detection methods have also shown promising results and a collaborative opportunity may exist for both projects. Integration of the incident detection algorithms may also be beneficial to the project's routing and controls goals, but the connection is not clear and if it is in scope at this point.

Given the described Shallowford Rd results showing a weekly average consumption reduction of 4.6% versus the intended goal of 20%, the reviewer believed it would be helpful to clarify how the future work portion of these efforts will move the overall benefits closer to the original targets. Specifically, is an increase in scope expected to dramatically improve overall energy benefits, or will additional controls such as routing and dedicated lanes be needed to achieve a larger improvement in energy reduction at the regional scale? Also, since the largest benefits in travel time reduction appear during off-peak hours, does the research team have any further insights about overall travel time impacts changing over the increase in scale. While the expanded experimental data will be informative to the overall project benefits and impacts, the scope of the intended experiments could be provided in a bit more detail to contrast what will be simulated with the expanded regional simulation.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer commented that developing these type of data and algorithms will assist in the development of more efficient energy mobility systems. The reviewer also felt it would be good to add a section on how the results will be translated from research to practice. The project is more of a research pilot, but in order for full dissemination several other components are needed.

Reviewer 2

The reviewer stated the overall goal of improved situational awareness is a key enabler for more intelligent overall system control and strategy implementation. The project's stated goal of 20% regional energy reduction is also in line with EEMS goals. The balance between travel time reduction and energy discussed in the presentation fits with the balancing of different EEMS outcomes.

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

Reviewer 1

The reviewer concluded that for the level of this pilot project, the resources seem sufficient. However, if this was a larger pilot (more locations added), additional funds would be needed.

Reviewer 2

The reviewer offered that resources seem adequate, although significant effort appears to have been spent on the difficult challenge of getting the data ingested and the CTwin Data Lake system functioning. With this in mind, some degree of supplemental funds may be needed for later stages of project scale-up, experiment execution, and analysis, if preliminary results support more investment.

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, NREL

Reviewer Sample Size

A total of six four 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, 0% of reviewers felt that the resources were insufficient, 25% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

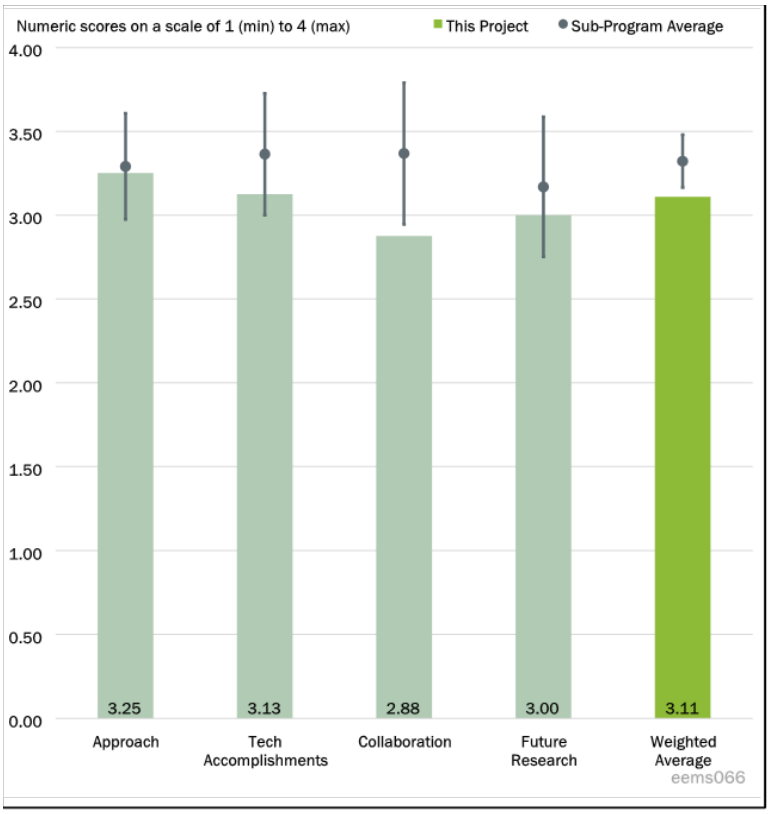

Figure 3-5 - Presentation Number: eems066 Presentation Title: Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing Principal Investigator: Lauren Spath-Luhring, National Renewable Energy Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that overcoming the technical barriers identified by this project on Slide 2 will be a great boon to countless stakeholders in the field of transportation. Access to data absolutely levels the playing field for modelers, planners, etc.; and the work thus far demonstrates the project team's capability to address the technical barriers and even expand the scope of the work.

Reviewer 2

The reviewer observed that this project is not research but serves a very important function of supporting research platform development. The main technical barriers of launching Livewire and improving its capabilities for expanding the community of stakeholders are addressed very well. The milestones of the project plan for this FY look well thought out. While Livewire is serving the EEMS and VTO funded projects for now (data sharing), the plan is to continue expanding beyond National Lab projects.

Reviewer 3

The reviewer believed the team's approach is to collaborate on building a data platform with large-scale user impact by expanding access to more users, growing the features catalog, and providing good support to users.

Reviewer 4

The reviewer cited several strengths for the project. First, the development of the Livewire platform was based upon existing, successful data platforms. Second, starting in Fall 2021, Livewire is focused on expanding access to more users, growing its catalog and features, and increasing user support. A Livewire Data Working Group (DWG) was established in 2021 to provide a forum for feedback and input from data owners and data users. A third strength of the project is a relatively comprehensive listing of milestones/quarterly progress measures.

The reviewer also listed some weaknesses for the project. One weakness is that the Livewire Data Platform project has an unusually long 6-yr period of performance. Another is that the metrics to truly gauge project success do not appear to have been comprehensively established.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer expressed that the technical accomplishments of the project team are very impressive. Building the platform to share data is impressive by itself, but the fact that Livewire has actively brought on contributors and grown its databases is an excellent indication of the ongoing success of the work.

Reviewer 2

The reviewer affirmed that technical progress is good. More automated ways of granting interested people access to the data, creating detailed metadata with considerations for scalability, streamlining and reducing manual processes, expanding quality metrics, and maintaining security are important. The research team may also consider how to improve the cost-effectiveness of the planned progress further, as it might be harder to justify the costs of incremental improvements in Livewire.

Reviewer 3

The reviewer commented that the technical accomplishments include user-facing site improvements, an updated design to enable embedded media and images on dataset pages, updated access and download permissions, metadata additions, data quality characterization, improved site security, and additional fleet datasets.

Reviewer 4

The reviewer cited several technical accomplishments for the project ,including: user-facing site improvements, an updated design to enable embedded media and images on project and dataset pages, updated access and download permissions, automated approval for .gov/.mil email accounts, detailed metadata additions, data quality characterization, site security, and improved site performance. The reviewer also listed several project weaknesses. The project appears behind schedule at only approximately 25% completion at more than halfway through the period of performance. In addition, There does not appear to be substantial progress on expanding the overall use of Livewire, nor establishing a clearly elucidated strategy to do so. Lastly, the overall addition of datasets seems to be relatively modest after more than 3 years into the project.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer expressed the testimonials from collaborators were very heartening to see. Based on this feedback, the team may want to consider what things are working to foster engagement in the future (if they are not doing this already). Additional items the team might consider are: 1.) for contributors, some

categorization of the databases and a diagram of some kind indicating who is contributing to each of these categories of data (giving us a sense of the activity of lab contributors and whether there remains a dearth of data in certain categories) and, 2.) a corresponding figure of the users of data amongst each of these categories.

Reviewer 2

The reviewer stated that while there is a fair amount of collaboration across three project leads, it would be useful to show more clearly which tasks are addressed by each National Lab team member.

Reviewer 3

The reviewer noted the team has shown excellent coordination between Idaho National Laboratory (INL), NREL, Pacific Northwest National Laboratory (PNNL), as well as partnerships with DOE EEMS, Systems and Modeling for Accelerated Research in Transportation (SMART) and Technology Integration programs. Platform feature development is also motivated by various partners such as Carnegie Mellon University (CMU), LBNL, Virginia Tech, etc.

Reviewer 4

The reviewer stated the project development team of NREL (API Platform), PNNL (Data Portal), and INL (Quality and Metadata) is appropriate. The project appears to have been slow off the mark in identifying and expanding collaboration and coordination with other potential user entities. This may have been a leading reason Livewire has seen relatively limited use to date.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer observed that the project team has identified future considerations on Slide 20 (real-time or automated processing of new data, outreach activities). It might also be useful to consider explicit targeted outreach of data resources where the team identifies a need (e.g., for policy actors, equity considerations, etc.).

Reviewer 2

The reviewer found that the project team considerations for future work are good. As it is indeed difficult to source empirical real-world data applicable to new mobility technologies (CAVs), it is highly recommended to be creative in promoting Livewire aggressively in order to attract a plethora of new users with their own interesting data.

Reviewer 3

The reviewer determined that the proposed future development involving the addition of low-level metadata and quality analysis, self-service capabilities for data uploads, expanded in-platform user capabilities, and targeted outreach of users are all well-motivated.

Reviewer 4

The reviewer remarked that the Livewire Data Working Group should continue to be heavily leveraged to identify the means to further expand data provider and user participation. The project team's collaborations with the EEMS research community, VTO programs, and mobility researchers have and should continue. Moving forward, the Livewire team should consider out-of-the-box approaches and enhancements to further the platform's applicability, utility, and appeal to the broadest domain of users as possible. Additional work is needed to further clarify and substantiate metrics to conclusively determine (or not) Livewire's value.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer deemed the project aligns with VTO objectives.

Reviewer 2

The reviewer expressed that the relevance of this project to the overall VTO subprogram objectives is very clear as its goals are in development of a promising data sharing platform; the reviewer had no further comments!

Reviewer 3

The reviewer stated the project supports overall VTO subprogram objectives by providing a secure, scalable platform for data storage, characterization, and management.

Reviewer 4

The reviewer commented that Livewire is relevant. The establishment of a deep, expansive reservoir of transportation and mobility-related data that is secure, functional, easily accessible, and user friendly is beneficial to accelerate the cross-fertilization, research and development, and implementation of advanced transportation technologies and systems.

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

Reviewer 1

The reviewer said the funding seems adequate, although there is some argument that the funding should scale up if the project begins to expand its current capabilities.

Reviewer 2

While this project seems to have sufficient resources, the reviewer suggested the researchers review the comments for Questions 4 and 6 for possible considerations on improvement.

Reviewer 3

The reviewer affirmed that the approved funding over multiple years is adequate for this effort.

Reviewer 4

The reviewer expressed that this project seems to be somewhat overfunded by DOE and there is no cost share.

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

Presenter

Dean Deter, ORNL

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.

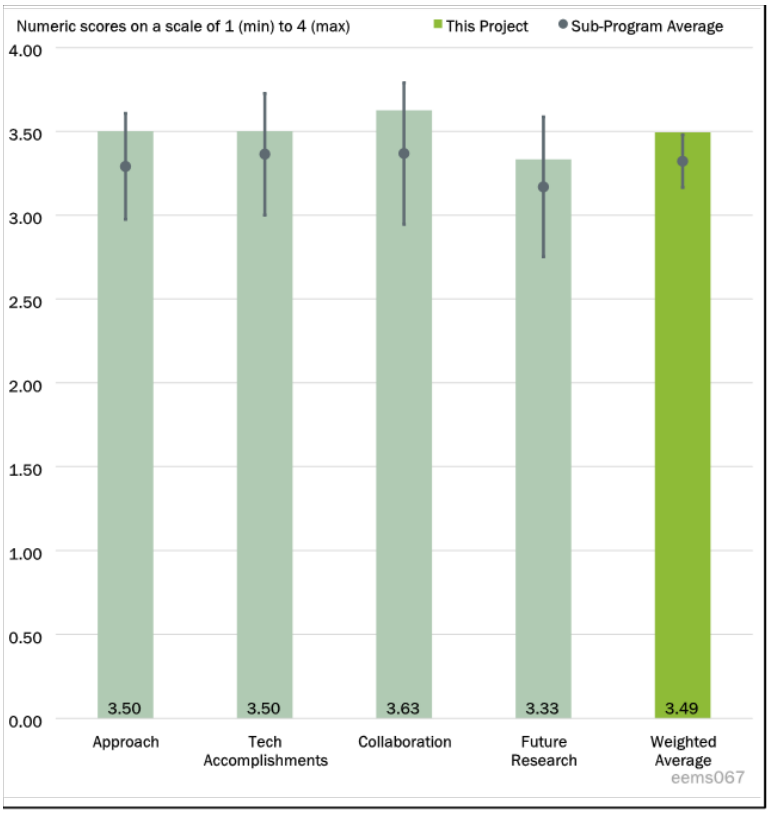

Figure 3-6 - Presentation Number: eems067 Presentation Title: Virtual and Physical Proving Ground (VPPG) for Development and Validation of Future Mobility Technologies Principal Investigator: Dean Deter, Oak Ridge National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that this project is complete. The technical barriers were addressed and the project was well designed.

Reviewer 2

The reviewer determined that the team's approach to performing the stated work has been to create a virtual proving ground with communication modeling, development, and validation, allowing cross-platform data sharing and co-simulation.

Reviewer 3

The reviewer noted the project is well designed and the timeline is reasonable. The objective of developing a unified tool chain for CAV's is noble, but no small and trivial task. The team has partnered with great suppliers of hardware and software that will make the project goals obtainable. Taking the vehicle off the road and enabling CAV testing and validation of behavior is where industry is going and there are a number of OEM's and Tier 1 suppliers headed in the direction of creating these capabilities. Obviously, DOE's thrust is to make the tool chain more accessible and publicly available versus integrating multiple tools today that can be cost prohibitive.

Reviewer 4

The reviewer stated this is a timely project that aims at building an advanced modeling, simulation and analysis platform for CAV technologies/applications. Considering the impacts of the pandemic, the research team did an excellent job throughout this project. The project shows a proof-of-concept on the multi-resolution modeling for CAVs and XiL co-simulation (i.e., two testbeds).

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer expressed that the project made a lot of technical accomplishments on a topic that is very complex and requires the integration of a large number of disparate computers, software, and hardware systems to work together.

Reviewer 2

The reviewer remarked that the new Connected and Automated Vehicle Environment (CAVE) laboratory is fully functional and being used. A flexible interface for co-simulation has been developed and includes multi-ego vehicle set ups useable across distributed labs. The labs include hooks to real V2X and traffic control systems.

Reviewer 3

The reviewer noted the team's integration of dyno, vehicle, real and virtual hardware and simulation environment software is amazing to see and demonstrated on real maneuvers. One question is the capability of the wheel dynos to handle torque transients, varying road surface conditions, and the ability to turn the wheels to examine the more difficult lateral control of the vehicle. These last few features, handling large torque transients (accelerating from stop, panic stopping or passing), handling varying "mu" conditions, and planned path tracking, are key for validation of CAV behavior and control, not only for energy, but for safety.

Reviewer 4

The reviewer considered the technical accomplishments and progress of this project to be significant. The reviewer had several follow-on comments:

1.) It is not clear if the communication latency is significant or not for two test cells working together in Task 2. If it is, how did the research team address this issue?

2.) For the vehicle testbed on the dyno, how can the team model the positional errors in a more realistic manner? Most of the CAV applications require a certain degree of accuracy on the locations of equipped vehicles.

3.) How scalable is the platform? For example, if other institutions have similar setups (e.g., dyno and/or driving simulators), would it be feasible to hook up with the same platform and run the same simulation simultaneously?

4.) Did you consider sharing (onboard/roadside) sensor information over wireless communications in the platform?

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated the project had good collaboration across team members and was also required to coordinate with several other EEMS projects for applications to test.

Reviewer 2

The reviewer noted the team has shown good collaboration with the American Center for Mobility (ACM), IPG Automotive, dSPACE, and CARLA.

Reviewer

The reviewer said the team has the right collaborations in dSpace, CARLA, ACM and IPG Automotive for execution of the project. The team might consider reaching out to AVL Powertrain in North America, regarding the DRIVE CUBE hardware and Model.CONNECT software that gets at the essence of what this particular project is doing.

Reviewer 4

The reviewer intimated it is good to know that OEMs and universities are also involved. A more integrated driving force would be expected to move this research further along.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer commented the Virtual—Physical Proving Ground that was established under this project will be used in the near future to simulate/evaluate applications being developed under other current EEMS projects. Another potential future enhancement to the VPPG could be the integration of a more realistic wireless communications simulator.

Reviewer 2

The reviewer noted the project is complete.

Reviewer 3

The reviewer stated the slide and discussion around future research are a bit vague, but it appears the major thrust is to integrate with other funding opportunity announcements and current EEMS projects that are highly parallel. It was not totally clear what is left on the XiL development in the project. If the researchers could make clear what is left to develop with some detail on the XiL front, and how it contributes to energy consumption, that would be a nice addition.

Reviewer 4

The reviewer observed that the research team discussed a few barriers or challenges in the slides, which are all reasonable from the reviewer's perspective. Also, some technical questions mentioned in Question 4 should be considered for future steps, as they might affect the fidelity and validity of the modeling platform.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer concluded that the project is very relevant to the EEMS program and established a virtual—physical testing environment that can be used to assess new application ideas.

Reviewer 2

The reviewer commented that the project supports the VTO subprogram objectives of setting up qualified virtual/hybrid laboratories to assess/evaluate/optimize technologies for electrified, connected and autonomous vehicles to reduce energy consumption.

Reviewer 3

The reviewer expressed that overall,the presentation and discussion was enjoyable. The thrust of the project is exactly what is going on at the OEM level to get rid of mule and development vehicles that require 1,000's of miles of testing and validation in unique environments. Having the ability to use unified tools without slow co-simulation to create the scenarios, and then test them at the vehicle level to acquire real response and performance, will be essential to fielding CAV technologies that improve safety and reduce energy consumption.

Reviewer 4

The reviewer agreed with the importance and relevance of an advanced CAV modeling and testing platform to enable EEMS research. However, it is recommended that the DOE effectively structure the research map on modeling/testing platform development to coordinate efforts and avoid too much overlap.

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

Reviewer 1

The reviewer stated the resources are sufficient and the project is complete.

Reviewer 2

The reviewer commented the approved budget for 2 years is appropriate.

Reviewer 3

The reviewer remarked that using multiple lab setups for vehicles in the loop with the developed simulation and environment tool chains is quite impressive and will be a significant enabler to complete the project and achieve the objectives. One thing to consider is correlation to real-world data. Is there a plan to essentially mimic and correlate results of the system to measured data of CAV's on the road? It is assumed this is likely, since ACM is a partner.

Reviewer 4

The reviewer deemed that resources for this project are sufficient, considering the involvement of various stakeholders, hardware, software, manpower and funding levels.

Presentation Number: eems082
Presentation Title: Validation of Connected and Automated Mobility System Modeling and Simulation
Principal Investigator: Dhiren Verma, American Center for Mobility

Presenter

Reuben Sarkar, American Center for Mobility

Reviewer Sample Size

A total of five 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. 80% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 20% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

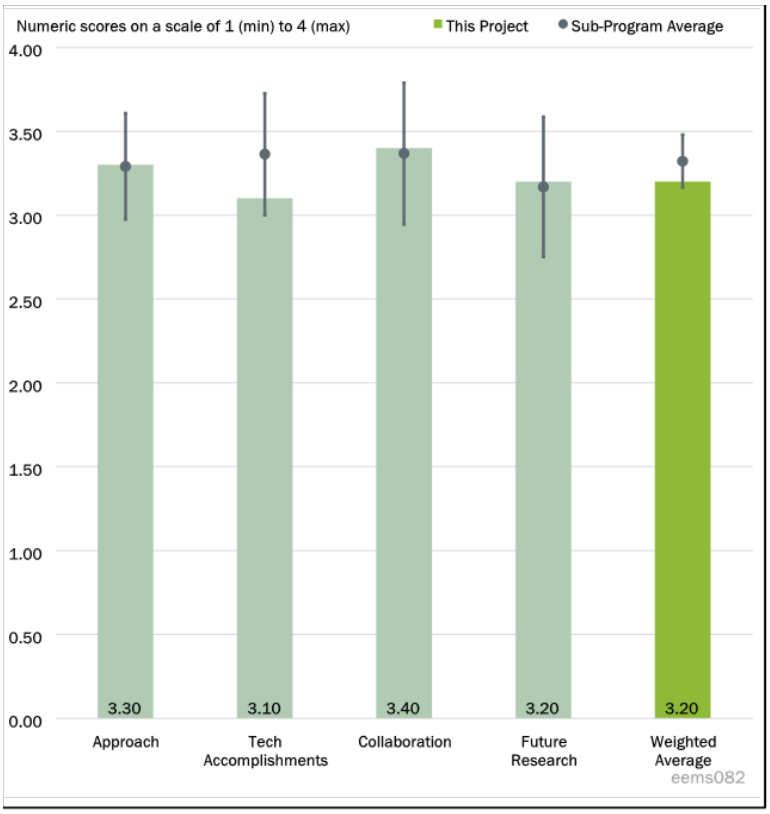

Figure 3-7 - Presentation Number: eems082 Presentation Title: Validation of Connected and Automated Mobility System Modeling and Simulation Principal Investigator: Dhiren Verma, American Center for Mobility

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer stated that the project has a clear approach and connection with other on-going activities funded through EERE. Proving simulation results in real-world testing is critical to advancing methods and algorithms to consumer use in the future.

Reviewer 2

The reviewer remarked that the project builds on previous/concurrent work and is a logical progression from algorithm to simulation to track. Involving ANL and ORNL is also helpful for efficient progress. The technical approach and timeline are reasonable.

Reviewer 3

The reviewer observed that the approach is excellent, using real algorithms and on-road test track experiments to improve algorithms that can then be incorporated into simulation tools.

Reviewer 4

The reviewer commented that the overall project approach appears well developed to meet the stated objectives, but the resulting transfer of insights and information is not obviously clear from the presentation. While quite a bit of infrastructure has been implemented for testing, subsequent updates and presentations will hopefully detail the insights and iterative transfer of information within the various laboratory projects that this

project supports. Real-world data collection is a critical validation step for many DOE research technologies and this project can greatly aid in these efforts, but more details would be helpful to truly understand the benefits and specific items best done using track testing versus other simulation and/or emulation methods.

Reviewer 5

The reviewer said the main barriers defined in the project are real-world measurement of the energy impact of advanced controls enabled by CAVs as well as the modeling and simulation of large-scale transportation systems. One of the main concerns of the reviewer is the scale of the projects accomplished so far. The projects have been deployed in smaller testbeds and use only a few vehicles. This is not a real-world scenario nor is it a large-scale deployment that the barrier defines.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer stated that there is still work to do of course, but the project demonstrated success in iterative testing/development feedback loop working with both ANL/ORNL partners. It is clear that significant effort was undertaken to develop the testing capability.

Reviewer 2

The reviewer mentioned that project progress against the milestones is good. COVID and staffing challenges required a minor no-cost time extension for the project.

Reviewer 3

The reviewer commented that accomplishments to date include development of the testing environment and the completion of the speed harmonization case. One question is how are the results and the open source tools being communicated, distributed, etc. so that the entire community can benefit from this work? Another is whether the current outreach approach sufficient?

Reviewer 4

The reviewer expressed that although a significant amount of capability development has been achieved, it seems as if the analysis, execution, and transfer of insights is lagging behind the project schedule. From the presentation, it is not clear how the validation data and any real-world insights have made their way into any of the DOE control strategies and projects (one of the primary goals of the project). Given the project is expected to end in 2022, more insights into the specific controls and issues encountered in the field would be expected. The presentation primarily details the completeness of certain testing sections or capabilities, but the project team does not yet seem to have much analysis completed at the time of presentation. Also, it is not clear how the vehicle retrofits are ultimately being used in the overall process since single-physical vehicle testing appears to be the primary focus up to this point. Furthermore, it is not entirely clear what benefits have been identified from the field testing versus other forms of simulation and testing. For example, energy consumption data and model validation are discussed in the presentation, but this is something DOE funds from other projects; a clearer example outcome would be helpful to show how this outcome supports the overall project objective. It appears that a significant amount of time has been spent developing test plans and understanding test-to-test variation, but any insights gathered are not mentioned in the presentation. More clarity needs to be provided for the MiTe-μ micro-traffic simulation. DOE projects are already using Simulation of Urban Mobility (SUMO). VISSIM, and Amesim amongst other programs. It is unclear why an additional simulation was used; if needed, information should be shown to validate that this additional simulation is adequate to work for the validation and emulation tasks within these efforts. For the system performance discussion, it

would be helpful to provide some insights into what an appropriate performance target should be for adequate vehicle performance. The given information does not give a strong indication if performance is simply adequate or dramatically better than needed for the validation needs of the different controls projects. Overall. it is clear that a lot of work has been done across a range of subcomponents, but it is not readily clear how all of the pieces fit together and supplement insight generation where a real-track environment is truly needed.

Reviewer 5

The reviewer commented that the team has configured a few test vehicles (EV, hybrid, and internal combustion engine [ICE]) and integrated algorithms developed at ORNL (speed harmonization and merging) and ANL (intersection eco-driving) into vehicles and infrastructure controls. Vehicles have been tested in controlled environments and results were compared. For each control algorithm, several scenarios were tested.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated significant coordination is required to execute projects of this scope. The team has clearly had success integrating work from each partner.

Reviewer 2

The reviewer noted that collaboration is good, especially by involving ORNL and ANL for specific applications. Michigan Technological University (MTU) does a nice job of leveraging prior and concurrent work that directly supports this project. ACM seems to struggle with staff continuity and that is a concern. It is important that sufficient technical expertise resides at ACM so that other research teams can quickly ramp-up to using the resulting tools.

Reviewer 3

The reviewer observed that collaboration among the team members appears to be excellent. It is unclear from the Annual Merit Review (AMR) what role California PATH has on the team. Can this be clarified?

Reviewer 4

The reviewer stated that the partnership between MTU and ACM seems to be established and running smoothly, but connections and feedback across the labs and their specific controls seems a bit less clear. While the lab efforts are separately funded, the collaboration to validate the controls and the specific insights gained for improved controls are not clearly highlighted in the presentation. Overall, the project seems well coordinated from a project management standpoint, but the exchange of information and iteration for improved controls and insights for DOE programs is not drawn out from the presentation materials. California PATH is also mentioned as a collaborator, but minimal information is provided as to what the collaboration component is for this partner.

Reviewer 5

The reviewer noted that there is great collaboration between American Center for Mobility, Michigan Technological University, ORNL, and ANL.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated that expanded testing plans to more cases is clearly defined and warranted given success of prior work implementing CAV strategies from ORNL/ANL.

Reviewer 2

The reviewer expressed that the proposed work is internally consistent with project objectives. The project is likely to achieve all objectives.

Reviewer 3

The reviewer mentioned that the future work being proposed may be unrealistic in scope. Five new use cases as well as evaluating highly automated vehicles, cybersecurity, vulnerable road users, weather, traffic, etc., is a lot to consider for the future work plan. A more focused list of future work would be more realistic. Also, it is highly recommended that the future work include outreach to automobile OEMs. The sooner that automobile OEMs get interested/involved in this type of research, the better in terms of near-term deployment

Reviewer 4

The reviewer commented that the near-term proposed work seems adequate to complete stated project objectives, but there is still quite a bit of testing, analysis, and feedback to support the overall project validation and strategy refinement goals of the project. Some additional future work items seem to be a bit more generic versus identifying specific additional supplementary efforts. The Proposed expanded scope seems reasonable, although some of the specific activities proposed do not necessarily align with current DOE controls development. Additionally, wireless power-transfer does not seem like a strong EEMS fit, although this would be possibly relevant for other DOE VTO programs. References to multiple vehicle physical testing is also not entirely clear as four vehicles were done for these efforts without explanation of what current testing is in/out of scope. Adverse weather conditions would be a welcome addition to these efforts as this is likely a major impediment for some of the prosed technologies being validated. Cyber-security analysis might also not yet be needed at the physical level as the hardware is developing so rapidly. Rather, a more detailed threat analysis would be a first step to ensure the correct priorities and issues are identified before investing in additional equipment or infrastructure.

Reviewer 5

The reviewer observed that the planned future work is to complete design and development of the experiments, validate results, and run experiments. This seems reasonable for the amount of time left on the project, but it does seem much of it is already done. Some of the future work on extending scope and integrating vulnerable road users are of interest, but it is not part of this project. It would have been good to include at least background traffic to the simulation and test the algorithms under heavy traffic as part of the planned future work for 2022.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer expressed that the project is very relevant and addresses required steps to bridge the gap from proof of concept to ultimate use in consumer vehicles.

Reviewer 2

The reviewer felt this work is very relevant by developing tools to bridge from desktop to track, allowing a reasonable number of experiments to demonstrate efficacy.

Reviewer 3

The reviewer stated that the project is very relevant to the EEMS program.

Reviewer 4

The reviewer noted that project goals and expected outcomes appear to be well aligned with EEMS goals, specifically, the continued development and real-world validation of DOE control strategies and technologies. While the stated intent to identify the levers leading to mobility fits within the overall EEMS scope, it would also be helpful to make clear the key points of validation and uncertainty to be assessed in these experiments (likely to be developed in collaboration with the DOE itself).

Reviewer 5

The reviewer mentioned that understanding the impact of CAVs in energy consumption of vehicles is a very relevant and timely topic.

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

Reviewer 1

The reviewer concluded that the scope of work is large, but the team clearly has the resources and facilities needed to complete the project.

Reviewer 2

The reviewer noted that resources are sufficient to execute the project. It is worth considering whether more resources would have provided more technical resource stability at ACM?

Reviewer 3

The reviewer remarked that the resources appear to be adequate to accomplish the project goals.

Reviewer 4

While somewhat on the higher-end, the reviewer commented that resources seem adequate for a large-scale vehicle development and infrastructure project. It is not entirely clear how much of the project was done prior to this project as some of the vehicles were highlighted as used in other projects, but this is not necessarily a negative reuse of resources. Overall, it seems a significant portion of the funds were used in capabilities development, which would be expected for this project's approach to developing and executing real-world validation. It would be helpful to understand how the overall capabilities mapped to specific implementation needs for the different projects and if there were any gaps in terms of capabilities, sensors, or needs that were still not addressed to fully emulate the developed DOE strategies.

Reviewer 5

The reviewer believed the team has sufficient resources to deliver the project.

Presentation Number: eems083
Presentation Title: CIRCLES: Congestion Impact Reduction via Connected and Automated Vehicle (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 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.

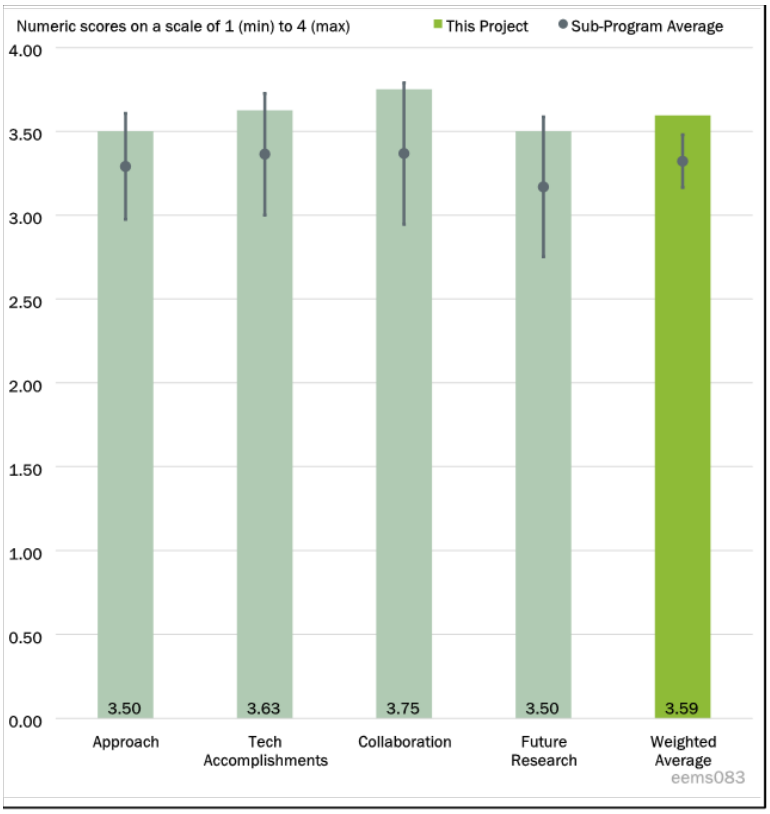

Figure 3-8 - Presentation Number: eems083 Presentation Title: CIRCLES: Congestion Impact Reduction via Connected and Automated Vehicle (CAV)-in-the-Loop Lagrangian Energy Smoothing Principal Investigator: Alexandre Bayen, University of California at Berkeley

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that all of the 2022 milestones are on-track (in spite of, for example, supply chain challenges). The simulation engine is complete, elements of the project are being fine-tuned, and the project is actively working on testbed development, field tests, and hardware implementation. The work appears to be on-schedule.

Reviewer 2

The reviewer pointed out that both of the barriers identified in Slide 2 are well addressed throughout the presentation. The evolution of technologies that has enabled connectivity and automation is clearly what has allowed for this project to happen, and the project team has nicely demonstrated the use of these technologies throughout the presentation. The accuracy of measuring energy impacts of the CAVs within the project is well demonstrated in the testing of the vehicle controllers. However, details of the measurement and calculation of energy consumption of the vehicles affected by the controllers was not entirely clear. This is a critical component of the successful evaluation of the project, as these measurements will determine the energy savings from the controllers.

Reviewer 3

The reviewer mentioned that the approach is very well thought out. The use of the video-based trajectories of all vehicles traveling along the section of the highway is a major "game changer" and is the key to determining if 100 vehicles in the traffic stream can really make a difference.

Reviewer 4

The reviewer stated that the project design is comprehensive, with keen awareness and consideration of the interactions between multiple, complex steps. The timeline for the remining work, which depends at least partly on timely completion and shakedown of the I-24 MOTION (MObility Technology Interstate Observation Network) test bed, is tight and may need to be extended.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer remarked that project progress is advancing, clearly outlined in terms of each respective goal (developing and evaluating vehicle controller candidates, scaling to 100 vehicles and 100 drivers, designing and constructing the I-24 MOTION testbed, and executing large-scale field-testing, respectively). Work appears to be largely on-track and next steps have been provided.

Reviewer 2

The reviewer noted that the technical accomplishments are impressive, and the progression from simulation models to deployment of vehicle controllers is one step closer to real-world application. The project team seems cognizant of the implications of their experiment and are taking appropriate measures of safety while deploying the project.

Reviewer 3

The reviewer intimated that it is impressive that the project has remained essentially on schedule during the supply chain delays.

Reviewer 4

The reviewer observed that this ambitious project appears to be on track to the extent possible, and project leaders seem to have successfully dealt with challenges and barriers to date. These include critical supply chain issues for I-24 MOTION test bed equipment, as well as institutional review board and safety considerations.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer felt that the project pulls in a variety of partners (including several universities, industry, and government), with each entity contributing in a distinct way to the work.

Reviewer 2

The reviewer affirmed that coordination and specific contributions of each partner is very well described on Slide 13, and has no comments on the collaborative aspects of this project.

Reviewer 3

The reviewer commented that the team is well coordinated with university partners, the Tennessee DOT, and two automobile OEMs (Toyota and Nissan).

Reviewer 4

The reviewer said this project appears to have attained its very high level of success to date through excellent coordination between multiple partners with clearly defined roles. This coordination is well done.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer commented that the project presentation clearly outlines proposed future research. Given past performance and the ability to leverage lessons learned from the work thus far, the future work is positioned to potentially achieve its targets. (Although there may be some challenges that pop up, for example related to the scale up to 100 CAVs, experience and considerations thus far may inform subsequent decision-making to overcome hurdles.)

Reviewer 2

The reviewer expressed that the technical aspects of the future research described in Slide 15 are logical extensions of the current project. It is suggested that further consideration be given to the first point made on Slide 14 and how behavioral elements may affect the potential energy savings of the experiment. Even if the project team is unable to mitigate "aggressive" behaviors (or non-efficient driving behaviors), quantification of these aspects of the project would be very valuable in better predicting the real-world implications of the controllers.

Reviewer 3

The reviewer stated the proposed future research has some challenges that were acknowledged by the project team. It may be difficult to fully understand all the nuances of the 100 car experiment until it is actually attempted with the 100 cars. The team will need to stay flexible and have "back up" plans for many aspects of the testing, including parking locations, spacing of vehicles, vehicle lane assignments, etc. The extent to which the team can develop "back up" plans may determine successful completion of the 100 car testing.

Reviewer 4

The reviewer said the proposed future research is spot on toward the end goal of evaluating the system energy implications of the 100 CAV fleet, although timing is tight.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer stated that this project is working to develop and demonstrate AI and control algorithms that smooth traffic flow and provide at least 10% energy savings. As increasing mobility energy productivity and building "an affordable, efficient, safe, and accessible transportation future" is the mission/vision of EEMS, this work supports DOE objectives.

Reviewer 2

The reviewer confirmed that VTO objectives are being met from this project.

Reviewer 3

The reviewer indicated the research is very relevant to understand if low levels of equipped "energy maximizing" vehicles in the traffic stream can actually make a difference in the behavior of the total traffic flow along a section of highway.

Reviewer 4

The reviewer observed that this project clearly supports the VTO EEMS strategic goals. Identifying the role of relatively low rates of CAV penetration on reducing system-wide energy supports the goal of "identifying the most important levers to improve the energy productivity of future integrated mobility systems." Development and testing of multiple control algorithms and the I-24 MOTION test bed supports the goal of developing "innovative technologies that enable energy efficient future mobility systems."

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

Reviewer 1

The reviewer stated that although additional resources could potentially help support additional testing and data collection, given that the project is 80% complete and work is on-track, the resources available seem to be generally sufficient.

Reviewer 2

The reviewer concluded that the resources of the project seem adequate.

Reviewer 3

The reviewer commented that the project appears to have adequate resources to complete the work. However, if the 100 vehicle experiment needs to be continually "tweaked", this could result in a request for additional funding.

Reviewer 4

The reviewer mentioned that the assembled team and its associated commitment towards goals appear to be excellent. The time needed to achieve the critical milestones 3.3 and 3.4 is challenging, and may need to extend beyond FY 22. If additional time is needed, the reviewer stated support for granting it, in order to realize the full potential of the work to date.

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.

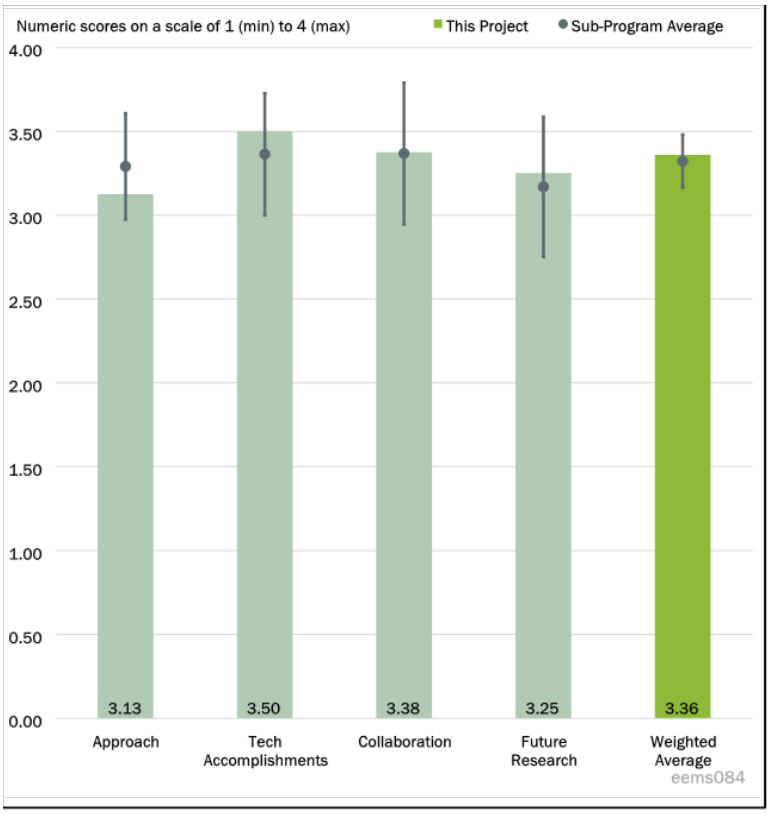

Figure 3-9 - Presentation Number: eems084 Presentation Title: Energy-Efficient Maneuvering of Connected and Automated Vehicles (CAVs) with Situational Awareness at Intersections Principal Investigator: Sankar Rengarajan, Southwest Research Institute

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that project milestones are well laid out and appear to have either all been completed on schedule or are proceeding on-time. The work seems to be well targeted and considers a variety of vehicle types, exploring the benefits of CAV technologies across different powertrain types and automation levels. The research seems well designed overall, although the team might consider the question of variability across different urban corridors.

Reviewer 2

The reviewer remarked that generally the slides indicated targets rather than barriers (Slide 2); however, some of these targets were not addressed in the presentation. While a framework had been developed to estimate the energy benefits, there was no mention of emissions and cost benefits in the project slides. Likewise, target outcome 2 indicates that the simulation would be "quantified and validated with real-world data"; while this is true in that data was garnered from a dynamometer, ultimately the presenter indicated that this should happen with a vehicle in real-world conditions.

Reviewer 3

The reviewer mentioned the approach to use simulation is good because this is the only method that can really try to quantify all various combinations of vehicle type, market penetration, infrastructure equipment, etc. One limitation is that for the corridor simulation, the results may be somewhat dependent on the specific Columbus, Ohio corridor that is being modeled. Using dynamometer and test track testing is also a key component of the approach.

Reviewer 4

The reviewer stated that the project is a helpful investigation into the effectiveness of CAV technologies on system-level energy implications, with a useful mix of vehicle powertrain and automation levels. The project provides solid technical work overall in developing and testing software-in-the-loop. Some weaknesses include representativeness and, therefore, scalability/broader applicability, including the intersection stack and associated communication protocols, and the driving corridor. This is a useful initial project; its broader applicability seems to call for additional efforts, including real world pilots in a more diverse array of applications, before it is ready for more serious consideration of tech-to-market.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer commented that the presentation provides a robust breakdown of results to date and highlights the implications of these findings effectively. The team appears to be solidly on schedule and working in line with milestones and laid out project plans.

Reviewer 2

The reviewer said that technical progress has been well demonstrated. The main deviation from the project plan relates to cost and emissions. These seem to be rather smaller components of the overall research efforts, as they can be post-process results from the bulk of the work. Otherwise, the project team has made substantial progress and demonstrated a very neat sets of results, although more work remains to be done for real-world validation and deployment in real cities.

Reviewer 3

The reviewer felt the project team has made significant progress in conducting the simulations and in verifying simulation results with dynamometer testing. The team also seems to be making progress on the tech-to-market component through engagement with the City of Chattanooga.

Reviewer 4

The reviewer deemed the project a valuable demonstration of system-wide energy reductions under various simulated conditions, including relevance of smart vehicle penetration and importance of vehicle-to-vehicle (V2V) versus vehicle-to-infrastructure (V2I). Additional exploration of the implications of V2I versus V2V will be important future work to better understand the key drivers of their success (or lack thereof) under an increasingly wide array of conditions.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated that the project combines partners with different strengths and roles in the industry. The role of each partner was laid out. Given the results thus far, the partnership seems to be operating fine,

although additional information about the partnership would also be of interest. It is great that Alamo Area Clean Cities Coalition is helping to facilitate public sector coordination and outreach.

Reviewer 2

The reviewer observed that collaboration and coordination with partners are nicely documented on Slide 19. The roles are clear, and there are no further suggestions for improving collaboration.

Reviewer 3

The reviewer deemed project team collaboration and coordination among team members to be very good.

Reviewer 4

The reviewer said project coordination appears to be fine. A summary of the results of the tech-to-market efforts, including outcomes of discussion with public entities and techno-economic analysis, would be useful.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer observed that the project outlines plans for future work, including subsequent testing and demonstration. The team is likely to achieve its target, although the researchers also lay out opportunities to expand on work beyond the project time frame (for instance, there could be additional collaboration with other cities, OEMs, etc.).

Reviewer 2

The reviewer stated the team has a clear vision of proposed future research, and the test track technology demonstration and pilot testing in a true urban corridor are logical extensions of the current work. Although there are certainly many challenges with implementation, carrying out the team's vision for upcoming research would ultimately lead to outcomes supporting the initial goals of the project. It is also suggested the team try and consider the generalizability of the findings across different networks. This means the team should attempt to characterize the factors (both static and dynamic) of the road networks and traffic conditions that could then be operationalized to understand the potential energy savings being measured in this project.

Reviewer 3

The reviewer commented that the future research component includes the test track demonstration. However, it is a little unclear as to how the test track results will be used, other than a feasibility test of implementation of some of the simulated technologies. For example, will the test track results be used to improve the simulation models?

Reviewer 4

The reviewer expressed the proposed future research includes reasonable next steps, although they are somewhat undefined. The research would benefit from elaboration on the expected outcomes and goals to accomplish these steps, including clarification on specific tasks and timeframes.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer remarked this project is working to quantify and understand the benefits of CAV technologies on an urban corridor and to understand the impact of intelligent infrastructure platforms from an energy efficiency perspective. This can potentially help to advance informed deployment/application of CAV technology to

support more energy-efficient travel in the future. As increasing mobility energy productivity and building "an affordable, efficient, safe, and accessible transportation future" are part of the mission/vision of EEMS, this work supports DOE objectives.

Reviewer 2

The reviewer confirmed this project is aligned with VTO objectives.

Reviewer 3

The reviewer stated this research is relevant to EEMS and addresses improved operations of vehicles on equipped traffic corridors.

Reviewer 4

The reviewer commented that the demonstration of simulated system-wide energy reductions resulting from CAV technologies, including the relevance of CAV penetration and vehicle-to-everything (V2X) approaches, works towards achieving VTO EEMS strategic goal #1, the identification of the "most important levers to improve energy productivity of future integrated mobility systems.".

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

Reviewer 1

The reviewer indicated that while more time and resources could help to further gather data and better capture and understand associated real-world complexity (for instance across different road/driver environments), the resources generally seem sufficient to work towards the stated project goals.

Reviewer 2

The reviewer concluded that this project seems to be adequately funded.

Reviewer 3

The reviewer observed that the project appears to have sufficient resources to achieve the remaining milestones. However, getting the test track demonstration to work does have some challenges as outlined by the project team, but the team has also identified mitigation solutions for these challenges.

Reviewer 4

The reviewer said resources seem sufficient to achieve the goals outlined for budget period 3.

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

Presenter

Dominik Karbowski, ANL

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.

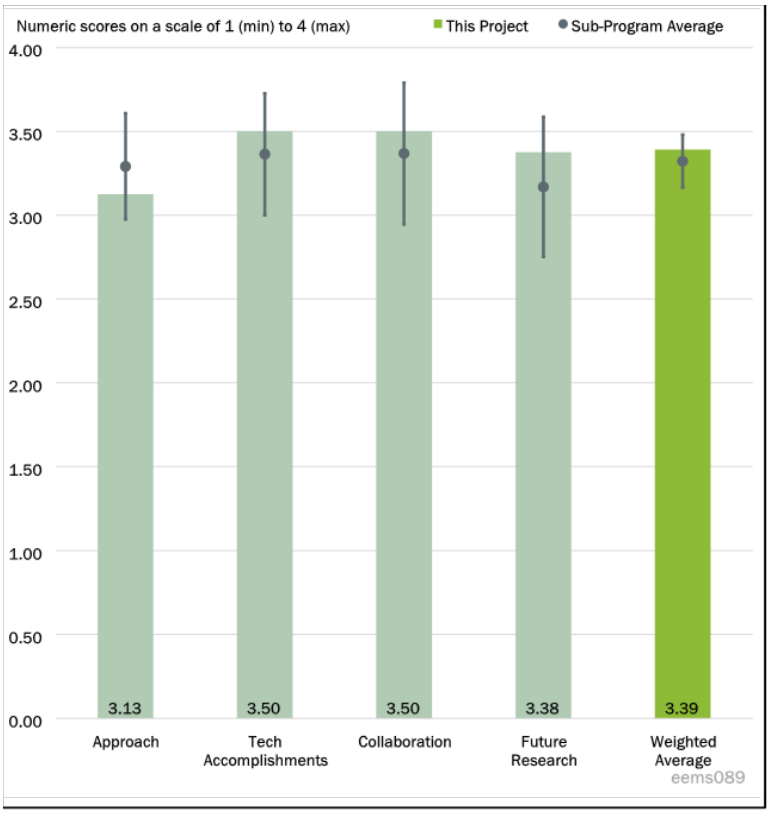

Figure 3-10 - Presentation Number: eems089 Presentation Title: Energy Efficient Connected and Automated Vehicles (CAVs), Workflow Development and Deployment Principal Investigator: Dominik Karbowski, Argonne National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer stated the team has clear barriers but the approach slides and discussion were a bit unclear the specific role this project plays. The interconnection of the many related projects was clearly conveyed, but with so much discussion of the rest, the project deliverables are unclear. Especially for those not intimately familiar with the prior work, the context of this presentation was very hard to digest.

Reviewer 2

The reviewer observed the project does a great job of covering all of the potential means of vehicle-to-x interactions and processes to model these interactions in a way that produces meaningful data.

Reviewer 3

The reviewer commented that the real vehicle demonstration of energy consumption has historically been quite difficult, particularly if the project focus is on powertrain energy reduction and the demonstration requires taking control of or over-riding OEM controls. Generally, this is not possible and even if partnered with an OEM, objections to allowing this control are made in favor of safety or torque security. However, with the dynamometer and coupling with virtual in the loop approaches of this project, these barriers can be overcome. The approach presented and accomplishments reported support this point.

Reviewer 4

The reviewer remarketed that development of advanced tools and platforms (e.g., XiL) to evaluate energy impacts of CAVs has significant importance. In recent years, various institutions have been developing their own tools or platforms for similar purposes. With the leverage of DOE national laboratory resources, the research team should be able to develop a comprehensive product. Based on the presentation, the team is moving forward to the right direction.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer cited specifics of the Sensor/V2X development are not clear as to which parts are newly developed or just integrated. The density of slides makes this hard to absorb even in post presentation review, let alone live. The workflows/software sections are reasonably clear though discussion was too deep at times for a review presentation.

Reviewer 2

The reviewer said that considering the number of moving parts (organizations, collaborations across organizations) in this project, progress has been outstanding, The project is delivering the results anticipated in the project plan on time.

Reviewer 3

The reviewer found that the team has made significant progress and accomplishments in the area of lateral dynamics and human driver models that seem to be a deficiency in most other current or previous projects. The workflow integration of traffic analysis and modeling with the XiL is key to demonstrating representative energy consumption characteristics and behaviors. The coupling of the tools to vehicle or vehicles on the test track is great for developing various scenarios that represent real world behavior. A number of other EEMS projects and automotive consultancy companies are on parallel paths. The enhanced features in Roadrunner as an outcome of the project to date are spot on and look fantastic. When will these features be readily available for field distribution?

Reviewer 4

The reviewer noted the technical accomplishments and progress make sense and the entire project follows the plan very well. The reviewer also had several questions and comments as follows:

1.) To enable the mixed reality test environment, it might require high-fidelity simulation network and scenario setup. How does the research team guarantee the simulated environment to be as realistic as possible to facilitate the integration with a real testbed?

2.) Will weather impacts be considered in the future development effort?

3.) How will the realistic interaction behaviors be modelled by the proposed platform and what kind of real-world data will be used to validate these modeling efforts?

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer thought the large team seemed effectively managed. The roles are defined throughout the presentation which was appreciated.

Reviewer 2

The reviewer remarked that the project exhibited great teamwork between academic institutions, national labs and at least one OEM. Since a lot of the work is aimed at developing techniques to coordinate movements among a mixed group of vehicles, the effectiveness would be greatly enhanced if there were a standard developed around what vehicles do with the V2X information presented. If vehicles do not react in the same predictable manner, it would seem the control effectiveness is diminished. Is there such an activity planned? Or is that considered out-of-scope?

Reviewer 3

The reviewer said that integration with Hyundai to get data for improved human driver model and traffic behavior is amazing. Leveraging the telematic systems from OEMs to develop large datasets for learning and model development is a rapidly expanding element being found in a number of DOE EEMS VTO projects. The team should be very proud of this work and the level of support from the OEM. The collaborations with other entities seem spot on and appropriate for accomplishing other facets of the project.

Reviewer 4

The reviewer commented it is good to see the collaboration between ANL and other stakeholders, e.g., universities, and automakers. It would be great if there is a closer coordination between DOE national laboratories, or between DOE and USDOT.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer observed the future work to clear and appropriate given current progress. It seems likely that the team will achieve its targets.

Reviewer 2

The reviewer said project next steps are a logical extension/expansion of the work done to date.

Reviewer 3

The reviewer stated the deployment of tools and workflows will be interesting to note on how they are used and leveraged for CAV development. The AI-based prediction and calibration methods, in general, seem to be a converging approach for a number of DOE EEMS projects. It will be good to see the team utilizing collaborative partners in developing these components of the project.

Reviewer 4

The reviewer expressed the future research mentioned by the team makes sense. Besides, some of the questions in Question 4 list may be considered as future steps.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said integrating tools is definitely relevant and a required step if techniques are to be adopted more broadly.

Reviewer 2

The reviewer confirmed the project is highly relevant to EEMS advancement of CAV technology and to working out the associated problems in a publicly accessible forum.

Reviewer 3

The reviewer concluded that this project ties into other EEMS projects very nicely, i.e., EEMS 067, EEMS 089, etc. The project is also highly relevant in decreasing the development time of CAV technologies with the specific focus of reducing energy consumption, and in validating that the technologies fielded do in fact reduce energy consumption under a broad range of driving situations.

Reviewer 4

The reviewer fully agreed with the importance and relevance of an advanced CAV modeling and testing platform to enable EEMS research, or more specifically, CAV energy related research.

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

Reviewer 1

The reviewer felt the resources are appropriate and well-integrated.

Reviewer 2

The reviewer commented the project is well funded and is progressing nicely.

Reviewer 3

The reviewer stated the team does appear to be sufficiently resourced and partnered/collaborating with external entities that enable execution of the project in the proposed time frame.

Reviewer 4

The reviewer affirmed that the resources of the project are sufficient. Leveraging the resources from DOE national laboratories is considered to be a plus for this project.

Presentation Number: eems090
Presentation Title: Applying Artificial Intelligence (AI) Based Signal Coordination and Controls for Optimized Mobility for the Nimitz Highway
Principal Investigator: Hong Wang, Oak Ridge National Laboratory

Presenter

Hong Wang, ORNL

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.

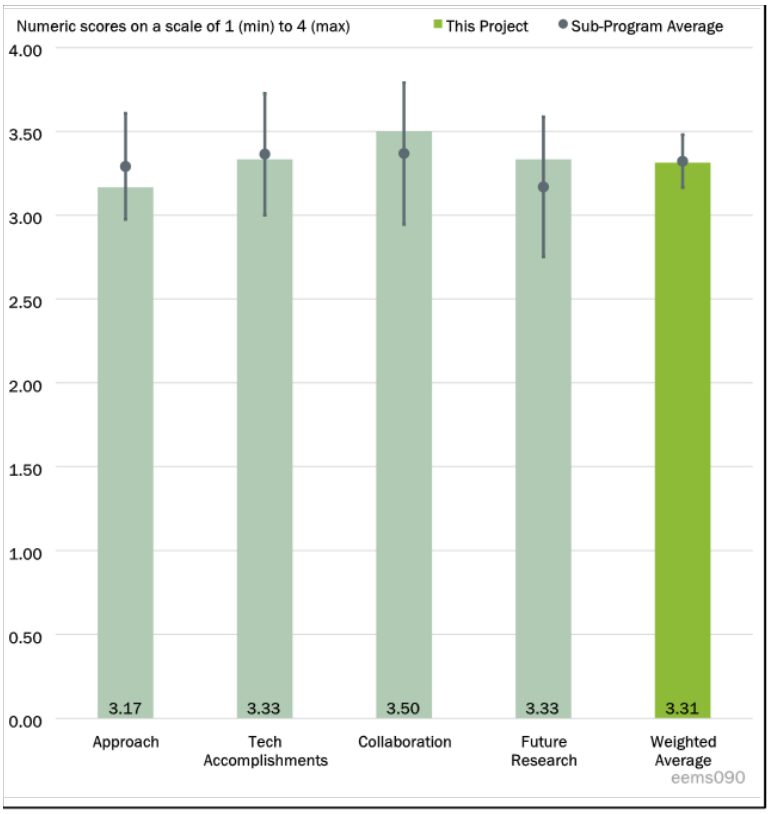

Figure 3-11 - Presentation Number: eems090 Presentation Title: Applying Artificial Intelligence (AI) Based Signal Coordination and Controls for Optimized Mobility for the Nimitz Highway Principal Investigator: Hong Wang, Oak Ridge National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer wondered whether the only data available long-term would be from the signal controllers installed, or if additional inputs would be available to feed the hybrid neural network? Understanding travelers' choices (e.g., taking alternate routes depending on traffic volume) would be important. Performing a before/after analysis would allow for a better comparison of the proposed approach.

Reviewer 2

The reviewer commented that overall, the project has a strong approach. Leveraging existing infrastructure as well as a focus on real-world benefits fit well with the overall approach and needs of the EEMS program. The focus on 24/7 real-world implementation of AI algorithms is much appreciated as a direct and real-world evaluation of promising AI methods. The project leverages recently installed traffic control technologies and facilities from Hawaii-Department of Transportation (HDOT), which is a strong starting point for high-value DOE investment (i.e., focusing on algorithm development versus infrastructure building). Year 2 focus on real-time implementation should provide a strong validation for the improvements shown in the simulation portion of this work. The combined goals of energy reduction and travel delay reduction are helpful to ensure a balanced application of the developed algorithms towards real-world improvements.

Reviewer 3

The reviewer stated the research team leverages the real-world traffic data, modern control theory, and machine learning (ML) technique to optimize the traffic signal operation along a major corridor in Hawaii. The approach makes sense. Due to the complexity of the problem, the application of ML techniques is promising from a practical point of view. To ensure the validity of the approach, the richness and fidelity of the real-world data as well as operational constraints (e.g., minimum green/maximum green) need to be guaranteed.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed the project seems to be on time based on the suggested timeline. However, the data aspects are not clearly integrated. Similar to the comment above, would other data be needed or just the controller will suffice? I know the project is trying to minimize data needs, but there are other aspects that might be of interest.

Reviewer 2

The reviewer commented that Year 1 efforts have resulted in a strong set of preliminary results and publications, including an IARIA best paper award and keynote speech. So far, project progress and accomplishments appear to be in line with the goals of developing algorithms and creating/validating the simulation environment under which the algorithms will be developed. Simulated results show strong progress towards travel time and energy saving goals. Since the project uses existing infrastructure, it is expected that the transition to real-world testing will be relatively smooth.

Reviewer 3

The reviewer felt the research team made a good number of technical accomplishments, including the earning of the Best Paper Award from a conference. The reviewer also offered a few comments regarding the technical details of the research:

1.) The model seems to be updated every two cycles, which might be a trade-off considering computational time and optimality. It would be great if cycle length is considered as a decision variable, although it might need to be consistent across the entire corridor.

2.) More detailed traffic information (e.g., lane-level rather than approach-wise queue length) is suggested to be available for the AI-enabled traffic signal optimization.

3.) It is assumed that there are quite a lot of pedestrians/bicyclists (e.g., tourists) crossing the intersections at the study site. If so, does the signal control need to take into account the impacts of these modes.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer commented that the work done to coordinate and navigate the implementation of this program in an island is impressive.

Reviewer 2

The reviewer stated that the project team has a strong mix of backgrounds and expertise. Working with Econolite provides strong and direct support for the implementation and learning of the developed techniques into real-world traffic systems. Working with HDOT is also a strong positive to this project as a primary

stakeholder for these techniques and will ultimately be responsible for integrating the project learning and insights.

Reviewer 3

The reviewer observed research partners include HDOT, Econolite, and academia. These partners should provide good coverage of different perspectives on the traffic signal operation. It would be great to learn more feedback from the end user, i.e., HDOT, or by conducting a survey of road users (e.g., local residents).

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer remarked the future research topics are as expected for this type of work. It would be good to compare the resulting improvements to an island versus to different metropolitan or rural areas.

Reviewer 2

The reviewer deemed the future work is in line with the expected project goals and outcomes. The transition to real-world implementation and data collection seems well-established and should be relatively smooth. The project team seems capable of achieving future milestones and the implementation results from the project applied in the real-world should be exciting to see. It would be helpful to highlight the degree to which the obtained results could be applicable to other systems—both in terms of transferring the learning algorithms to other traffic systems as well as any high-level abstractions for the "rules" created by the neural networks utilizing emerging developments in explainable ML.

Reviewer 3

The reviewer found the proposed future plan to make sense. Besides the focus on improving signal control algorithms (e.g., applying different ML techniques),here are two other major areas that may require attentions: 1.) It would be important to better predict the network-wise traffic states by taking advantage of real-world data and applying advanced ML technique; and 2.) The multi-modal interaction at intersections or along the corridor should be treated with care.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer intimated that assisting non-continental US states and territories should be a priority for VTO EEMS due to the energy crisis for several of these regions. Similar programs could be applied and compared to other US territories.

Reviewer 2

The reviewer believed the project is very much in line with EEMS goals both in overall project intent and balance between travel time and energy reduction as well as in a focus on real world implementation with a mix of strong and highly relevant project partners.

Reviewer 3

The reviewer commented the project is focused on traffic signal optimization for improving mobility of the whole transportation system. There are also efforts on accessing energy impacts or even plans on signal optimization for energy consumption. It aligns with the VTO subprogram (e.g., EEMS) scope and support the corresponding objectives.

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

Reviewer 1

The reviewer remarked that while performing research outside of the continental US is expensive, the project resources are sufficient. However, depending on what is needed for more implementations. The project might need additional funds.

Reviewer 2

The reviewer found resources to be adequate. Project focus on leveraging recent HDOT investments also offers a strong value-proposition for DOE.

Reviewer 3

The reviewer indicated that the support or collaboration with Hawaii DOT, Econolite, and University of Hawaii should provide sufficient resources for the project. Considering the percentage (60%) of completion and the project timeline (end in January 2023), the research team may need to increase efforts to ensure project completion in a timely manner.

Presentation Number: eems092
Presentation Title: Behavior, Energy, Autonomy, Mobility (BEAM) CORE
Principal Investigator: Anna Spurlock, Lawrence Berkeley National Laboratory

Presenter

Anna Spurlock, LBNL

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.

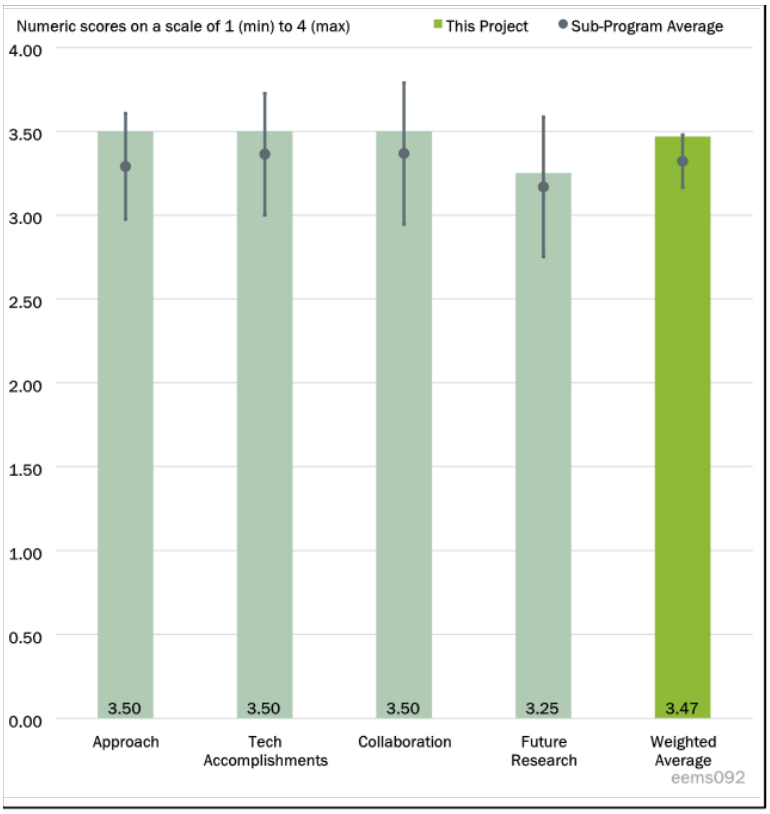

Figure 3-12 - Presentation Number: eems092 Presentation Title: Behavior, Energy, Autonomy, Mobility (BEAM) CORE Principal Investigator: Anna Spurlock, Lawrence Berkeley National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that it is commendable that the project team made early and extensive efforts to solicit inputs from key stakeholders to help inform the design and development of the modeling framework. The open source nature of BEAM CORE is important for model transparency, dissemination, and evolution. The fact that BEAM builds upon MATSim, which is also open source, demonstrates this importance. The modeling framework of BEAM CORE is comprehensive, and represents the interactions among various components well. The incorporation of DEMOS to model population evolution is novel. The ability to model detailed socioeconomic characteristics (including equity-related ones such as race) of individual agents (persons) equips the modeling framework well for analyses of equity impacts of future mobility technologies and policies. Also, ACT looks to be a useful tool for sharing modeling results with stakeholders. Lastly, the modularity of the modeling framework where individual models can be used independently will add value to the final product.

Reviewer 2

The reviewer indicated this is a very complex project, by design. “All models are wrong. Some are useful.” The most important aspect of this complex model project is that it is open-source. That addresses the largest technical barrier. A black box tool is easy to use, but difficult to verify correctness. The open-source nature makes this tool verifiable. Other researchers will question how it functions and potentially modify it to suit their needs. If the tool gains sufficient traction with researchers, it could indeed provide valued inputs to policy

makers and planners. Computational requirements are a challenge, but more tools are coming (e.g. quantum computing).

Reviewer 3

The reviewer stated technical barriers presented in Slide 3 are posed as more of generalized research questions, but it would be helpful if specific barriers to the modeling work were identified. These barriers could then act as a focal point in explicitly providing the audience with information on what efforts were taken in the modeling approach to overcome them.

Reviewer 4

The reviewer observed that the project has a well-defined approach to consider household evolution and vehicle ownership dynamics, demographics, vehicle transition and technology adoption, and freight capabilities. By considering new technologies, evolution in each household, demographics, and technology adoption, a fairly clear picture can be achieved that can be used for planning and analyzing impacts of different options.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer remarked the project seems to be on track with reasonable progress made to date. The number of technical accomplishments is impressive, but not surprising given the size of the project and the expertise of the project team. The performance enhancement of the model framework is focused on the right areas (faster runtime, tighter integration with end-to-end automation, more accurate representation of phenomena and behaviors, etc.). The incorporation of freight capabilities is a major undertaking, but is also important for capturing the interactions between passenger and freight movement in transportation systems. The progress made up to this point is promising.

Reviewer 2

The reviewer said that based on the milestones and checkmarks, the project is on-track.

Reviewer 3

The reviewer expressed the presentation clearly demonstrated progress on the modeling front and expanded capabilities of the BEAM CORE system. Slides 35 and 36 were excellent to see, providing a view beyond technical modeling aspects to an explicit demonstration of application and outreach activities. It might be beneficial to follow up with some of the stakeholders to gauge whether workshops and meetings led to any real-world impacts. The team also explicitly calls out efforts to consider equity outcomes in the modeling. In the same vein, the team should consider engagement with specific stakeholders to push for equity impacts of their research as well.

Reviewer 4

The reviewer noted the team has accomplished good models. Validation of some of the earlier models are provided which are shown to be promising. However, more validation and in-depth planning for such validation are needed.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated that coordinating a multi-partner team in a highly complex project is always challenging, but the progress and accomplishments presented indicate well-coordinated efforts. The integration of multiple models in the framework with automatic handoff of model inputs/outputs can only happen with good collaboration among the partners within the project team. The number of external partners from universities and industry is limited. There may be additional datasets or modeling expertise that can be brought in to further enhance BEAM CORE.

Reviewer 2

The reviewer said there are many partners with a large budget. The project appears to be well coordinated.

Reviewer 3

The reviewer noted that collaborations are very nicely documented on Slide 40; no further suggestions are offered as it seems that the team id working cohesively on the modeling.

Reviewer 4

The reviewer confirmed this is a strong team of collaborators from multiple labs.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer commented the proposed future research is mapped out very well, and represents reasonable milestones toward achieving the project goals.

Reviewer 2

The reviewer stated future milestones are internally consistent with overall project objectives. The project appears to be on track.

Reviewer 3

The reviewer noted the project team has nicely identified challenges and proposed future research to continue the project on Slides 41-43. One primary concern is whether some of the challenges of the modeling effort can be overcome. BEAM CORE is already a fairly complex modeling system, and it is unclear whether computational performance can be substantially improved to the point where the model is readily available and accessible to interested stakeholders. Additionally, the model is "designed to be deployable to most regions...with publicly available data"; are the parameters and inputs needed to run the model readily available to allow BEAM CORE to cover the rest of the US? Adding additional regional coverage is a fairly large effort to include, and if so, the team should be more explicit about this. Lastly, it is suggested that a greater emphasis be placed on Task 4 (application and outreach) specifically with regards to model/output accessibility. In what ways can the model (or its outputs) be made more readily available to interested parties, and what might some of the impacts be of stakeholder engagement?

Reviewer 4

The reviewer felt that overall, more discussion of planned validation of the models is needed. The reviewer-only slides showed the results of the validation of ATLAS-V1, and not many details are provided for V2.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said the ability to predict potential mobility and energy impacts of new transportation technologies and services is critical for the VTO, the EEMS subprogram, and other relevant agencies in deploying or guiding these technologies and services in a sustainable and equitable fashion.

Reviewer 2

The reviewer mentioned vehicles and energy-efficient mobility systems are a huge component of overall energy consumption, GHG generation and equity challenges. Optimization of said systems is complex and interdependent. This project addresses exactly that complexity and is very relevant.

Reviewer 3

The reviewer confirmed the project supports the VTO subprogram objectives.

Reviewer 4

The reviewer commented this is a very relevant project. Many simulation projects, while considering human behavior, do not considering the evolution of households and technology options and adoptions.

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

Reviewer 1

The reviewer noted the project funding is very large, but commensurate with the scope and ambitious goals of the project.

Reviewer 2

The reviewer commented the project is mostly labor. The annual funding is sufficient to support more than a dozen highly-trained full-time equivalent (FTE) staff and is consistent with the "dozens" of (part-time) researchers collaborating on this activity. That level of effort is consistent with the breadth of objectives.

Reviewer 3

The reviewer mentioned the budget is large but it covers what is clearly a substantial modeling effort by a large modeling team.

Reviewer 4

The reviewer stated the team has access to sufficient resources to deliver their project.

Presentation Number: eems093
Presentation Title: Transportation System Impact: POLARIS Workflow Development, Implementation and Deployment
Principal Investigator: Joshua Auld, Argonne National Laboratory

Presenter

Joshua Auld, ANL

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.

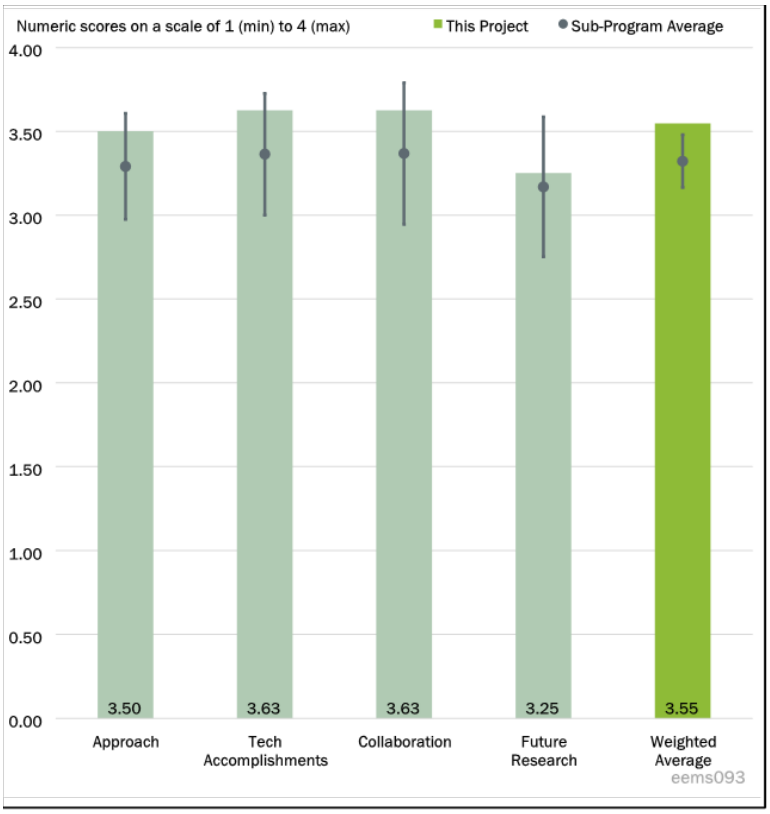

Figure 3-13 - Presentation Number: eems093 Presentation Title: Transportation System Impact: POLARIS Workflow Development, Implementation and Deployment Principal Investigator: Joshua Auld, Argonne National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that POLARIS-centered workflow encompasses a broad array of features and capabilities that can be used to study a wide range of transportation improvement and decarbonization pathways. The ability to model electric vehicle (EV) charging and grid interaction is appealing, especially in light of the federal effort to create a nationwide EV charging network. Also, the inclusion of freight and multimodal travel at the agent level enhances the realism of the modeling.

It is commendable that the project design is stakeholder-driven, with early engagement to understand needs and regular interaction to receive feedback. The presenter explained that the current approach for technology transfer is based on licensing coupled with direct training and technical support. Perhaps, it is out of the scope of the current project, but additional efforts on model documentation and capacity building may be needed to encourage continued utilization of the workflow by the current stakeholders and adoption of the workflow by new stakeholders beyond the life of the project.

Reviewer 2

The reviewer stated the project is large in scope and well thought out to address the complexity. Many organizations are involved, leading specific applications to answer research questions in their areas of need and expertise. ANL pulling the majority of it together makes sense. The approach of an licensed open-source to ensure almost all modifications by users are piped back into the tool for others to use is appreciated. The

licensing will no doubt reduce distribution, but can perhaps lead to a well-controlled tool. The open-source nature supports independent validation. The timeline is reasonable.

Reviewer 3

The reviewer expressed it is not entirely clear if the technical barriers are in reference to past work or future work. With regard to technical barriers that have already been overcome, the slides were not explicitly clear on the challenges faced by the modeling team. However, it is clear from the development of the workflow and the coverage of the results that the team has technical proficiency and no doubt addressed many modeling challenges along the way. In regard to future technical barriers, the project presented upcoming challenges on Slide 43. However, there was not any discussion within the presentation as to how the project members intended to address these challenges. Given the length and time constraints of the presentation, this was understandable, but it would have been good to present an example of how the team's capabilities could overcome these challenges.

Reviewer 4

The reviewer asserted this is a great tool. The approach of engaging stakeholders to identify the gaps and needs, adding new features based on the feedback, improve workflow, and develop scenarios and analyze is a great approach for a project of this scale and size.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer noted the project team has made good progress in which most of the milestones have been met. Notable achievements include incorporation of micromobility modes, modeling of EV charging behaviors, and assessment of equity impact of the tested scenarios. Extensive efforts have been made in calibrating and validating the different components of the workflow.

The presenter discussed the application of the workflow to study the impacts of a variety of transportation technologies and services. There are lots of modeled results. Where applicable, it would be interesting to compare the results from the workflow to those from existing modeling tools at the metropolitan planning organizations (MPOs). It is also encouraging to see cloud computing being explored as an alternative to HPC, which could help lower the barrier to entry for many potential users.

Reviewer 2

The reviewer said the project milestones appear to be well on schedule.

Reviewer 3

The reviewer observed that technical progress has been clearly demonstrated as the slides showed different outputs from a variety of case studies resulting from the POLARIS platform. This is most succinctly shown on Slide 14, with the milestones of the project displayed in great detail. The breadth of the analysis is very impressive and the team does a good job in showcasing this in the presentation. however, besides highlighting the modeling results, it is suggested to also provide an overview of other outcomes of the modeling effort (e.g., publications, policy impact, other real-world actions taken in response to the modeling).

Reviewer 4

The reviewer commented that that currently only 22 users are using this strong tool, which is surprising. Similar to the comment from last year, it seems this tool should be an open source. The team response to this comment from last year is not satisfactory. Free license and open source are very different. Open source will

help with development of guidelines and other resources to reduce the learning curve or provide simpler modules for others to use.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer noted that coordinating a multi-partner team in a highly complex project is always challenging, but the progress and accomplishments presented indicate well-coordinated efforts. The integration of multiple models in the framework with automatic handoff of model inputs/outputs can only happen with good collaboration among the partners within the project team. Also, the number of external partners from both academia and industry is impressive.

Reviewer 2

The reviewer intimated there are many cogs in this machine. Again, having a variety of entities lead specific applications is a nice way to distribute the development and validation while also leveraging specific expertise. Licensed open-source is a valid approach to capturing these inputs. Unlicensed open-source could lead to unexpected improvements, but would be much less coordinated. Perhaps there is a later phase where the tool transitions to unlicensed and obtains additional value and insight once the base tool has sufficient momentum.

Reviewer 3

The reviewer found that the project clearly demonstrates a broad array of collaborations being made throughout a variety of industry, MPO, and academic stakeholders. However, it was difficult to gauge the level of effort and interaction with these stakeholders besides their involvement with specific sub-products. While this may again be a product of the length of the presentation, it would be beneficial to delve a bit more into detail on the level of collaboration and what expertise/contributions that stakeholders were bringing to the table (at least providing one or two examples from specific projects). This would give a better sense of the types of interaction and collaboration that are happening between the core project team and external stakeholders.

Reviewer 4

The reviewer noted there are several national labs, universities, and private public partners on the team.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer remarked the proposed expansion of workflow capabilities and applications suggests an ambitious plan, but it is well directed at addressing the remaining challenges and barriers.

Reviewer 2

The reviewer said the proposed work is internally consistent with the overall project objectives.

Reviewer 3

The reviewer stated topics of the proposed future research (Slide 44) are nicely documented and sensible extensions of the existing work. (Although occasionally there seems to be some overlap in topics, it is assumed these may not be fully fleshed out in the current instantiation of the model). In addition to model capabilities, the project team should consider being more explicit about stakeholder engagement and model/results accessibility. It is heartening to see a call out to "documentation, training and support tools", but a greater emphasis on translating all of the modeling work into direct impacts would make a lot of sense.

Reviewer 4

The reviewer observed one of the future works should perhaps be on community engagement with the goal of investigating the roadblock for researchers not adopting POLARIS and increasing the awareness among the researchers.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer stated the ability to predict potential mobility and energy impacts of new transportation technologies and services is critical for the VTO, the EEMS subprogram, and other relevant agencies in deploying or guiding these technologies and services in a sustainable and equitable fashion.

Reviewer 2

The reviewer noted the system of systems level modeling for transportation is directly aligned with VTO and EEMS missions and objectives: energy, GHG and equity.

Reviewer 3

The reviewer said the project clearly supports VTO EEMS objectives, and the breadth of transportation systems that POLARIS covers inevitably overlaps with the goals of the EEMS program.

Reviewer 4

The reviewer confirmed POLARIs is a very relevant tool and the project has clearly shown several existing projects are using it.

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

Reviewer 1

The reviewer stated the project is equipped with a large number of resources, but this is reasonable for such a major undertaking by a very large project team.

Reviewer 2

The reviewer felt the annual funding is sufficient to support more than a dozen highly trained/experienced FTE staff, or dozens of part-time researchers. The funding is sufficient to support the number of entities listed and allow for the necessary collaboration.

Reviewer 3

The reviewer remarked the budget seems reasonable. The amount of funding for the project is quite large but this is reflected in the size of the POLARIS team, in the breadth of work and outputs, and the number of research partners that the project team engages with.

Reviewer 4

The reviewer said the team has enough resources to deliver the project.

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

Presenter

Brandon Heimer, Dominik Karbowski, ANL

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.

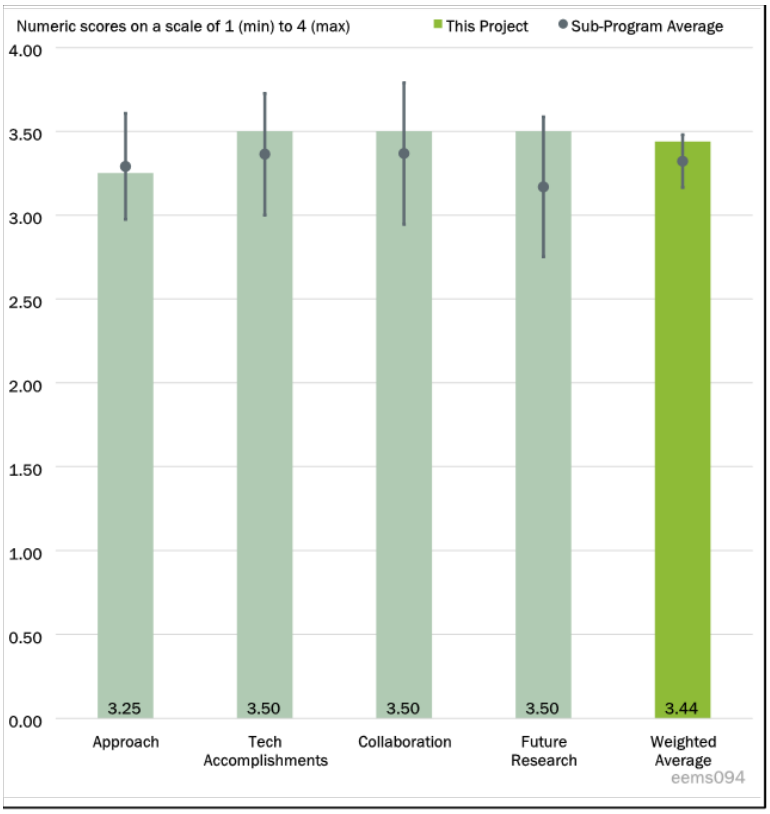

Figure 3-14 - Presentation Number: eems094 Presentation Title: Development and Validation of Intelligent Connected and Automated Vehicle (CAV) Controls for Energy-Efficiency Principal Investigator: Dominik Karbowski, Argonne National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer noted that it is not clear how this project stands alone from others. The need to quantify energy savings of scenarios in the real-world is a clear technical barrier. It is nice to show connections but in the slides and during the presentation it was hard to evaluate the project with clear boundaries to this specific activity. Of course, understanding the connection is important but a better job could be done in clarifying boundaries.

Reviewer 2

The reviewer commented the project does a very good job of tackling the issues related to CAV control with excellent demonstrations of the techniques developed. One issue, which may be outside the scope of the project, is how to deploy the techniques in production vehicles. It seems control strategies are needed that can work effectively just by communicating standard commands/signals rather than reaching into vehicle powertrains for direct control.

Reviewer 3

The reviewer mentioned the project does an excellent job of addressing stated barriers. Project achievements are directly tied to stated technical barriers: improving CAV energy efficiency for diverse powertrains and evaluating CAV energy use by defining test scenarios and methods.

Reviewer 4

The reviewer stated the project laid out the important groundwork to eventually overcome all planned technical barriers. Even though the principal investigator (PI)is confident the project will achieve all its goals, there is concern over one really hard barrier: "Real-world implementation requires diverse experimental vehicles and new test procedures" As a result, this barrier might take longer to resolve than originally planned.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer remarked the team clearly demonstrated progress in testing CAV methods including demonstrations in lab and on track with XIL. However the energy benefits discussion was hard to follow during the presentation and the slides do not support a clear understanding.

Reviewer 2

The reviewer said the team provided an excellent demonstrations of the project deliverables. The project is on schedule.

Reviewer 3

The reviewer noted the project team achieved impressive validation results compared to simulation across a wide variety of scenarios thanks to automated test procedures in simulation and XIL. Technical maturation was very comprehensive as it grew from simulation-only to dynamometer to track, and results at each stage showed very good understanding and control of all the test parameters. The technical findings are also well-explained in the slides. Further, the adaptive cruise control (ACC) engagement analysis is intriguing. Could this type of analysis be applied to help define an operational design domain (ODD)? It is crucially important that vehicles be able to recognize when they are outside their ODD as well as within it and that this be done with sufficient time if the systems require human intervention. Finally, it is unclear if the energy-evaluation test methods or test scenarios (or even just lessons learned) are being promulgated anywhere outside of ANL.

Reviewer 4

The reviewer expressed the project made planned progress. The preparatory work under "Math-to-lab-to-road" is positive, and convincing. The project results feed into other EEMS projects as subtasks (listed on Slide 4). Such subtasking is useful to achieve more effective execution of the project, and it is shown in the accomplishments to date.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer said the team seems to be well integrated, and coordination with the PI seems strong.

Reviewer 2

The reviewer commented the project has an excellent group of partners with a logical division of labor and good processes for transferring work.

Reviewer 3

The reviewer asserted the collaborations with Clemson, University of South Florida, and ACM appear very strong.

Likewise, the General Motors (GM) cooperative research and development agreement (CRADA) is very encouraging, although the scope of the CRADA is unclear. Does it cover just the GM-provided data on ACC engagement, or is GM also interested in implementing the algorithms developed by the PIs of this project?

Reviewer 4

The reviewer observed the project has strong partners that seem to coordinate well. It is important to have not only academic partners (four of them) but also the key industrial partner (GM) which provides real vehicle data for verification of simulations.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the proposed future work, including the on-track real-world testing, is appropriate and does support achieving the project targets.

Reviewer 2

The reviewer said the project's next steps are well defined and the work appears on track to meet the project goals.

Reviewer 3

The reviewer noted the proposed future work is a logical evolution of research and progress made to date. Given the project's progress and strong performance from simulation to road testing, it would be good to see a stronger emphasis on potential technology transfer.

Reviewer 4

The reviewer mentioned the proposed future research is clearly defined and challenging, yet achievable. Specifically, the idea of implemented AI based CAV control is well-received. It is believed that the team plans to employ a Reinforcement Learning (RL) based controller, which is indeed a popular method of on-line intelligent control. It is recommended the team assess how much data is needed to control CAV by RL to reduce the amount of trial and error typical of RL algorithms. It is further recommended that combining different XIL (anything in the loop) needs to be analyzed carefully as such systems can cascade down much more uncertainty than expected, sometimes resulting in outcomes much worse than expected in preliminary experiments.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer maintained that quantifying energy benefits in real-world scenarios is critical for adoption of CAV techniques in future vehicles.

Reviewer 2

The reviewer commented CAV controls activity is central to EEMS technology development, of which CAVS is one of the pillars. The work is necessary to make CAVs viable and is useful for not being proprietary, as most CAV activity currently is.

Reviewer 3

The reviewer remarked the project seeks to quantify and improve energy efficiency of CAVs, which aligns with EEMS goals.

Reviewer 4

The reviewer confirmed the project is highly relevant to the goals of EEMS as it studies how to improve energy efficiencies of connected and automated vehicles.

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

Reviewer 1

The reviewer noted the team clearly has the technical and facility resources necessary to achieve the milestones.

Reviewer 2

The reviewer said the project appears well funded, with no delays due to lack of resources.

Reviewer 3

The reviewer affirmed that resources appear sufficient since the project is on schedule and meeting its deliverables.

Reviewer 4

The reviewer stated the project resources are sufficient to achieve all proposed milestones.

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, ORNL

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.

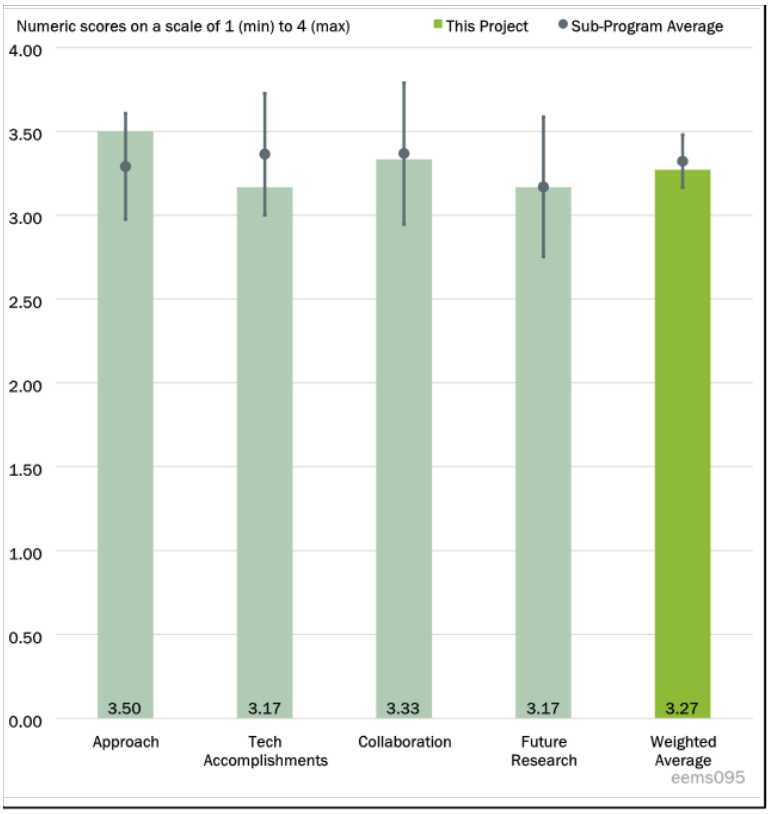

Figure 3-15 - Presentation Number: eems095 Presentation Title: Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use Principal Investigator: Timothy Laclair, Oak Ridge National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer mentioned the researchers identified clear barriers and objectives in developing vehicle based optimization relying on traffic signal timing information. It is unclear whether the team assumptions about DSRC/cellular vehicle-to-everything (CV2X) radio communication range are correct (100-200m); this seems quite short unless in dense downtown type environments. The challenges of cellular backend database management are also good to note.

Reviewer 2

The reviewer commented that assuming Slide 6 has a typo and the actual milestone date for functioning speed control algorithms is September 2022, project milestones appear to be on schedule and achievable. The last milestone occurs in March 2023. Is that really the last milestone before the project ends in September 2023? Also, the control algorithm is scheduled for deployment to Shallowford Road by March 2023; the project team may want to add a milestone review with City of Chattanooga to ensure the state/local DOT has reviewed and is comfortable with the deployed software.

Reviewer 3

The reviewer stated the project is using a sound approach, employing simulation, hardware in the loop, and on-road testing to develop and analyze the potential of cooperative traffic signal and vehicle operations to save energy.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed good progress in speed control strategies. The results of signal timing effect are not very clear, although the test of RyThMiCCS is good to see.

Reviewer 2

The reviewer noted the slides do a poor job summarizing the technical efforts investigated. Part of the confusion seems to stem from inconsistent/unexplained nomenclature. For instance, the bi-linear and queue-aware eco-driving algorithms are introduced in the slides without any context about what they are (centralized/cellular or decentralized/direct communications), albeit it was eventually verbally reported that they are both decentralized control algorithms. Likewise, it was only verbally reported that the centralized control was a "simple baseline algorithm." On Slide 14, it would have been helpful to show performance plots side by side (or on subsequent slides) rather than through PowerPoint animation (which was only visible during the AMR presentation). There was also no clear takeaways about which demonstrated the best performance (although after reviewer questioning, it was verbally reported as distributed algorithm with queue prediction). On Slide 15, tables and figures are not consistently labeled with axes and units, which muddies the technical impact of the work. The technical work may be excellent, but the presentation of it was rather sloppy. Finally, assuming the tabulated technical results on Slide 15 are % energy savings, the results appear promising even for low penetration rates and the implementable queue. Is there a technical explanation for why eastbound and westbound results are significantly different from each other?

Reviewer 3

The reviewer remarked the team is making good progress on the technical accomplishments and milestones. One area that the team cited as having some uncertainty is the readiness of the CAVE laboratory environment.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer said the project exhibits appropriate team members and seemingly good coordination by team leaders.

Reviewer 2

The reviewer noted that while Toyota is listed as a partner, it seems the company is primarily participating by supplying the test vehicles. There were no references to active collaboration with Toyota, nor any interest cited in furthering the development effort. The same can be said for Cubic, in that their equipment and maybe IT support is being used, but it is unclear how involved the company is in the research or its findings. In contrast, Chattanooga seems like a more involved partner, as the tests took place on active roads.

Reviewer 3

The reviewer mentioned the team includes members from the automobile OEMs (Toyota), the traffic signal control equipment vendor community (Cubic/Gridsmart), and a local transportation agency (City of

Chattanooga). This diverse team is very important in both the development and demonstration phases of the project. If successful, these team members are also key for outreach on further advancing this topic.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer asserted the project has a clear and appropriate future work plan that seems likely to enable the team to achieve its targets.

Reviewer 2

The reviewer expressed the project has identified some major challenges and barriers for future research, mostly related to interoperability and the complexity of deploying such new technologies. However, the proposed future research is focused predominantly on refining the algorithms and does not address these deployment challenges. It is important that the proposed research not become overly academic and insufficiently demonstration-focused.

Reviewer 3

The reviewer felt the future work is supportive of the project goals and includes leveraging work from other EEMS projects (EEMS101 and EEMS061).

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer suggested that integrating CAV functions in real-world traffic corridors will require integration with signal control to some degree. This project addresses that need.

Reviewer 2

The reviewed commented the use of controls and communications to improve energy use of CAVs very much aligns with EEMS goals.

Reviewer 3

The reviewer said the project is very relevant to the EEMS program and is developing and testing vehicles that interact with the traffic control system to operate in a more fuel friendly manner.

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

Reviewer 1

The reviewer stated the team has the resources needed to complete the project.

Reviewer 2

The reviewer confirmed the project appears sufficiently funded and staffed; its milestones have been achieved on schedule.

Reviewer 3

The reviewer mentioned the resources appear to be adequate to accomplish the project goals.

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, ANL

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.

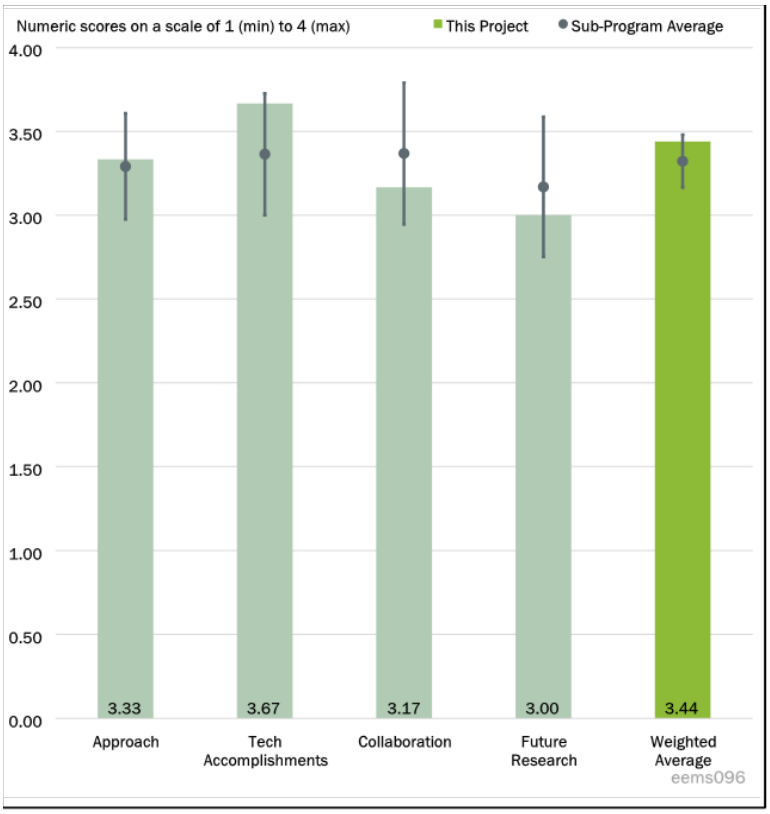

Figure 3-16 - Presentation Number: eems096 Presentation Title: Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies, Sensors, and Connectivity Principal Investigator: Thomas Wallner, Argonne National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented the project is well designed and ingenious in extracting as much information as possible given limitations on available information, which is mostly proprietary.

Reviewer 2

The reviewer offered that feedback on the testing framework is compiled in June 2022, but then is not delivered until September 2023. The project team may want to move the latter milestone earlier, if possible, as the engagement with external communities should happen as early as possible to: 1.) ensure alignment, and 2.) not miss timely opportunities to provide input.

Reviewer 3

The reviewer stated the project goal is unclear. Is the primary/final focus on data itself, analysis results of the collected data, or some form of a synthesized model for connected and automated vehicles? On the "APPROACH" slide, the last box states "Experimental Testing and Evaluation Methodology Investigation". However, I do not see sufficient details for this box itself, other than three boxes that lead to this one.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer remarked the technical progress has been impressive. Starting almost from scratch, the team has done great work in setting up the test properties and acquiring the data needed.

Reviewer 2

The reviewer noted the new collected datasets of production (Tesla, GM SuperCruise) L2+ features should be very useful to cooperative driving automation (CDA) researchers. The list of collected signals looks quite comprehensive; if radar/lidar and object tracking lists are also recorded, these types of datasets may also have great relevance for USDOT safety researchers. In addition, NREL's recruitment of shared data from Locomation and Cummins will undoubtedly be highly sought after, as OEM data is usually very difficult to obtain. The sensor data collection effort highlights how models can vastly differ from reality if modelers assume manufacturer specs/descriptions at face value. Moreover, manufacturer characterizations may take place in very different operating environments relative to where they are actually deployed. Such findings demonstrate the high value of projects like these. Lastly, testing standards definitely need to be tightly plugged into SAE standards development efforts.

Reviewer 3

The reviewer observed that progress shown on the "MILESTONES" page does not seem to perfectly match the progress implied in the Budget section, i.e., expended budget so far. It appears like more than one-third of the total tasks is still remaining.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer noted excellent collaboration between industry (medium-/heavy-duty) and national labs and among the labs. Most of the required partners for success are onboard.

Reviewer 2

The reviewer asserted partnerships among the national labs appear very strong. It is recommended that the team also make sure the SAE standards participation is equally as strong.

Reviewer 3

The reviewer stated it is fascinating that the project team has already established the connection with a couple of partners for MD/HD duty connected/automated vehicle data collection. There is a question as to whether the team has a test and evaluation plan for data collection with Cummins Inc and Locomation? For example, how many runs does the team plan to conduct? Will the data collection be conducted during actual business operations, or will this be a separate test run just to collect the data? Does the team have any evaluation matrix defined (this is needed to determine which data should be collected)?

Especially for the data collection plan with Locomation testing, it should be noted that the Operational Design Domain (ODD) of the Locomation testing includes only ideal conditions (e.g., four or more lanes with a shoulder, free flow, good weather, no physical obstacles (such as tolls and work zones), etc.). With that in mind, if the project team's intention is to collect the data for various traffic conditions, there should be an

additional effort to design additional cases for this purpose. Lastly, the Locomation testing this year will likely use a human driven lead truck followed by an L2 truck (not L4/L5).

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer state next steps are a logical continuation and extension of the project work done to date.

Reviewer 2

The reviewer commented that for the connectivity characterization, the team should first review what US DOT (will have) released for Intelligent Transportation Systems—Joint Programs Office (ITS JPO) CV2X testing data and analysis to avoid reproducing work. It would also be helpful to begin identifying and connecting with potential end users to understand how they might use this data. For instance, do users envision POLARIS updating models, or is this mostly data to release to university researchers? Will MPOs be building their own analysis tools, or is this for regulators trying to better understand performance of these technologies?

Reviewer 3

The reviewer remarked the proposed future research is defined clearly enough. However, it would be challenging to complete at least two of the future work elements. For M/HD data collection and testing, it appears the team is still doing the negotiations with the selected partners, which will take lots of effort and time. This is true especially if those negotiations are to result in a test and evaluation plan. In addition, the project team seems to lack understanding on the Locomation testing plan. For expanding sensor characterization to connectivity, it may be challenging to include C-V2X unless the project team already has an established environment for this.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer deemed the project relevant to EEMS and the connected autonomous vehicle technology pillar. It also supports the Vehicle Analysis program objectives with real-world data.

Reviewer 2

The reviewer stated the project collects real-world hardware data to refine and reduce variabilities in modeling and simulation efforts, which is a very desirable activity to reduce modeling uncertainties as the technologies mature.

Reviewer 3

The reviewer concluded the project supports overall VTO subprogram objectives. In particular, the results should be useful for two subprograms (Vehicle Analysis and EEMS).

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

Reviewer 1

The reviewer said the funding appears adequate. The researchers have done an excellent job of maximizing "bang for the buck".

Reviewer 2

The reviewer commented the resources (funding, staffing, materials) appear sufficient, as the project has already begun producing actionable data.

Reviewer 3

The reviewer intimated that it is difficult to tell if the resources are excessive, sufficient, or insufficient just based on the presentation content. However, the reviewer has concluded that the funding is more than sufficient to cover what was presented.

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

Presenter

Andrew Duvall, NREL

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.

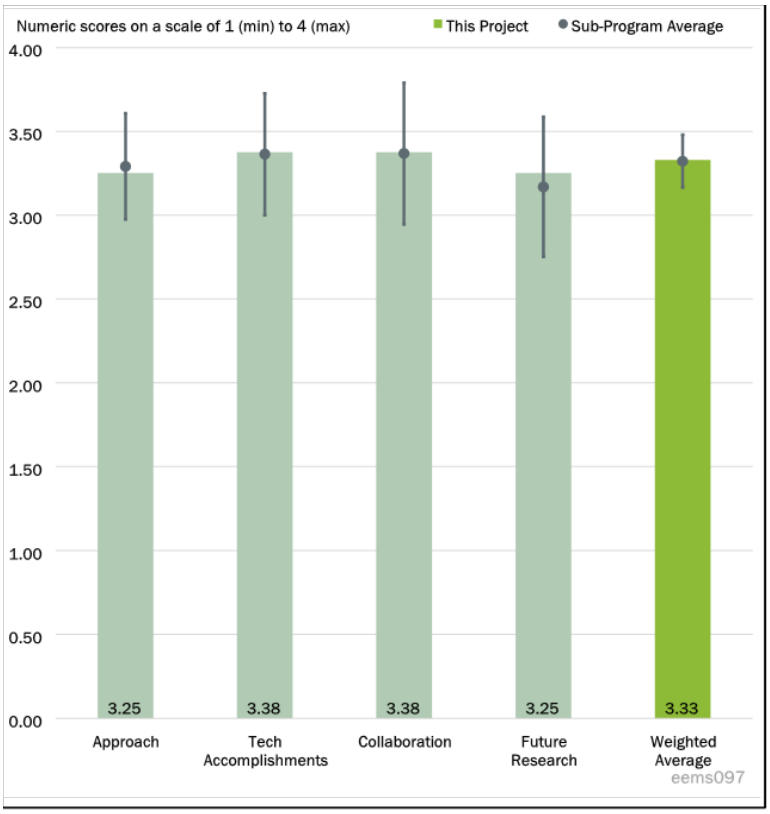

Figure 3-17 - Presentation Number: eems097 Presentation Title: Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE) Principal Investigator: Andrew Duvall, National Renewable Energy Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer indicated that researchers have a seemingly well designed approach and have made good progress and reaching the project objectives.

Reviewer 2

The reviewer commented that the project augments SMART Mobility by enhancing workflow models to include micromobility based on real-world data. It addresses technical barriers working towards ranges of micromobility assumptions and transit interconnection while accounting for location and demography. Within SMART Mobility efforts, this project integrates with BEAM CORE (informing scenario integration), freight (microfreight), and curb space (curb activity impact of micromobility and microfreight).

Reviewer 3

The reviewer stated the technical barriers were identified in Slide 2, with two primary barriers: uncertainty in future demand scenarios for micromobility, and a better characterization of MEPs. The first issue was nicely addressed, specifically with the consideration of low/medium/high scenarios (Slide 3) and the discussion of low and high possibilities of energy impacts (during Slide 8). The second, involving the characterization of MEPs, was not discussed in the remainder of the presentation.

Reviewer 4

The reviewer mentioned the project appears to be logically planned and the timeline is reasonable. More detail regarding the microfreight task would be appreciated. For instance, what are the volumes and weights of the micro-freight packages? What is the max capacity of micro-freight per scooter? How does the modeling account for multi-stop routes? Does the microfreight energy consumption modeling include increased weight of the microfreight load and increased aero-drag due to microfreight packages? On the demand side, what is the current count or percentage of package deliveries that would qualify for microfreight delivery?

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer noted the authors have made good progress in moving from model development to scenario implementation, with modeling for several cities, and data from a larger group of cities (despite the limited amount of data in the area).

Reviewer 2

The reviewer stated the project has progressed in all five tasks. In Task 1, the first publication in energy bounds estimation for shared mobility was developed along with ongoing conversations with the BEAM and POLARIS teams. Task 2 analyzed micromobility trip data from docked bikeshares in 11 cities and dockless bike/scooter share data in 10 cities. Task 3 established a behavior model that estimates how people chose micromobility modes. Task 4 evaluated micromobility operations for energy optimization including e-scoter in-field data acquisition. Task 5, drew microfreight scenarios from cargo bike pilots in Seattle and NYC.

Reviewer 3

The reviewer expressed the breadth of technical accomplishments is very impressive, including the peer-reviewed publication for energy demand characterization of shared micromobility options. The accomplishments nicely complement the project objectives identified on Slide 3. One suggestion is that given the importance of extending the results to other cities, it would be good to see an explicit treatment of the calibration to cities (and validation if possible).

Reviewer 4

The reviewer noted the impacts of covid are understandable and valid but the team has the option to make assumptions regarding the missing data and push forward. The project may benefit from a workshop where subject matter experts and experimenters talk through hypothetical scenarios and modeling assumptions, and results are discussed in detail with stakeholders. This exchange would be useful for helping the team to validate its assumptions and get feedback from stakeholders.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer said the team incorporates a good group of researchers from national laboratories, U.S. Environmental Protection Agency (EPA), academic partners, and cities. The work is also being incorporated into BEAM. It will be exciting to see how the model can be integrated into city planning as it continues to develop.

Reviewer 2

The reviewer asserted good collaboration among NREL, ANL, and PNNL in addition to several non-lab research partners including University of Colorado-Boulder, EPA, USDOT, University of Tennessee, and Portland State University. Additionally, the MITIE team continues to engage with industry stakeholders and identify data sources and complimentary partners. The team collaborative relationships are essential to gain access to data and to understand needs and trends.

Reviewer 3

The reviewer commented that efforts of the team across the national laboratories were well documented, and the portions of the project and contributions of the various researchers were nicely articulated during the presentation. However, the collaborations with other external stakeholders are not entirely clear. Besides data acquisition, it was not clear how stakeholders such as academic institutions and industry stakeholders are involved with the project and whether there are other types of contributions. It would be useful to be more explicit about the types of collaborations that are happening with the project team (even in the backup slides, that is, Slide 23, this is not clear).

Reviewer 4

The reviewer said the team appears to have attempted to collaborate with a large number of stakeholders on this project.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the researchers have made good progress in the scenario development for micromobility, and are meeting the project milestones. It appears that the authors have a few more tasks to accomplish, but are well on their way to successful project completion. It would be interesting to see what work the authors would propose beyond done in the current project.

Reviewer 2

The reviewer noted the fiscal year (FY) 2022 milestone includes development of micromobility scenarios for smaller representative cities while continuing in-field data collection. The FY2023 milestone includes the final report with estimation of net energy use of micromobility and energy consumption and sensitivity analysis on the tested micromobility vehicles.

Reviewer 3

The reviewer observed the proposed future research seems rather brief and primarily focused on wrapping up the analysis and producing a final report. It is suggested that the project team explicitly consider dissemination of findings (and perhaps even provide custom modeling efforts) to interested stakeholders (as was discussed in the question and answer). On Slide 19, the project identifies the potential to address mobility for equity considerations with micromobility; this can be an important aspect of stakeholder engagement and would align with DOE objectives to address equity issues in mobility.

Reviewer 4

The reviewer stated the future work stated appears to be within the scope of the current project. A couple of bullets on logical follow-on targets for investigation are also suggested. For instance, microfreight can also be delivered by unmanned aerial vehicle (UAVs); how does scooter microfreight energy consumption compare to UAVs? How does microfreight delivery energy consumption change when the scooter is autonomous?

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer noted the area of micromobility is going to be an important piece of developing an overall strategy for improving mobility options going into the future. Micromobility will also be important in developing strategies around first and last mile solutions for bus and rail transport users. This project should provide some important information on filling the gaps on micromobility. The authors also have a nice summary slide on this topic in the presentation.

Reviewer 2

The reviewer commented that the research supports EEMS by advancing technologies and systems to improve MEP when adopted at scale and exploring modes whose energy impacts have not been well studied. In turn, micromobility with clean energy technology to move people and goods can reduce energy costs and increase energy security.

Reviewer 3

The reviewer said the project aligns with VTO objectives.

Reviewer 4

The reviewer confirmed the work is relevant to the VTO EEMS mission.

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

Reviewer 1

Overall, the reviewer stated the project has sufficient resources for completion with the potential for future expansion assuming additional funding down the line.

Reviewer 2

The reviewer thought the budget seems appropriate for the 3-year micromobility project scope and multiple partner involvement.

Reviewer 3

The reviewer mentioned the budget of the project seems commensurate with the modeling efforts and size of the project team.

Reviewer 4

The reviewer remarked the project shows evidence of making reasonable progress based on current funding.

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

Presenter

Victor Walker, INL

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.

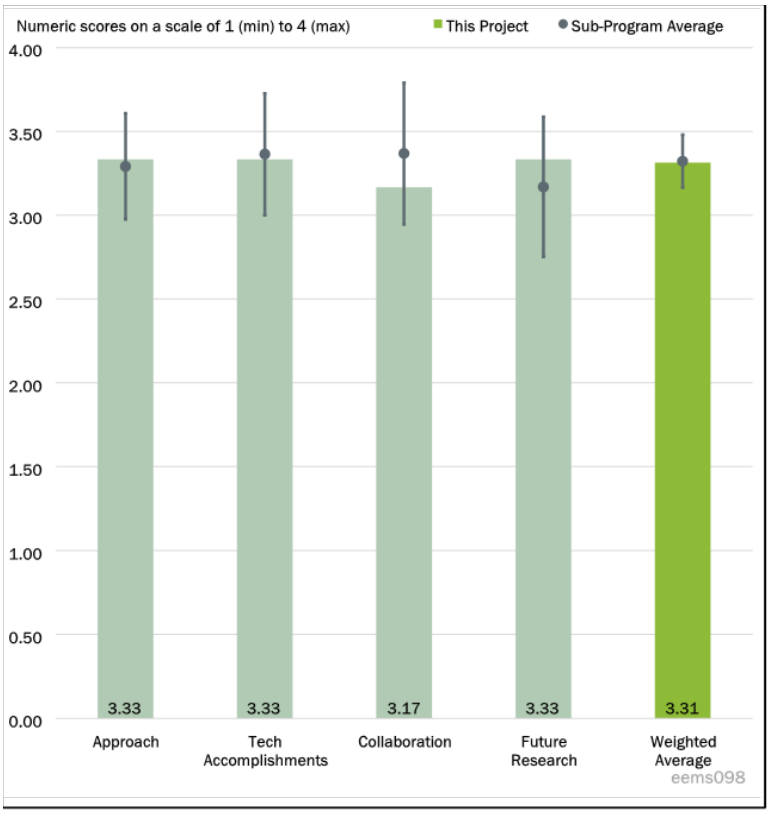

Figure 3-18 - Presentation Number: eems098 Presentation Title: Optimizing Drone Deployment for More Effective Movement of Goods Principal Investigator: Victor Walker, Idaho National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that the project initially gave the impression that it its scope was too large; however, the practical insights that have been developed to date indicate that the project plan has its merits.

Reviewer 2

The reviewer stated the approach is to develop a detailed test plan for drone testing, identify primary scenarios, complete environmental and energy testing of drone hardware, gather data for route optimization, and investigate various operating scenarios. This is a sound plan and covers various aspects of drone deployment and use.

Reviewer 3

The reviewer said the project approach appeared well thought out in addressing technical barriers of drone technology and gaining greater understanding of drone behavior and delivery applications. The project timeline appears to have been well planned with completion in sight later this calendar year. As outlined by the PI, the approach involved a combination of open-environment, lab-based testing for input into simulation models and eventual validation of those models. The PI appeared to address previous reviewer comments for ensuring industry collaboration for test protocols and simulations and drone selection (small/large and rotary/vertical take-off and landing [VTOL]) for most relevant real-world application and market representation.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer remarked the technical accomplishments are impressive from the standpoint that the work include data collection, model formulation, scenario development, and analysis. Moreover, the insights generated have utility for real-world applications.

Reviewer 2

The reviewer noted the technical accomplishments are sound and include drone instrumentation and field testing on a broad range of operations, energy data analysis, weight and speed impact studies, and evaluation of operating scenarios.

Reviewer 3

The reviewer expressed the project has made significant technical progress towards original objectives as presented by the PI. The PI presented interesting findings on drone energy use overall, as well as insights for drone sizes and drone types. The results also included interesting insights on drone speeds and payloads for optimal energy use, possible preferential or infeasible duty cycles/routes for rotary and VTOL drones, and how mixed fleets may offer greater utility and lower energy profiles. Finally, the business-business delivery scenario insights are useful in the application of different drone types and understanding of alternate advantageous charging options.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer mentioned that collaborations appear to be very effective for addressing this problem space.

Reviewer 2

The reviewer noted the team has shown broad collaboration and cooperation with primary partners such as Wing, Spright, Interpath, Wingcopter and CMU, as well as various other supporting partners such as Workhorse, UPS, Virginia Tech, etc.

Reviewer 3

The reviewer commented that overall, the project has significant collaborative partners across manufacturers, service providers, delivery companies, government institutions, and universities. While the PI did confirm industry partner collaboration regarding model data, additional specificity on partner contributions across project elements including testing, simulation, and validation would have been useful.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the future work that is outlined is logical and important for this activity. The validation and open air experiments are especially important.

Reviewer 2

The reviewer noted the proposed future work plan focused on modeling, validation, and communication is well-motivated.

Reviewer 3

The reviewer indicated that the remaining proposed research activities under the project appear reasonable in accomplishing project objectives. Remaining activities include completion of model integration, Scenario 3 (delivery as a service) completion, simulation validation through open-air testing, and outreach through partners. It is assumed the final report will include discussion and insights on the many research challenges encountered on the project including drone selection, environmental impacts, metrics development, partner requirements, and additional data/sensor requirements for future drone research efforts.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said drone delivery has relevancy in the transportation market place and DOE should understand its energy consumption characteristics to be able to predict future benefits/impacts and possible technology development needs.

Reviewer 2

The reviewer observed the project supports the overall VTO subprogram objectives of minimizing energy consumption for the movement of people and goods. The study has identified certain scenarios wherein a combination of large and small drones would be more optimal than using traditional delivery trucks. This is a powerful result, especially with the quantitative supporting information the authors have provided.

Reviewer 3

The reviewer felt the project is relevant to VTO's EEMS subprogram and fits under the Multimodal freight (MMF) pillar of the Systems and Modeling for Accelerated Research in Transportation

(SMART) Mobility Consortium. Specifically, this project is providing significant insights on future drone energy use and utility for the U.S. freight industry.

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

Reviewer 1

The reviewer said the project has been very productive with the current resource allocation.

Reviewer 2

The reviewer noted the approved funding is appropriate for this project.

Reviewer 3

The reviewer confirmed the resources for this project appear to be sufficient for achieving project objectives and significant research results within the original project timeline.

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, NREL

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.

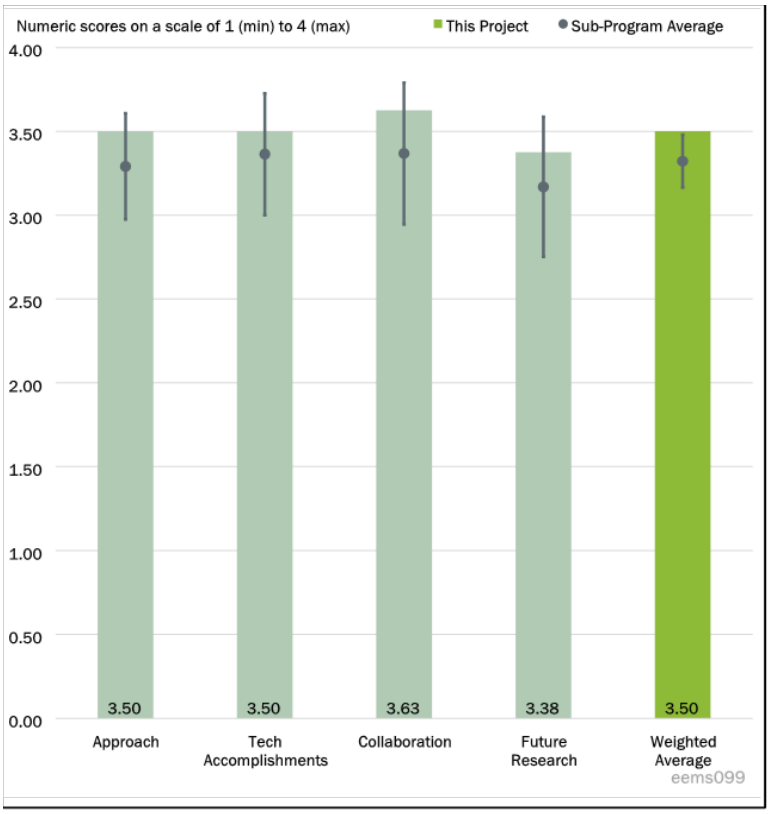

Figure 3-19 - Presentation Number: eems099 Presentation Title: Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems Principal Investigator: Venu Garikapati, National Renewable Energy Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer noted that MEP provides a unified framework for quantifying mobility and energy impacts of transportation investments and technologies. The new capabilities of MEP, such as variation by time of day and multi-modal routing, improve the utility of the metric. The person-based Individual Experienced Utility-based Synthesis (INEXUS) metric is an interesting concept, and is intended to complement the location-based MEP metric. There are three related but different types of INEXUS metrics. It will be important to clearly explain the purpose and interpretation of these different INEXUS values.

Reviewer 2

The reviewer commented that this work is an important tool for connecting the MEP concept in a practical way with the needs of policy makers/decision makers. The timeline is reasonable, assuming that infrastructure investments are sustainable, where this analysis will be useful.

Reviewer 3

The reviewer stated the authors seem to have a well thought out approach to performing the work. The team has made good progress in enhancing the development of the MEP calculations. These data analyses are worthwhile in breaking down technical barriers in understanding questions related to mobility.

Reviewer 4

The contractor remarked the work plan appears to be appropriate and well-focused. This area is so important that getting in-depth technical review by outsiders should be part of the activity. Part of the plan that may be missing is to dumb down some of the technical presentations to more clearly explain critical relationships that are included in the work. Does the project produce technical papers to explain the processes and cost functions that are being applied?

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer commented the project team has made several improvements to the MEP metric, which increase the utility of the metric. The interactive dashboard that has been developed will be a very useful tool for comparing and visualizing the results. Also, can data from the Whole Traveler survey be used to support/augment the estimation of the energy decay coefficient?

Reviewer 2

The reviewer stated that progress to date is good in relation to the planned activities. The SMART/MEP enhancements planned for FY22 (emissions, safety), however, may involve much more time/resources to be successful.

Reviewer 3

The reviewer observed that the performance metrics have been met for this project, or are on track to be met. The milestones for the second year appear to be completed or on track, and the project appears to be on the way to successful completion in the third year.

Reviewer 4

The reviewer noted the project is productive in advancing the evolution of the MEP metric.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer remarked there are collaborations with a variety of organizations (government, non-profit, university, and industry). The inclusion of MEP in American Council for an Energy-Efficient Economy's (ACEEE) Scorecard and the commercialization project with Streetlight Data are impressive.

Reviewer 2

The reviewer felt that team collaboration to date seems effective. Collaboration with EPA will be needed for FY22 to link emissions enhancements with existing tools (i.e., MOtor Vehicle Emission Simulator [MOVES] model).

Reviewer 3

The reviewer mentioned the team has good coordination and cross collaboration. The team is a strong mix of national laboratories, state DOTs, and industry partners. The fact that the team has run the calculation for over 100 cities suggests that the results could be useful to a wide range of outside entities. It will be interesting if the researchers can continue increasing the number of partnerships with other more regional government entities or cities as the project evolves.

Reviewer 4

The reviewer noted that collaboration with partners appears to be generating strong return on investment for expanding inclusion of MEP in DOE's models and for application of the MEP to real-world problems.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer said the proposed future research listed on Slide #20 is focused on continuing/completing the progress made to date. It is unclear whether and how the remaining challenges and barriers listed on the previous slide will be addressed.

Reviewer 2

The reviewer stated that future research goals, including incorporating emissions, infrastructure quality and safety, seem overly ambitious—at least if done well in a way that will be robust and reliable. Livable cities, especially in the European Union, have focused attention on noise. Adding acoustic emissions to project may be useful as a long-range goal.

Reviewer 3

The reviewer commented that the researchers seem to have a good plan in moving forward with their work on the individual-level MEP metric, enhancements on emissions and safety, and incorporation of the MEP calculation into POLARIS and BEAM.

Reviewer 4

The reviewer noted that the 'carry out assessment of additional factors to include the MEP metric calculation' is of strong interest. This work deserves to be validated and refined further.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer commented that the ability to quantify and compare mobility and energy impacts of transportation investments and technologies is critical for the VTO, the EEMS subprogram, and other relevant agencies in assessing those investments and technologies.

Reviewer 2

The reviewer remarked the MEP metrics are relevant for establishing a comparative basis for assessing mobility needs in urban areas using the SMART model.

Reviewer 3

Overall, the reviewer noted this metric is showing a widening influence, and is having a useful impact on characterizing mobility. Given the importance of understanding mobility in a changing landscape of transportation options throughout the country, this work appears to be well positioned to support DOE's overall objectives.

Reviewer 4

The reviewer said the project is highly relevant to evaluating energy productivity of transportation systems.

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

Reviewer 1

The reviewer mentioned that based on project efforts, both already made and planned for the future, the level of project funding is reasonable.

Reviewer 2

The reviewer believed the resources have been sufficient to date, but there are concerns that the future work on model enhancements may require additional resources

Reviewer 3

Overall, the reviewer stated that this project has sufficient resources for completion, with the potential for future expansion with additional funding down the line.

Reviewer 4

The reviewer deemed project resources are sufficient to reach the stated milestones. That said, the continuing development of this metric deserves additional funding by DOE.

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

Presenter

Chase Dowling, PNNL

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.

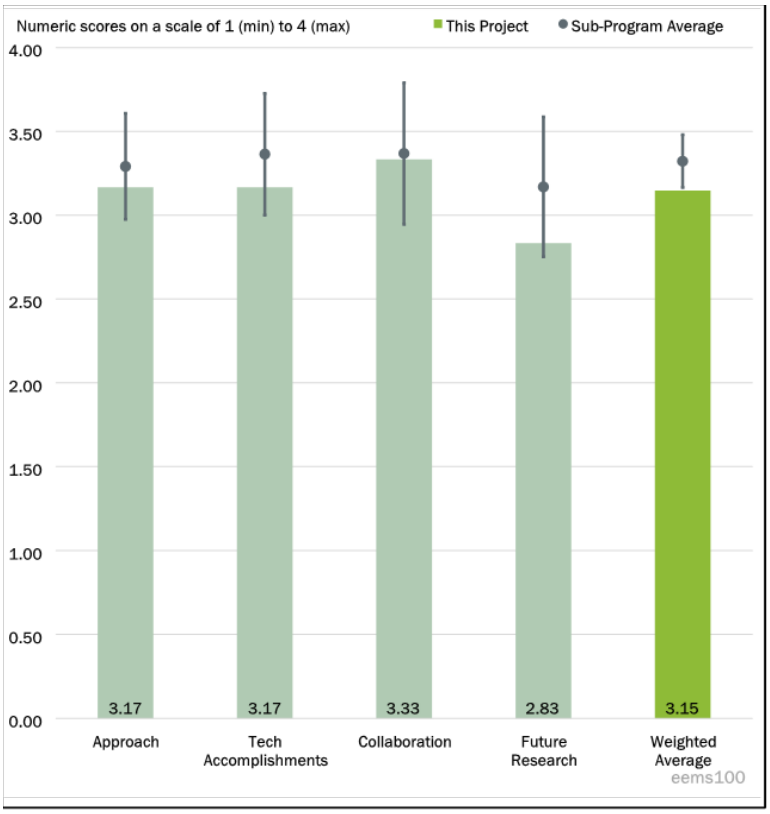

Figure 3-20 - Presentation Number: eems100 Presentation Title: Dynamic Curb Allocation Principal Investigator: Chase Dowling, Pacific Northwest National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer noted two milestones, M7 and M8, seem delayed, but the presentation does not address the benefit of the delay (e.g., the delay for M7 will double the number of participants). It is important to understand the benefits of the delays in order to justify them.

Reviewer 2

Overall, the reviewer felt the project is well designed to take an initial step toward addressing the impacts of curb use on traffic flow. However, it is not clear if the simulations that were conducted to develop the fundamental diagrams have been validated with real-world data. Additional information on the validity of the simulations of curb use would be useful.

Reviewer 3

The contractor stated the project addresses some interesting barriers: how to propose changes when A/B testing is not a feasible option, and how to have an adoption be seamless for drivers who might not be able to adapt to new technology. One additional potential barrier is adoption by local municipalities, which could be a challenge if the main reason to adopt policy changes would be advice from a research project. What kinds of evidence can the team produce that could convince local policy makers to adopt proposed policies, and what would be the payoff? How can the research recommendations be translated into payoff decisions by local governments?

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer stated that it is not clear how the financial burden to the jurisdiction (e.g., technology needed to measure, data analytics personnel, enforcement, and system maintenance) are considered in the optimization of the process of dynamic curb allocation. Is the benefit the same regardless of the jurisdiction size? What type of minimal infrastructure is needed to ensure it works as intended.

Reviewer 2

The reviewer noted the project is making good progress. As presented, the lack of the planned curb occupancy data from San Francisco may have an impact on schedule as new project partners are sought.

Reviewer 3

The reviewer comments the approach uses microsimulations with VISSIM to estimate vehicle travel on a simulated grid, and then macrosimulation environments (BEAM) to estimate energy use based on changes in policy. This is a reasonable, and the additional approach element that adjusts different zones for buses, etc. in individual grids can be used to explore how changes can be made and their different behaviors interpreted. There are still two concerns, one of which will be delivered in the June 30th milestone: how to validate the microsimulation data based on information gathered from tests. If the microsimulation agrees, then the tool could be very useful. If there is a big difference, then there is a risk that the proposed changes might not be actualized, and the resulting policy will not pay off as expected.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated the project has a lot of moving pieces, but it seems it is under control. Once other members/participants (sensors/devices) are available, it will be important to see if the process continues to work as intended.

Reviewer 2

The reviewer expressed the team appears to have good collaboration and coordination. However, the team is also seeking a new local partner that can provide access to curb occupancy sensor data.

Reviewer 3

The reviewer commented the team has partners in Lawrence Berkeley National Laboratory, National Renewable Energy Laboratory, University of Washington Urban Freight Lab, Penn State University, and Lacuna (a startup). The simulator design, fundamental diagram learning techniques, usage of BEAM, and the optimization metrics, all come from these institutions. The optimization metrics could be enhanced with cooperation from cities, to understand how to provide metrics for success that would be convincing to adopt policies during engagement sessions.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer said a cost variable or simulation component should be considered in order to ensure it is a pragmatic approach.

Reviewer 2

The reviewer observed the results of the curb simulations are showing very little differences in traffic impacts for the various scenarios that were modeled. It is a bit unclear if the end product, the dynamic curb zoning application will have much user value if it cannot distinguish between various curb use options.

Reviewer 3

The reviewer remarked the proposed future research at this point is about understanding the potential for impact, and targeting application of the results for transition. Two items may be of interest to the team: 1.) validating changes that took place in a city, using historical and current estimates to show the changes on that city's topology; and 2.) establishing the potential energy payoff as a key metric for success, potentially allowing this as a reason for adoption.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer expressed the project is certainly relevant to VTO, and developing a framework and methods for implementation of a true dynamic curve allocation will assist many jurisdictions in the future. However, the project seems to have several budget implications that should be addressed. It cannot be assumed all jurisdictions will be able to afford and implement something like this. The team should consider how this could be designed in an equitable manner given all the implementation needs for the jurisdictions in the future.

Reviewer 2

The reviewer said the project is very relevant to the VTO EEMS program.

Reviewer 3

The reviewer commented the project contributes to overall VTO subprogram objectives in EEMS due to the joint consideration of both vehicle motion (micro) as well as energy use (macro) considerations.

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

Reviewer 1

The reviewer noted the project's budget seems to be sufficient at this time. The inclusion of different sized jurisdictions would be important in the future in order to better understand any future challenges (small towns versus Med/large cities). If this comparison is feasible, a larger budget might be needed.

Reviewer 2

The reviewer felt the project has sufficient resources to achieve its milestones in a timely fashion.

Reviewer 3

The reviewer stated the resources for the project are sufficient.

Presentation Number: eems101
Presentation Title: RealSim, An Anything-in-the-loop Platform for Mobility Technologies
Principal Investigator: Dean Deter, Oak Ridge National Laboratory

Presenter

Dean Deter, ORNL

Reviewer Sample Size

A total of five 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.

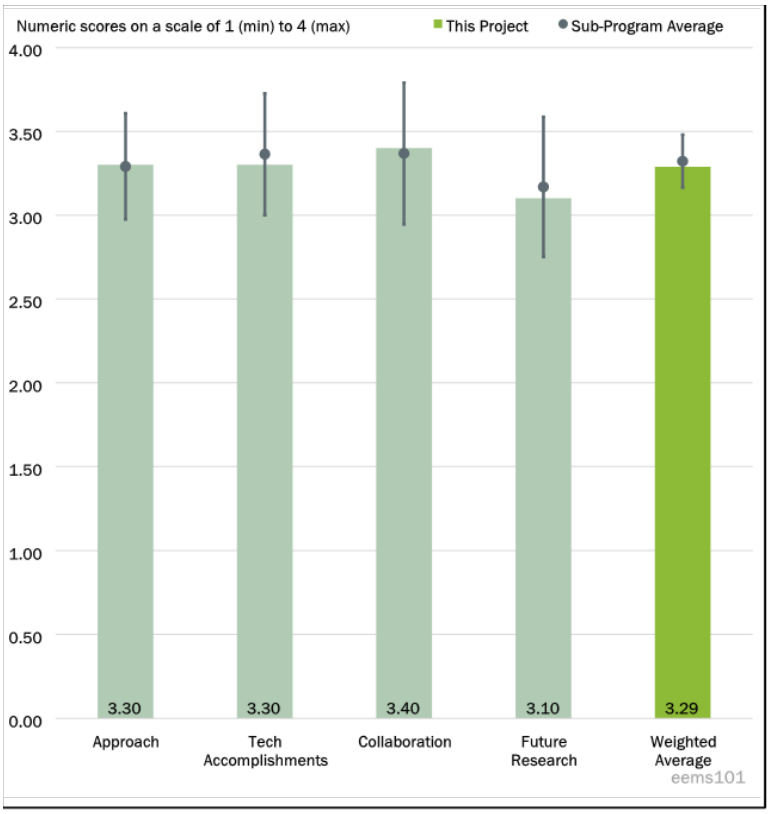

Figure 3-21 - Presentation Number: eems101 Presentation Title: RealSim, An Anything-in-the-loop Platform for Mobility Technologies Principal Investigator: Dean Deter, Oak Ridge National Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented the approach addresses the need for realistic simulation of connected and automated vehicle environments and applications. The barriers include the lack of standard tools and the computational requirements needed to develop simulated environments. The project is focused on overcoming these barriers, but the complexity of the simulated environment is still very challenging.

Reviewer 2

The reviewer noted the team has developed a sound approach to addressing this challenge by integrating sensors in the XIL and virtual environment 2.0, creating digital twins using the Real-Sim platform and validating the above using current on-road data from other EEMS projects.

Reviewer 3

The reviewer stated the overall scope of the project is to address the barriers of: 1.) modeling and simulation environment lack of inclusions for all scenarios, 2.) lack of standard co-simulation tools or hooks across vehicle and traffic environments, and 3.) computational requirements of complex environment simulation. Each of these seem well in line with several critical barriers related to the EEMS program. While quite a bit of the work is geared towards capabilities development, these capabilities are somewhat limited in the current research environment. It is not entirely clear how "all" scenarios will be addressed by the current research efforts without an incredibly large data storage and testing infrastructure, but the current effort does appear to provide some much-needed supplementary data. Future presentations could benefit from some specific priority

examples where the developed data-streams would help infill current data gaps. Some of these items might be out-of-scope from the existing budget, so it is understandable why certain more complex systems have been left to future/proposed work. Combining a real signal controller into the virtual environment is also a strong benefit to this work as it makes the transfer and applicability of DOE developed strategies very clear in terms of ultimate implementation and possible real-hardware limitations. While certainly known to the authors, this work will likely be increasingly difficult as more complex and integrated systems are developed, making emulation much more difficult. Although challenging, this work appears to provide a foundation from which to continue to expand and develop these techniques.

Reviewer 4

The reviewer observed the approach appears appropriately designed and is intended to be integrated or integral to other EEMS projects and outcomes. The development of the digital twin around real world traffic infrastructures looks to be a major component.

Reviewer 5

The reviewer perceived this project as an extension of the capability of VPPG by integrating more sensors modeling and digital twin elements. The proposed system architecture makes sense. Considering the complexity of the whole real-sim system, it is suggested that the research team better define the scope of the research and ensure the tasks can be completed within the timeline.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer remarked the project has accomplished much related to sensor integration on the vehicle side and signal phase and timing and traffic control integration on the infrastructure side. The vehicle and infrastructure components have undergone initial testing including digital twin data collection in Kane County, Illinois.

Reviewer 2

The reviewer found the team has achieved full emulation of camera/radar/lidar, XIL integration of traffic control devices, confirmation of APaCK-v and -i, and data collection for Randal Road.

Reviewer 3

The reviewer mentioned the project has shown strong accomplishments across the testing and emulation infrastructure required to perform a range of topics and validation experiments. While not totally clear, it is assumed that these capabilities will be adequate for the Task 3 objectives mentioned later in the presentation. Barriers related to computational expense appear to be partly addressed at this point since simulations are operational; however, it appears more insights to the specific balance of computational power versus expense and research value could be a supplementary task within this project. The inclusion of multiple microsimulation programs is a particular strength to these efforts as this ability will likely aid multiple researchers by allowing for an otherwise consistent testing interface and procedures. While still preliminary, it would also be helpful in future presentations to better detail some of the specific validation needs from Task 3 such that a mapping of capabilities and priorities to specific validation outcomes could be readily available. Overall, strong technical progress has been made, with execution building in the later stages of the project.

Reviewer 4

The reviewer stated the ability to perform virtual perception using methods aligned with how real perception hardware (laser imaging, detection, and ranging [LiDAR], radar, camera, etc.) work and function is key to the

whole CAV ViL approach. The team has demonstrated that virtual sensors can behave and perform just like real sensors. A big question is how does the "noise" or "jittering" of the (LiDAR) or radar outputs look in the virtual environment. Can imperfect perception signals be replicated?

The hardware stack build-up in the vehicle for perception and data collection is a pretty time consuming task.

Reviewer 5

The reviewer commented that considering the potential impacts from the pandemic, project progress (40%) makes sense. Increased efforts for the rest of tasks are expected to ensure the completion of the planned project. Also, it is a bit confusing about what "multi-layer digital twin" means in this project. Does it refer to "traffic layer" (traffic signal control in SUMO) and "application layer" (physical traffic signal controller)? It

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer observed the project requires collaboration and coordination across multiple EEMS projects whose applications will be testing under the simulation/digital twin environment. The ORNL team is partnered with ANL to accomplish the development of the simulation environment.

Reviewer 2

The reviewer said the team has shown good collaboration with other EEMS projects, ACM, and IPG.

Reviewer 3

The reviewer remarked the project shows strong collaboration across labs and with additional software vendors and testing facilities. Although mentioned in the comments, it is worth mentioning that connecting with an OEM for not only the validation of the specific projects, but also the testing/emulation capabilities would be beneficial. This may provide some perspective on how OEMs anticipate testing these systems in the future and highlight the crossover research as well as gaps where DOE capabilities could supplement industry efforts. It would also be interesting to see if any industry standards bodies or test procedure development groups could benefit from these research insights, so this type of collaboration is suggested as well.

Reviewer 4

The reviewer noted the project team is well coordinated with other national labs and EEMS projects and previous project outcomes.

Reviewer 5

The reviewer asserted it is good to know that both ORNL and ANL collaborate with each other in the project, which can well leverage resources from both laboratories. The inclusion of ACM and other stakeholders would definitely help move the project forward. As pointed out by the PI, the coordination of HiL testing seems to be a major hurdle, which requires attention across different project teams.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer observed the project has identified next steps for sensor integration and development of additional digital twin locations to support selected EEMS projects. This will be a very valuable tool for evaluating EEMS project applications under a variety of simulated scenarios.

Reviewer 2

The reviewer stated the proposed future work involving switching to OPS-CAR (ORNL Platform for Sensor and Control) factory radar sensor, developing traffic control stacks covering 6-8 intersections, completing digital twins, inertial measurement unit (IMU) emulation, establishing computational limits, and verification testing, are all well-motivated.

Reviewer 3

The reviewer felt the near-term future work has been detailed clearly, but later stages of the validation work are less clear. Specifically, some examples of DOE strategies to be validated and how they are supported by the developed experimental infrastructure would be helpful to better understand the overall scope of the future work. An indication of work additional to the proposed scope would also be insightful. For instance, does the research team expect to add more sensor technologies to the emulation or data collection platforms in the future, or would the majority of future work simply relate to executing the current system across a range of validation experiments? A deeper dive into the tradeoffs of data-structures and resolutions needed to emulate higher fidelity sensors would also be suggested as this might help prioritize the computational burden highlighted in the challenges section.

Reviewer 4

The reviewer expressed that switching sensors, namely radar, and changing out IMU is not a direct 1:1 swap. There will be a debugging phase that hopefully does not over consume the team's efforts. The C-V2x hardware seems like an interesting point to expand upon details for the future given that DSRC appears nearly dead.

Reviewer 5

The reviewer commented that it is not very clear about the specific and descriptive to-do list for Task 2 and Task 3. It seems to be a bit dynamic. Therefore, it is a bit difficult to judge how likely these tasks or targets will be accomplished.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said this project is very relevant to the EEMS program and provides a tool/mechanism for other EEMS projects to evaluate their proposed applications in a simulated/digital twin environment.

Reviewer 2

The reviewer remarked the project supports the VTO subprogram's objectives of developing tools and hardware to model vehicle/traffic scenarios to work towards minimizing transportation energy consumption.

Reviewer 3

The reviewer stated the work matches well with the objectives of the VTO EEMS program. Specifically, the integration of both on- and off-vehicle sensing is well suited to the overall scope and goals of the EEMS program. The project also seeks to provide real-world experimental platforms, data, and validation, which is key to the ultimate success and integration of DOE developed insights and technology concepts.

Reviewer 4

The reviewer mentioned the project is most relevant in developing and validating the virtual perception tools that are a further enabler to CAV ViL/XiL. The project integrates or relates to a number of other EEMS projects and will only help to accelerate the market introduction of the technologies for safety and energy reduction.

Reviewer 5

The reviewer noted the project is definitely related to the VTO subprogram objectives, especially EEMS. The development of mixed reality modeling/testing platforms is a cost-effective way to evaluate CAV technologies.

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

Reviewer 1

The reviewer stated the resources appear adequate to complete the project. If issues arise with funding or with complexity of the future development, an option would be to add funds or limit the number or scope of the digital twin experiments that will occur. However, it is unclear how much this would negatively impact the other EEMS projects preparing to test in the digital twin environment being developed under this project.

Reviewer 2

The approved budget of 3.58M for 3 years is appropriate.

Reviewer 3

The reviewer commented the resources appear sufficient for the current scope and baseline hardware creation, but may need to be increased as the project progresses into later testing stages and more complex hardware and software capabilities are needed. As mentioned by the presenters, the computational challenges related to this project are expected to grow as higher resolution sensing begins to be used more frequently. Furthermore, emulating these responses in the virtual environment will likely become more burdensome as well. The Task 3 funding may also need to be reevaluated depending on the scope and difficulties encountered during real-world validation of the proposed methods. In this case, depending on the scale of testing, resources may need to be increased.

Reviewer 4

The reviewer remarked the team is sufficient on resources for hardware, software, sensors and translation of captured data for development of the virtual tools.

Reviewer 5

The reviewer observed the research team can leverage resources from multiple DOE laboratories, testing facilities, software companies, OEMs, and universities, which should be sufficient for the project. However, the HiL testbed resources seem to be critical and competitive across different projects, which needs more attentions.

Presentation Number: eems102
Presentation Title: AI-Engine for Optimizing Integrated Service in Mixed Fleet Transit Operations
Principal Investigator: Philip Pugliese, Go Carta

Presenter

Philip Pugliese, Go Carta

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.

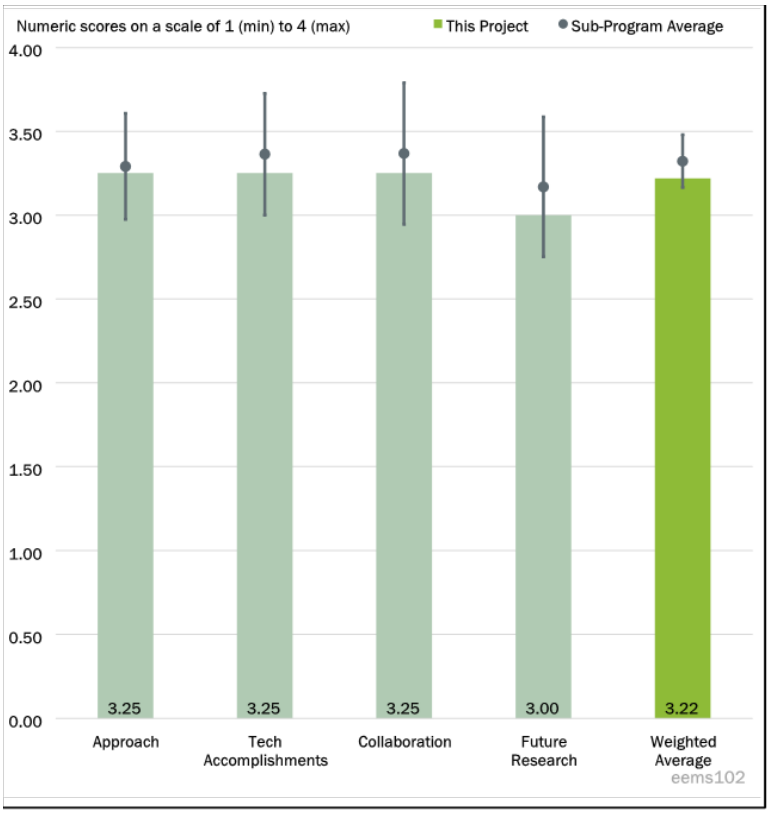

Figure 3-22 - Presentation Number: eems102 Presentation Title: AI-Engine for Optimizing Integrated Service in Mixed Fleet Transit Operations Principal Investigator: Philip Pugliese, Go Carta

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer expressed the approach to increasing user accessibility seems good, but integration of fixed and dynamic services is not clear from the presentation given the focus to date on paratransit (presumably, point-to-point service). The Integrated System Concept (Slide 16) shows three systems tied together to an unstated end. Neighborhood microtransit and shared mobility modes are mentioned, but their integration with fixed route services was not. How the community engagement task might induce non-transit users to adopt lower-energy modes is also unclear. Further, project objectives include 10% reduction in total energy consumed. If this is for transit energy use only, it may conflict with the objective to increase trips served by transit.

Reviewer 2

The reviewer noted the timeline showing 45% compete indicates that the integration of so many analytical and simulation tools has been very effectively accomplished, considering how difficult this is to achieve. The noted "sparsity" of trip requests could prove to be a limitation from the data source, although the smaller size of the CARTA transit system is understood to be advantageous during the development of the complex AI engine. The resulting tools would best be ultimately tested (possibly as an extension of this project) under the auspices of this research team and R&D regiment using a larger transit system to assess the efficiency of the AI engine use for larger fleets and trip-request demand patterns. This would also afford an evaluation of the frequency of real-time trip requests, i.e., a more challenging dynamic vehicle routing problem.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer said the presentation does not include a project plan to compare progress against. There has been good progress on discrete elements, especially paratransit optimization and the fleet electrification grid impact analysis. Important elements that are yet to be done include integration of the full multimodal system and interventions to promote adoption of new travel options.

Reviewer 2

The reviewer stated the complexity of developing, refining, integrating and testing so many parts of the comprehensive AI functional plan is acknowledged, and considered in this assessment. The technical white papers prepared to date are noted and give evidence of the AI functional parts being developed. The challenge of completing the deployment and testing, refinement, and validation of the multi-faceted software tools in the remaining two year time-frame appears to be fully capable of being accomplished. Optimization of the battery electric bus fleet deployment and operating schedule is still a major hurdle to clear. The AI engine should be capable of analyzing fleet size considerations combined with the analysis and balancing of the timing throughout the day of high power-demand rate charging cycles, as compared to the alternative strategy of more frequent, lower power-demand charging cycles. This should be part of the ultimate AI engine capabilities.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer remarked the specific roles for all members of the core team are identified, including industry, national labs, universities, and a transit agency. The three entities listed under "community coordination" are not community organizations, so additional effort is warranted to ensure that there is adequate community input, e.g., from underserved populations.

Reviewer 2

The reviewer acknowledged the challenge of coordinating so many players in the algorithm and software development process. With a schedule showing 45% complete, it shows that collaboration and coordination across the team is going well. Elevating CARTA's interest in real-time, on-demand neighborhood circulator service for first mile/last mile (FM/LM) connections to fixed route transit would significantly enhance the applicability of the AI engine for future AV fleet applications. This collaborative aspect with CARTA to accomplish the real-time, on-demand circulator application should be considered for the final stage of work, even if time and resources only allow the accomplishment of a future research project definition, and a determination of the necessary additional data collection that would be required.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the purpose of most pending accomplishments is clear. The likelihood of success in "algorithmic integration with fixed-line vehicles" as it relates to microtransit is unclear, as work to date has focused on paratransit. The nature of the community "intervention strategies" is not explained, so likelihood of success cannot be evaluated.

Reviewer 2

The reviewer stated the plan for future research that is defined for this project's remaining duration is good, but it would be very advantageous to also address the desire of CARTA to apply the tools beyond current paratransit service application to include neighborhood on-demand circulator applications.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer felt the project aims to maximize efficiency of transit services and increase use of energy efficient modes support the EEMS objective to increase mobility energy productivity.

Reviewer 2

The reviewer remarked AI engine development through this research project is highly relevant to the task of advancing public transit services in the coming age of electrified, automated transit vehicle fleet operations. The project work aligns well with the fulfillment of the VTO EEMS goal for AI applications to "recognize patterns and extract actionable information to answer transportation-related questions through predictive data analytics." The AI engine application is well suited to optimizing the transit fleet operations, minimizing energy use and related costs, and increasing the level-of-service provided to transit riders (including aspects of their behavioral response to alternative services).

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

Reviewer 1

The reviewer said there is no evidence of insufficient resources for the project.

Reviewer 2

The reviewer stated the basics of the AI engine development, testing and refinement should be able to be completed within the remaining time in the project schedule.

Presentation Number: eems103
Presentation Title: Transit-Centric Smart Mobility System for High-Growth Urban Activity Centers: Improving Energy Efficiency through Machine Learning
Principal Investigator: Jinhua Zhao, Massachusetts Institute of Technology

Presenter

Jinhua Zhao, Massachusetts Institute of Technology

Reviewer Sample Size

A total of one reviewer 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.

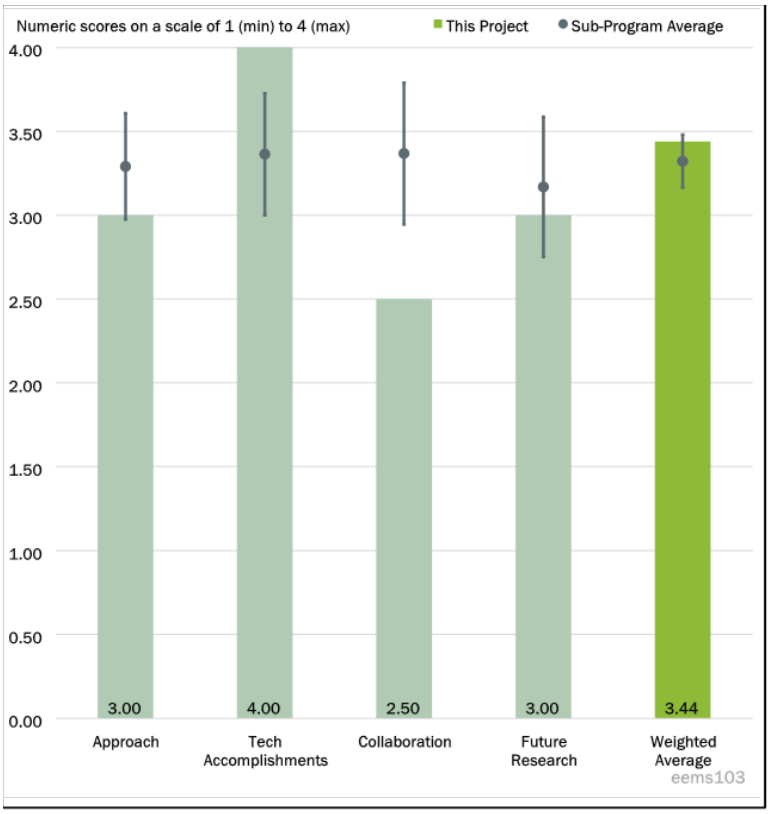

Figure 3-23 - Presentation Number: eems103 Presentation Title: Transit-Centric Smart Mobility System for High-Growth Urban Activity Centers: Improving Energy Efficiency through Machine Learning Principal Investigator: Jinhua Zhao, Massachusetts Institute of Technology

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented the explanation of the relationship between the barriers identified and the approach taken is clear. However, the approach is highly theoretical, and whether it would go far to address Barrier 3 ("transit system is underdeveloped to meet the soaring demand of high-growth urban areas") is not obvious. The proposed 5% improvement in transit level of service and mode share does not seem adequate to address this barrier. Also, it is not clear what the baseline is for the improvement targets, since the transit service in question seems to be partly or entirely new.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer stated the progress on the project is consistent with the project plan, with all milestones met for the first budget period of the project. The technical modules in some cases substantially overperformed the go/no-go points.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer observed all partners (national labs, university, and transit agencies) are assigned to major tasks, but their contributions are not specified in all cases and their participation to date is unclear.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer remarked the proposed future work makes sense given the project approach. Nothing in the work to date suggests that the proposed work will be unachievable. The nature and success of the "pilot experiments" in the next budget period will be important to the value of the project.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said the project supports the VTO EEMS objective to increase mobility energy productivity for individuals and businesses.

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

Reviewer 1

The reviewer found no evidence of insufficient resources for the project.

Presentation Number: eems104
Presentation Title: Increasing Affordability, Energy Efficiency, and Ridership of Transit Bus Systems through Large-Scale Electrification
Principal Investigator: Ziqi Song, Utah State University

Presenter

Ziqi Song, Utah State University

Reviewer Sample Size

A total of one reviewer 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.

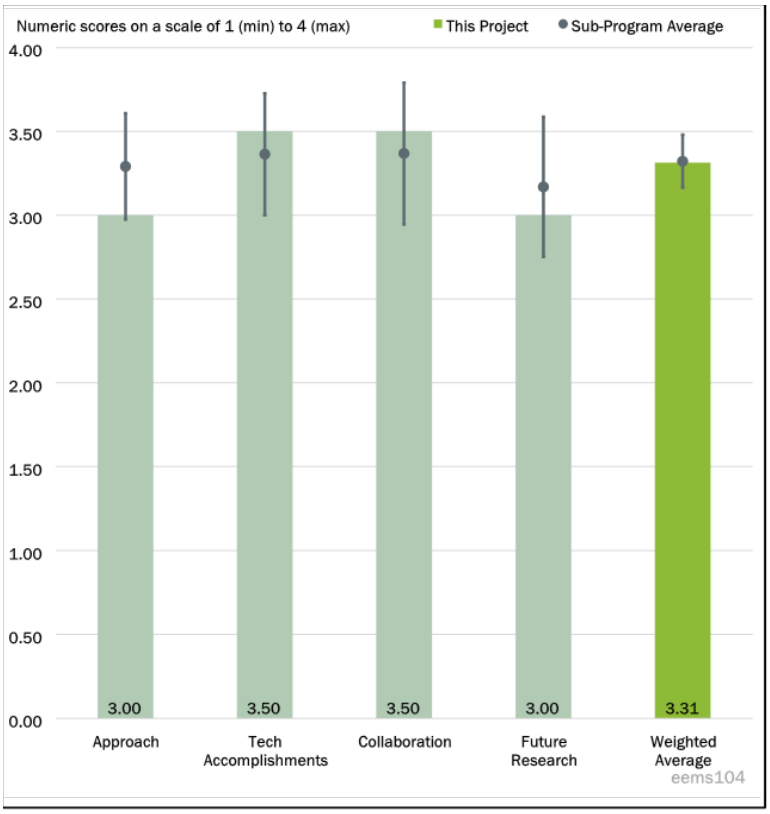

Figure 3-24 - Presentation Number: eems104 Presentation Title: Increasing Affordability, Energy Efficiency, and Ridership of Transit Bus Systems through Large-Scale Electrification Principal Investigator: Ziqi Song, Utah State University

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented the project is well-designed to address the need for planning and operations tools for an electric bus fleet. Quantitative objectives for the project are stated in terms of percent cost reduction relative to the non-optimized electric bus case. However, the presenter mentioned that operational costs for electric buses were not proven to be lower than those for conventional buses, which seems like a crucial cost issue to address in the project. The project also aims to increase bus system ridership through electrification. It is unclear how the user surveys will contribute to that result. User views of electric buses, for example, are unlikely to be a primary determinant of ridership. Availability and features of first-mile/last-mile modes would certainly be relevant to ridership, but there is no explanation of what interventions are contemplated around FM/LM modes or how these relate to bus electrification.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed the project has reached several milestones as planned and is otherwise generally on schedule, apart from delays due to COVID as noted. The presentation does mention a delay in grid model development and simulation due to electric bus deployment uncertainty. The reason for this and how much of a problem it presents are not explained.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer remarked that partners include national laboratories, universities, a utility, and transportation agencies, all with designated contributions to the project. It is recommended that project researchers communicate with those in the Chattanooga project (EEMS102), which also involves a tool to assess "potential impacts on and constraints of the power grid" from bus fleet electrification.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the purpose of future work is generally well-defined, and the technical work seems feasible based on project accomplishments to date. However the purpose of the survey work is not entirely clear, as discussed above. The presentation notes diminished transit ridership and low response rates to the survey, presumably due to COVID. Continuing low ridership would work against the project goal of improved efficiency and effectiveness of bus systems and aggravate the uncertainty around electric bus deployment.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer commented the project supports the VTO EEMS' objective to increase mobility energy productivity by promoting the adoption of electric buses and improving bus system efficiency. However, challenges to transit systems nationwide due to COVID may call for a rethinking of how transit service can best contribute to this objective.

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

Reviewer 1

The reviewer said there is no evidence of insufficient resources for the project.

Presentation Number: eems105
Presentation Title: Energy Optimization of Light and Heavy Duty Vehicle Cohorts of Mixed Connectivity: Automation and Propulsion System Capabilities via Meshed Vehicle-to-Vehicle (V2V)- Vehicle-to-Infrastructure (V2I) and Expanded Data Sharing
Principal Investigator: Darrell Robinette, Michigan Technological University

Presenter

Darrell Robinette, Michigan Technological University

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.

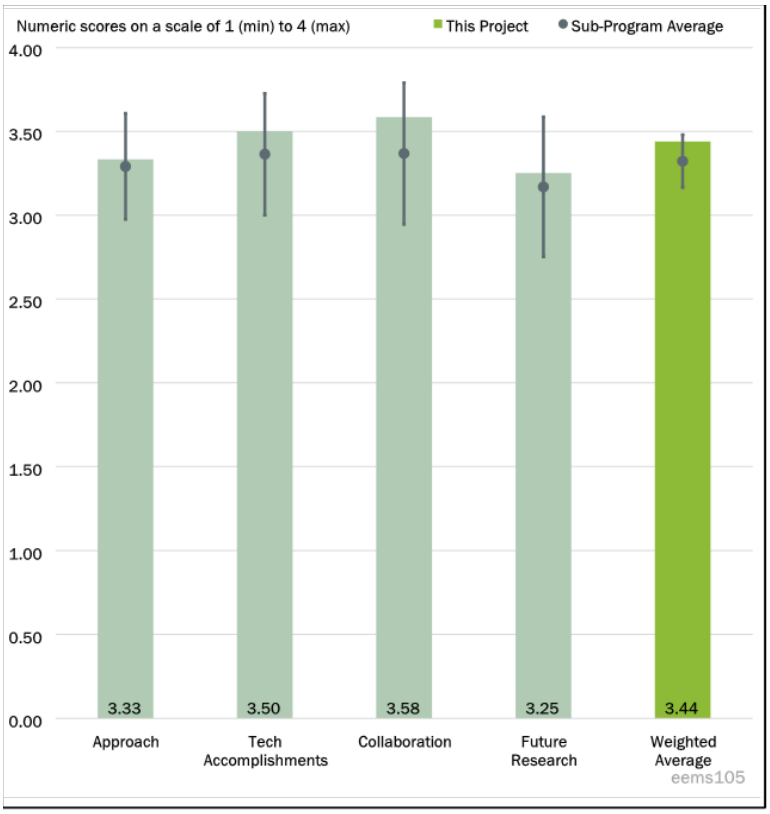

Figure 3-25 - Presentation Number: eems105 Presentation Title: Energy Optimization of Light and Heavy Duty Vehicle Cohorts of Mixed Connectivity: Automation and Propulsion System Capabilities via Meshed Vehicle-to-Vehicle (V2V)- Vehicle-to-Infrastructure (V2I) and Expanded Data Sharing Principal Investigator: Darrell Robinette, Michigan Technological University

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented the project clearly addresses the stated technical barriers (improving mixed fleet fuel efficiency by using V2X) and does so in a fast-paced, yet rigorous way incrementally using simulation, hardware-in-the-loop (HIL), and road-testing.

Reviewer 2

The reviewer felt the technical approach is sound and the timeline is realistic. Building on other DOE/ U.S. Department of Energy Advanced Research Projects Agency-Energy (ARPA-E) projects is clearly valuable. The wide range of 10%–50% is unsatisfying if a single quantity estimated with such wide spread. But I suspect this is a combination of multiple target/ranges which would be better estimated as separate, tighter bands.

Reviewer 3

The reviewer intimated there are no substantial concerns with the approach to performing the work as written. It is unclear as to what work will be completed. Slides 2 and 7 show work ending in December 2022; however, the slide deck mentions 2023 work. Is the work in FY2023 contractually required? Or is it an option for DOE

to consider? This project seems similar to FHWA's Traffic Optimization for Signalized Corridors (TOSCo) project. It is encouraged the team look for opportunities to leverage what's already been completed by that project: https://rosap.ntl.bts.gov/view/dot/50741; and https://www.campllc.org/traffic-optimization-for-signalized-corridors-tosco-phase-2-build-and-test/.

One thing not considered is background traffic. Are the energy savings only for the vehicle in the cohort or is it for the entire system? Unconnected background traffic, either interfering with the cohort's ability to following the recommended trajectories, or following fuel inefficient trajectories behind the cohort (stop and go), may detract from overall fuel consumption savings. FHWA did some initial work in this space through its study of queue-aware signalized intersection approach and departure: https://journals.sagepub.com/doi/full/10.1177/0361198118793001.

This project would also benefit from clarity on language. While the DOE AMR has a structured presentation and limited time, really specific terminology is important for this project since it's introducing a new concept with the idea of cohorts.

Reviewer 4

The reviewer noted the approach seems good, but there are concerns about work remaining in the calendar year and the source data for simulations being unclear/undefined. It seems the bulk of simulation and physical testing is to be completed this year after AMR, and that is a significant amount of valuable work. It would be good to more clearly state where simulation assumptions come from—is the Class 8 tractor in the cohort fully loaded, partially loaded or empty? Is a full mix of vehicle weights being considered to determine the acceleration and deceleration capabilities of the "cohorts' slowest vehicle". The assumptions feeding into the HD tractor performance are critical to the simulation results coming out of this work and as such should be clearly defined (as well as the other vehicles when a Class 8 tractor is not part of the cohort). Additionally, how is the cohort test duration defined and is there any assumptions about cohort duration as a % of overall drive cycle considered? A 20% savings may be significant if it is on a significant percentage of the drive cycle—but insignificant if it is only on less than 1% of the total driving.

Reviewer 5

The reviewer stated that overall, the project approach seems strong. The overall project team contains a wide mix of expertise and the project proposes a range of simulation and real-world experiments that should provide robust and interesting data and insights. The focus on real-time strategy implementations is much appreciated as the project is clearly focused on creating and evaluating strategies that can be implemented in real-world vehicles.

Reviewer 6

The reviewer observed the project explores how to examine connectivity as it can be used in conjunction with automation and real-time technology for energy savings in mixed-vehicle traffic. Mixed-vehicle corresponds to varying levels of automation within the flow.

Fundamentally the project aims to answer the question: can connectivity + automation reduce energy consumption? Most would probably answer this question "Yes" even without research, but as a starting point for exploring how much impact, it is a way to motivate the work. In fact the presenter mentioned between 10-50% improvement, which is an aggressive goal that may be too bold, but would be welcomed if it can be achieved. The approach is to look at situations of signalized intersections, arterial corridors, highway driving, and changes to an integrated drive cycles.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer commented the project has demonstrated significant progress towards its goal of creating a centralized controller to govern the behavior of mixed fleet cohorts to avoid traffic stops by leveraging connectivity. The AI_spd optimization algorithm seeks to ride the "green wave" using a different optimization approach than others in the VTO EEMS portfolio. In the last six months, the algorithm has significantly improved its ability to predict signal timing even for intersections with adaptive signals. The team has prudently employed extensive simulation testing (1,000s of runs) in the project's Design of Experiments to show 19% energy savings in simulation. Results have been partially validated via track test. The project has also demonstrated that cloud latencies (250 msec) are likely acceptable for energy-efficient CDA applications. It is unclear if the 2Hz broadcasted data content uses (or could use) any standard SAE messages. If it does, this could accelerate experimental deployments.

Reviewer 2

The reviewer confirmed progress appears to be well on track. The ability to communicate and process in the cloud is encouraging for future technologies.

Reviewer 3

The reviewer stated the team has handled delays related to COVID well and are on track to finish the project on time according to what was presented at AMR.

Reviewer 4

The reviewer mentioned milestone due dates were not provided in the slides, but assuming the dates given for completion were on time, the project is on track. The project plan does seem back loaded, but that was addressed in the previous question.

Reviewer 5

The reviewer observed that while quite a bit of progress has been made to the overall development and infrastructure needed for testing and evaluation, it appears that quite a bit of experimental testing and analysis is still slated for testing given the 70% completion of the original project timeline. That said, progress seems reasonable given the scope of the project as well as expected delays due to the issues highlighted in the appendix. The design of experiments approach is much appreciated for the arterial work. Some additional high-level insights from the overall study would be greatly appreciated to better understand the energy savings distributions and possibly highlight high-impact considerations and scenarios. It would be helpful to identify the current status to the expected benefits shown in the introductory table. It is not clear where the progress stands for each sub-test and result. Another suggestion would perhaps be to identify a few real-world combination cycles to give an overall improvement for the suite of technologies used across a range of real world driving conditions (as opposed to a focus on specific maneuvers such as approach/departure).

Reviewer 6

The reviewer commented the project has had deliverable results along the following axes: application of powertrain models across the vehicle fleet; production of a simulation environment configurable by acquired data and simulated signaling intersections; platoon optimization techniques based on coordination with infrastructure; simulation baselines against which to compare simulated results; and simulations in various scenarios (arterial for one). The project's technical results strongly match what is proposed, and some of the initial results indicate the potential to (in some cases) meet the high bar for energy savings when compared

against selfish approaches. Initial demonstrations are ensuring that the teams understand connectivity dropouts to be taken into account during validation approaches.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer noted each organization has meaningfully contributed critical pieces to the overall project to produce a well-integrated and cohesive product.

Reviewer 2

The reviewer said the team includes a broad range of experts and appears well coordinated.

Reviewer 3

The reviewer observed coordination within the project team is strong. However, there are not many OEMs included on the project team. What's the plan for engaging with OEMs and trying to make the case to get this fuel saving algorithm implemented on production vehicles? Getting the OEMs on board is an underappreciated task and this project would significantly benefit from more OEM involvement in future years. FHWA used the CAMP Consortium as a way to get OEMs involved on TOSCo testing and prototyping.

Reviewer 4

The reviewer remarked coordination is not directly addressed in the slides, but based on progress and responsibilities from different partners collaboration seems to be working. It would be helpful to acknowledge which partners are doing the work on the progress slides.

Reviewer 5

The reviewer maintained the project team is very strong with a mix of industry and academic partners. Overall, the different project contributors are very impressive and should help project execution as well as contributing knowledge to a large range of stakeholders.

Reviewer 6

The reviewer commented the American Center for Mobility provides access to their closed test track facility. AVL Powertrain provides insights into the system of systems simulation environment, simulation, optimization, and CAV drive quality evaluation. BorgWarner provides insights into light duty vehicle-powertrain models and optimization methods. Navistar is an OEM partner for heavy duty vehicles, and Traffic Technology Services provides access traffic signal information. The collaboration across partners is strong, and each partner has insights and expertise that make them a critical partner.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the future research plan for FY23 is a logical extension of work performed and is very likely to meet its targets given the amount of incremental testing done to date. There could be a greater emphasis on exploring how results could be deployed more widely.

Reviewer 2

The reviewer observed the proposed work is internally consistent with project objectives.

Reviewer 3

The reviewer noted there are no concerns with the future research as described (although it is confusing as to what future work is in scope, as mentioned in Q2). It is recommended the future research include a partnership with OEMs and research that looks at the impact of background traffic on the algorithm (and the impact of algorithm plus background traffic) on total energy savings.

Reviewer 4

The reviewer expressed the future research proposed seems to have a clearly defined purpose and seems critical. As previously mentioned, the physical testing seems significant in relation to the time left on the project. As such the targets are aggressive, as vehicle testing often has setbacks. Hopefully, the team can accomplish this because correlating physical test results to simulation is critical to the project's value.

Reviewer 5

The reviewer noted the future project work process steps are identified and it appears that continued progress will be made towards overall project goals. Additional details provided in the supplemental materials are appreciated for a more detailed overview of the on-going developments. Barriers appear to be adequately addresses, but any new insights found during real-world and track testing would be helpful for additional future directions once testing has been completed.

Reviewer 6

The reviewer stated the remaining proposed work is focused the amount of data exchange that is required, and the horizon required for optimization. One technical barrier is in synchronizing among vehicles; this is a somewhat critical concern to understand the constraints, as it may be that the available technology cannot meet constraints. What is the time requirement you need to meet, and how do you plan to mitigate risks if you cannot meet that?

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer commented the project demonstrates how connectivity-enhanced automation can decrease energy use of mixed-fleet cohorts and therefore meets VTO EEMS objectives.

Reviewer 2

The reviewer noted that demonstrating mechanisms for coordinated vehicle control to pass through lights is directly consistent with VTO and EEMS program objectives. TTS is a good partner and a potential commercialization path.

Reviewer 3

The reviewer observed "the VTO created the Energy EEMS Program to understand the range of mobility futures that could result from disruptive transportation technologies and services and to create solutions that improve mobility energy productivity MEP, or energy efficiency, affordability, and access provided by the transportation system," as noted on the DOE website link. This project contributes to the EEMS mission by developing new algorithms/methods to reduce energy consumption by leveraging two types of future disruptive transportation technologies (connectivity and automation). Thus, this project supports EEMS objectives. The project contributes to EEMS Strategic Goal #2: Identify and support early-stage R&D to develop innovative technologies that enable energy efficient future mobility systems.

Reviewer 4

The reviewer remarked the project is relevant to multiple VTO objectives. But the relevance is tied to impressive simulation and AI work being tethered to realistic input assumptions and physical testing correlation.

Reviewer 5

The reviewer found a strong connection to VTO EEMS goals, particularly the focus on mixed traffic flows as well as a mix of different real-world scenarios and implementation conditions.

Reviewer 6

The reviewer said the project is relevant to VTO EEMS priorities.

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

Reviewer 1

The reviewer confirmed the project has demonstrated potentially significant energy savings in relatively little time, so it appears to be well-staffed and well-resourced.

Reviewer 2

The reviewer commented the resources seem appropriate for the project plan and schedule.

Reviewer 3

The reviewer affirmed the project resources seem commensurate with the output of the project.

Reviewer 4

The reviewer mentioned significant funding was allocated to accomplish the goals set out and should be adequate. There is some concern that not enough funding has been saved to complete the remaining tasks.

Reviewer 5

The reviewer stated the resources seem adequate alongside the contributions of numerous project partners.

Reviewer 6

The reviewer noted the resources are sufficient.

Presentation Number: eems106
Presentation Title: Developing an Energy-Conscious Traffic Signal Control System for Optimized Fuel Consumption in Connected Vehicle Environments
Principal Investigator: Mina Sartipi, University of Tennessee

Presenter

Mina Sartipi, University of Tennessee

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.

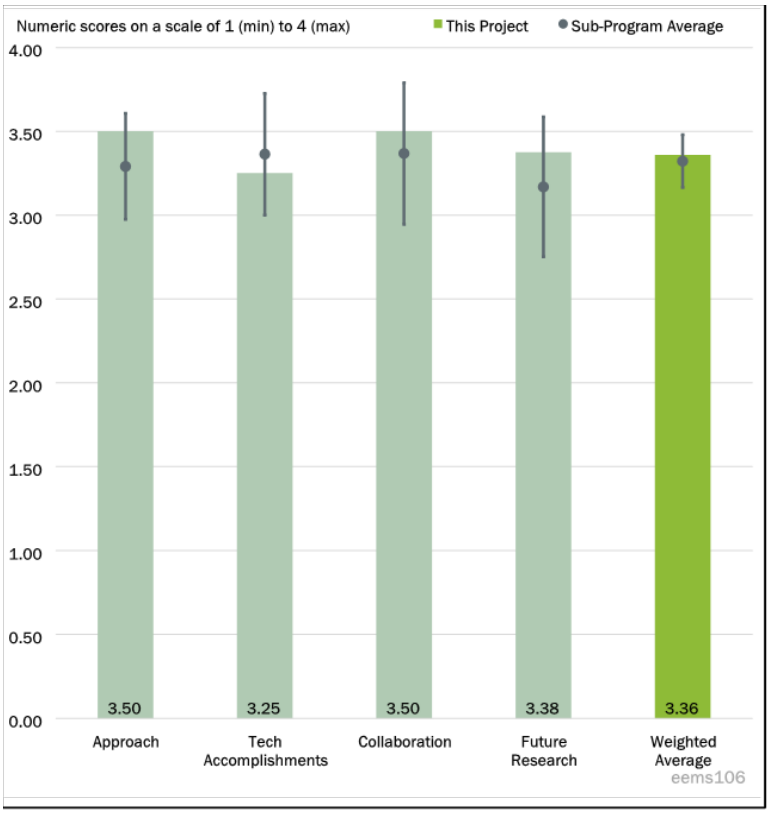

Figure 3-26 - Presentation Number: eems106 Presentation Title: Developing an Energy-Conscious Traffic Signal Control System for Optimized Fuel Consumption in Connected Vehicle Environments Principal Investigator: Mina Sartipi, University of Tennessee

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer stated the project appears to be on track for FY22. The FY23 transition from simulation to real world demonstration in a year is an ambitious goal and should be closely monitored. Several other projects began their hardware instrumentation and integration work in parallel with algorithm development to mitigate the integration risks, but this one is just beginning to work on hardware.

Reviewer 2

The reviewer commented the approach seems good for this stage of the project. It is unclear about Eco-PI, fuel consumption, GHG and other emissions, as well as time delay in terms of what is being optimized. Additional time delay is not expected, if the traffic flow is the same or better. Additional localized emissions from idling at a stop is definitely a different perspective than fuel-consumption alone. GHG is a global cost, but nitrogen oxides is an example of a more acute local cost when considering local populations. That is interesting to consider, especially in non-attainment zones. But even in attainment zones, micro-locations are adversely impacted by many cars idling. Properly maintained ICE vehicles with warmed-up aftertreatment systems emit almost nothing, But much the overall vehicle fleet is older and emit significantly. The approach from model and algorithm to CAVE HIL lab and then the street is appropriate.

Reviewer 3

The reviewer noted there are no major concerns with the proposed approach. he proposed solution will not require significant infrastructure investments to legacy systems for deployment. This will eliminate many barriers for implementation in the longer term.

Reviewer 4

The reviewer commented that overall program goals and objectives are well thought out, organized and planned, and would make a significant contribution to the field.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed that the number of technical approaches has been reduced to a more manageable set of two. (Previously, there had been roughly three approaches considered, each for local and global optimization. This could have given rise to an unruly number of local/global combinations to evaluate.) The approaches (game theory and reinforcement learning) are also consistent across the local/global optimization process, which should hopefully make for a more seamless integration than a mix-and-match approach. This project has made significant progress towards its goals of developing energy-efficient signal control using a variety of technical approaches. Simulation results show promising energy savings, decreased stop delay, and decreased queue length. It is unclear whether/how the controller algorithms address multi-modal priorities.

Reviewer 2

The reviewer said the 40% completion seems a bit behind plan, but perhaps the author is being too conservative in self-assessment. The examples shown appear to represent good progress.

Reviewer 3

The reviewer mentioned that based on Slide 4, there are no concerns with technical progress that has been made compared to the project plan. According to the PI, the project schedule is on target, with no major technical barriers expected to impede anticipated project schedule completion.

Reviewer 4

The reviewer remarked the technical accomplishments are on track and task progress shown. One item was not clear on the integrated HIL and high-fidelity fuel consumption estimation capabilities in simulation. Is this the purpose of the CAVE lab and if so, how is this done? Use of the ECO-PI metric is not clear. How many vehicle classes, propulsion options are considered? The effective weighting is also not clear on time versus fuel consumption. Further, why partition fuel consumption into A, D, and I and normalize to FCi/T? Is fuel consumption (FC) the sustainability metric and time (T) the mobility metric? How are GHG emissions evaluated?

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer noted the project features strong collaborations across the partnering universities; each is contributing a critical piece of the total effort.

Reviewer 2

The reviewer commented a variety of institutions and experts are involved and appear to be well coordinated. Additional powertrain and emissions experts along with health/environmental expertise may be helpful from a

consulting perspective, if budget allows, or for future work. Ecological Performance Index (Eco-PI) optimization target trade-offs such as criteria emissions versus fuel consumption (which is mostly the same as GHG emissions).

Reviewer 3

The reviewer noted that based on the presentation, it appears that there is great collaboration within the project team listed on Slide 20. It may make sense to consider adding additional MPOs/local agencies to a stakeholder engagement group just to ensure that the ecological adaptive traffic control system (Eco ATCS) is of interest to other agencies and will work based on their legacy systems hardware and architecture.

Reviewer 4

The reviewer said the team is extensive with relative expertise and resources between partners.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer noted real-world integration may be a considerable challenge. It is unclear how the City of Chattanooga will vet the simulation results before greenlighting the real-world demonstration on the MLK corridor. The PIs spent considerable effort developing EcoPI for their optimization efforts, and it is quite independent of the controllers developed here. EEMS may be interested in consider EcoPI as another performance metric they can evaluate going forward, in addition to MEP.

Reviewer 2

The reviewer confirmed the planned work is internally consistent with the project objectives.

Reviewer 3

The reviewer stated the proposed future research listed on Slide 22 seems logical and reasonable given the time horizon left on the project. As mentioned above, there are no technical concerns with the development of the Eco-ATCS algorithm or deployment on the Smart Corridor to test real world benefits. However, the project may benefit from additional engagement with local agencies that will (hopefully) be deploying the Eco ATCS algorithm just to make sure there are no gaps or concerns as the owners and operators of the legacy systems.

Reviewer 4

The reviewer observed the simulation and field validation will provide significant outcomes matching the goal of the overall program.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer noted this project is focused on improving transportation system-level energy-efficiency by optimizing traffic signal timing, which supports VTO EEMS goals.

Reviewer 2

The reviewer said coordination of traffic systems and vehicles (connected or not) is directly supportive of VTO and EEMS objectives. Demonstrating potential savings will help spur adoption and funding of technologies.

Reviewer 3

The reviewer remarked the project supports EEMS strategic goal #2: Identify and support early-stage R&D to develop innovative technologies that enable energy efficient future mobility systems. A huge benefit of this

project is that the Eco-ATCS can operate with data that is obtainable from legacy systems. That could make this project an early win because it is easily deployable.

Reviewer 4

The reviewer commented improvement at the corridor level of mobility and energy reductions for urban environments is an important contribution to the VTO EEMS program objectives.

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

Reviewer 1

The reviewer stated the project has made significant progress towards its technical objectives on schedule, so it appears resources are sufficient.

Reviewer 2

The reviewer noted funding resources border on light, but are sufficient for the stated objectives.

Reviewer 3

The reviewer confirmed project resources seem commensurate with the output of the project.

Reviewer 4

The reviewer said resources are appropriate for the project.

Presentation Number: eems107
Presentation Title: Improving network-wide fuel economy and enabling traffic signal optimization using infrastructure and vehicle-based sensing and connectivity
Principal Investigator: Joshua Bittle, University of Alabama

Presenter

Joshua Bittle, University of Alabama

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. 83% of reviewers felt that the resources were sufficient, 17% 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.

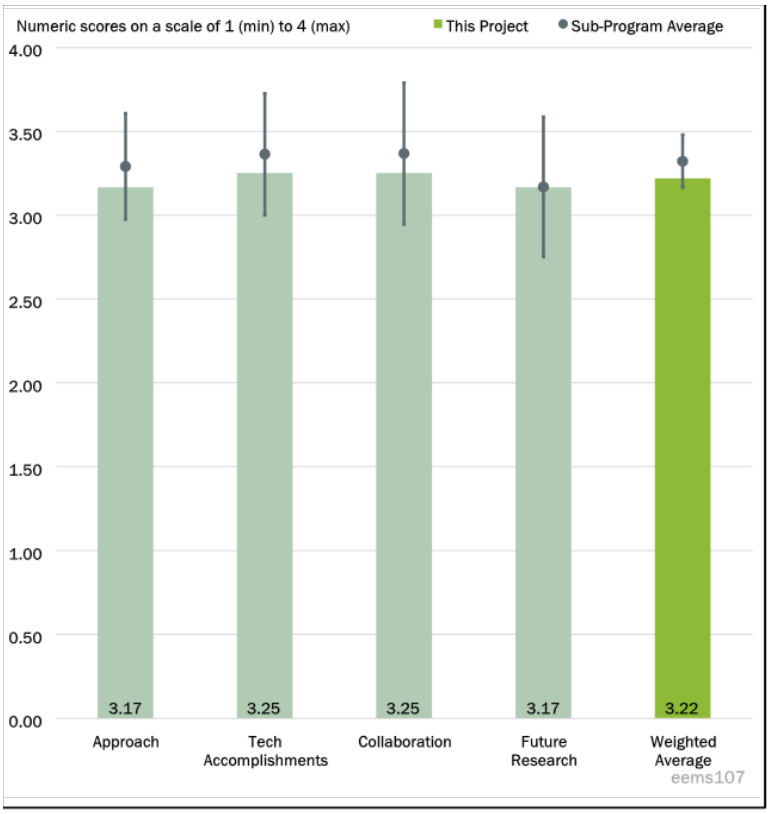

Figure 3-27 - Presentation Number: eems107 Presentation Title: Improving network-wide fuel economy and enabling traffic signal optimization using infrastructure and vehicle-based sensing and connectivity Principal Investigator: Joshua Bittle, University of Alabama

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer noted the project directly addresses the stated technical barriers of quantifying energy savings from the use of AI/ML and CAVs to improve traffic management. The project is well-designed (though rather conservatively scoped—only three intersections with a relatively traditional technical approach) to achieve its stated goals.

Reviewer 2

The reviewer stated the technical approach from intersection up-fit to algorithm, modeling, hardware and road validation is good. The timeline is longer than most at 4 years, but it is unclear if there was some delay. The overall objectives are reasonable and achievable with 20% being a good stretch goal.

Reviewer 3

The reviewer observed the project team is doing a good job of addressing technical barriers with this work. The use of the updated Traffic Analysis Toolbox (TAT) Volume III for the calibration of the microsimulation network is appreciated. One caution is that FHWA found in a recent project (https://www.fhwa.dot.gov/publications/research/operations/21071/index.cfm) that models can be well calibrated according to TAT Volume III recommendations, but the simulated trajectories may still not match real world trajectories. It does not appear the team is using the simulated trajectories as inputs to future

calculations (e.g., using simulated trajectories as inputs to Surrogate Safety Assessment Model (SSAM) or MOVES to look at safety or environmental performance metrics), but the issue is raised as a general caution. If the team is, then try to make sure the trajectories are also used as part of the calibration of the traffic simulation model.

Also, are the optimized trajectories broadcast to connected and automated vehicles or connected human driven vehicles? The probe vehicles are L2, but the presentation seems to emphasize the importance of connectivity, not necessarily automation. If the focus is on connected human drivers, how is the team planning on overcoming issues related to driver compliance (i.e., not following the suggested trajectories) and the potential impacts on the system performance? Regardless of which system (e.g., CAV, human driven vehicle) the algorithm is going to be deployed on, how does the team plan on handling interference with optimized trajectories from other vehicles in the traffic stream (e.g., the algorithm says to decelerate at X m/s^2, but the vehicle cannot due to safety issues with the leading vehicle)?

Reviewer 4

The reviewer stated the vehicle and infrastructure instrumentation is clear and moving ahead within the scope of the approach. The co-optimization method of traffic signal and vehicle optimization was not presented so the approach is not clear. Is there a vehicle demonstration on road in the corridor or are the results to be simulation- or CAVE lab-based?

Reviewer 5

The reviewer noted that the overall project approach seems strong. The vehicle instrumentation selected appears well suited to the data collection needs (i.e., AVL fuel scale). Vehicle detection methods and integration platform seems well suited to overall project objectives and progress seems adequate for Year 1 progress. The timeline seems reasonable despite some hardware-based delays. One area for improvement would be to better highlight the anticipated vehicle-level controls that will be developed in later years of the project. The strong use of both real-world, HiL, and simulation testing is likely to provide a set of robust and validated data. The statement "Future Looking Integration of vehicles and traffic control system through C-V2X/DSRC/ V2N at various penetration levels can enable gains now rather than waiting (algorithms will be the same regardless of data source)" is well said. The emphasis on developing algorithms that can utilize multiple data sources is strongly aligned with overall VTO EEMS goals. One suggestion might be to better define the accuracy and detection capabilities at a generic level so different technologies can be identified/refined to meet the general requirements for these types of systems.

Reviewer 6

The reviewer observed the project is jointly considering the infrastructure required, as well as how information can be shared from vehicles, in order to optimize traffic for reduction of energy use. The approach is to deploy infrastructure sensors such as radar, camera, and radios, for awareness of the flow of vehicles. Similarly, vehicles are outfitted with DSRC radios in order to communicate with the infrastructure regarding their own state. The technical barriers are to estimate energy and emissions in future mobility scenarios, quantify the benefits of active traffic management with (and without) connected vehicles, and to explore how AI-related tools are able to aid in this optimization.

The project and timeline are reasonably planned, though one technical barrier highlighted is with regards to connecting to vehicle control for validation. This may be coming too late in the timeline, and the team recognized that there were challenges with respect to the approach. How will this risk be mitigated?

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer noted this project has made significant progress, particularly in its hardware readiness. Its V2X radio testing has been the most thorough of any effort within the current EEMS portfolio, which is why it was presented to USDOT ITS JPO and the SMART Mobility Consortium. Likewise, the infrastructure and probe vehicle sensor installation and characterization have been very methodical. * Energy savings will also be systematically quantified by both repeatable HWIL runs in the ORNL CAVE Lab as well as on-road demonstrations. The approach utilizes very high fidelity representations of both existing and proposed traffic management systems, which may make for a smoother transition to potential wider-spread real world deployment. This is especially true given Alabama DOT has more than 85 instrumented intersections, and this project leverages only 3. There has not been a strong technical focus on algorithm development yet in the project. Despite the fact that algorithms are the greatest source of potential innovation and energy savings, it remains unclear what traditional or AI/ML techniques will be investigated. To date, most of the effort has been focused on the more straightforward components and tasks required to build the ITS system.

Reviewer 2

The reviewer said progress to date appears good, against the plan.

Reviewer 3

The reviewer praised the work to integrate National Electrical Manufacturers Association (NEMA) into SUMO and thanked the team for sharing it openly for others to use. The team is not reporting any concerns with delay to schedule, outside of the radar technical issues (which seems to be resolved). The project seems to be on-track for on time completion and there are no concerns with project progress.

Reviewer 4

The reviewer stated progress on the vehicle and infrastructure activities is clear, but accomplishments for optimization is not clear. How is sensor fusioning being used within the construct of the project? Also, it is not clear what estimates these produce and who consumes them?

Reviewer 5

The reviewer commented the Year 1 milestones and objectives seem to be on track, despite delays related to hardware. The project team seems to have recovered well due to equipment delays and building process flows for analysis and detection. NEMA style dual-ring controller implementation and integration into SUMO alongside publication and release is promising and a strong contribution to the overall user community. DSRC testing looks complete and well done although it appears that some near-corridor areas have limited connectivity (perhaps due to line-of-sight issues). While the vehicle camera detection methods discussion is helpful, it might be useful to highlight an expected level of performance needed for adequate performance as well as any current commercial system capabilities as a point of comparison for the developed methods (i.e., are they a significant improvement or are the existing methods already adequate?).

Reviewer 6

The reviewer observed that ongoing work has demonstrated a clear ability to configure simulation engines such as Sumo with data from the intelligent sensing intersections. The traffic model and V2X testing were critical pieces to the project, and they have been successfully completed. The probe vehicle sensing capacity is also complete, and was a critical piece. While the smart intersections have missed one piece of their technical

deliverable, it was due to challenges in hardware from a supplier that are being reconciled following pandemic-influenced supply chain issues.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer noted the project team has a strong collaboration across the university departments, though not as demonstrably strong a relationship outside of the University of Alabama. Very encouragingly, it also has very strong support from Alabama (AL) DOT, with which it regularly coordinates to install and calibrate new instrumentation.

Reviewer 2

The reviewer observed collaboration with Mercedes-Benz, ALDOT and ORNL are good. If Mercedes-Benz is not willing to share the CAN/ECU details needed then the team should consider asking other research groups for help. There is a lot of CAN reverse engineering that happens for DOE, ARPA-E, EPA, etc. Even if the databases cannot be shared, the know-how can help jump ahead to the solutions.

Reviewer 3

The reviewer stated there is strong support across the project team. he involvement of ALDOT is appreciated, including concerns about deployment onto legacy hardware. The team is encouraged to keep looking for opportunities to engage with OEMs (if the optimized algorithm is intended to go onto automated vehicles). The team may also want to engage with other state and local agencies (infrastructure owners and operators) to make sure a wide set of real world deployment issues are being addressed.

Reviewer 4

The reviewer said coordination with ORNL is moving forward for HIL testing.

Reviewer 5

The reviewer stated the project highlights a strong set of collaborators both within the project lead (University of Alabama) as well as other project contributors. ORNL roles are clear as discussed at this point since Year 2 and Year 3 has more HiL and related simulation. The mentioned connection to ALDOT is emphasized as a strong positive and, if possible, would be strengthened to enable more information transfer and real-world insight to be transferred to/from the project teams.

Reviewer 6

The reviewer noted collaboration with ORNL will provide the access to close the loop with the vehicle for integration testing. This is a critical partnership, and the results of the project will depend on ensuring that the hardware-in-the-loop can be achieved in order to do validation testing.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer noted FY22 and FY23 work remain focused on integration efforts. It remains to be seen what innovative control algorithms will help meet the 20% energy savings target; simulation with more traditional approaches has yielded roughly only 10% thus far. The presentation slides hint that tighter alignment with a specific OEM may be needed to leverage vehicle sensor data. This would make scalability much more difficult across multiple OEMs.

Reviewer 2

The reviewer said proposed research is internally consistent with overall project objectives.

Reviewer 3

The reviewer commented future work presented on Slide 7 and 22 is well defined and has a clear purpose. The team is encouraged to think about how background traffic may interfere with the system wide fuel saving potential.

Reviewer 4

The reviewer stated additional details on co-optimization methods are needed to assess effectively.

Reviewer 5

The reviewer observed the project is in its first year, so future work seems acceptably tied into overall project objectives. The translation from 10% go/no-go targets to an overall improvement of 20% is not entirely clear, but significant research time still exists for project execution and refinement. Demonstration with ALDOT is an excellent Year 3 objective as outreach and understanding at the DOT level is critical to real-world implementation and development of EEMS systems. While not discussed in the current scope, it may be helpful to try and identify any off-corridor changes in traffic due to the implementation of the corridor optimization methods, but this may require more sensing than allocated within the project. It is always of interest to make sure additional issues are not created (or are at least made apparent) when new controls are implemented. A possible connection to other EEMS experimental projects may be relevant here as well, for example the EEMS101 data collection systems and vehicles.

Reviewer 6

The reviewer stated the proposed work for the remainder of FY22 is to continue to collect data for system parameterization, and to perform hardware in the loop testing. The FY23 work (if approved) would be to validate the savings in real-world testing, assuming that vehicle control can be achieved. Thus, the connection to be able to close the loop with the car is a critical milestone to be met or mitigated.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer remarked this project is clearly aligned with VTO EEMS goals via the USDRIVE analysis roadmap, which it directly cites.

Reviewer 2

The reviewer stated demonstrating that infrastructure improvements combined with shared information enabling reduced energy consumption is directly aligned with VTO objectives. This approach is similar but different than other ongoing work, and will provide additional insight.

Reviewer 3

The reviewer cited “VTO created the EEMS Program to understand the range of mobility futures that could result from disruptive transportation technologies and services and to create solutions that improve mobility energy productivity (MEP), or energy efficiency, affordability, and access provided by the transportation system.”, as stated on DOE’s website link. This project looks at the ability on connectivity (and automation?) at improving energy usage. Additionally, this project contributes to EEMS strategic goals 1 and 2.

Reviewer 4

The reviewer noted co-optimization in urban corridors of energy and mobility is relevant to DOE EEMS program.

Reviewer 5

The reviewer observed the project is highly relevant to EEMS goals and highlights the need for improved vehicle detection and control at both the vehicle and infrastructure levels. Detection infrastructure and algorithms are also helpful to assist in the ability to detect traffic flows and vehicles within the corridor.

Reviewer 6

The reviewer said the project is related to VTO EEMS goals.

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

Reviewer 1

The reviewer commented the bulk of hardware deployments and characterization are underway, and the project is making good progress towards completion. It appears funding, staffing, and procurement resources are sufficient and appropriate.

Reviewer 2

The reviewer observed the funding over 3 years seems very light, especially when considering hardware costs, and access to CAVE. Perhaps there is a lot of unclaimed cost-share that this project is based upon.

Reviewer 3

The reviewer said resources seem commensurate with the output expected on the project.

Reviewer 4

The reviewer noted the project has several collaborators within the University of Alabama in needed fields.

Reviewer 5

The reviewer stated the project resources appear to be sufficient, although it should be noted that the project team has accomplished quite a bit of hardware integration and development while also building a data and analysis pipeline, which is done well within the timeline and budget provided. Hopefully, the infrastructure systems continue to function as this seems to be the largest slowdown at this point, albeit outside the control of the project team.

Reviewer 6

The contractor said resources for the project are sufficient.

Presentation Number: eems108
Presentation Title: Co-Optimization of Vehicles and Routes
Principal Investigator: Jack Schneider, PACCAR

Presenter

Jack Schneider, PACCAR

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.

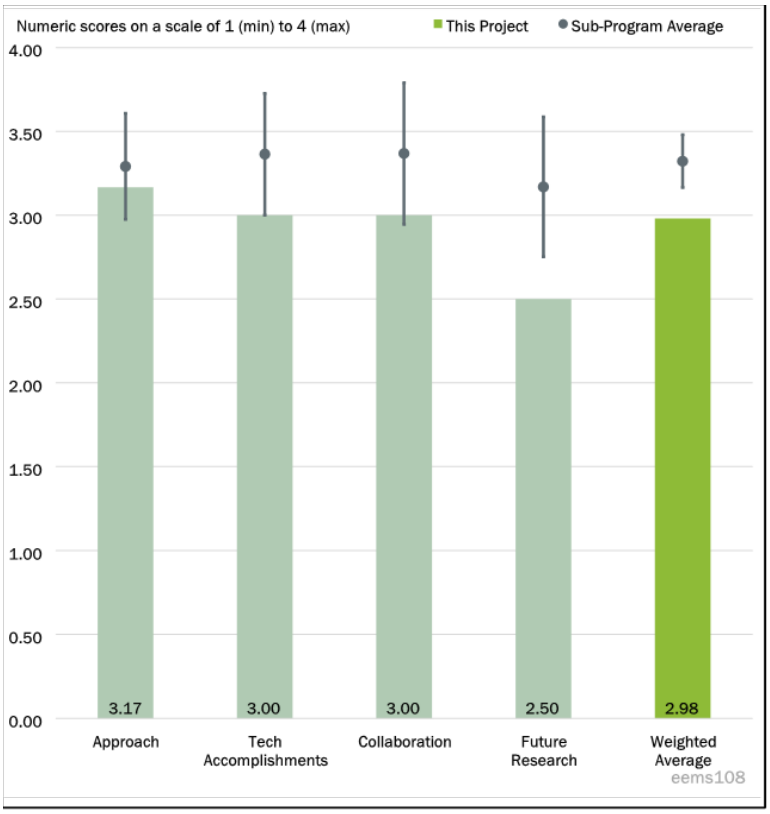

Figure 3-28 - Presentation Number: eems108 Presentation Title: Co-Optimization of Vehicles and Routes Principal Investigator: Jack Schneider, PACCAR

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer stated the project asserts that it will address the barriers associated with business models for these OEMs/fleets. There is not really an attempt to address the commercialization potential of these technologies.

Reviewer 2

The reviewer noted the 25% fleet efficiency goal is stated, but the barriers to achieve it are not evident. The project went through 2 years of simulation, and it appears that there may not be enough time to do the implementation and document the lessons learned.

Reviewer 3

The reviewer commented the project is integrating multiple connectivity features to optimize driver efficiency, eco-routing, powertrain recommendation, telematics and a fleet management system. The first budget period was focused on technology development, the next one is implementing the technology, and the last one will test and validate the technologies developed under the project.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed this project asserts that it is about "co-optimization", but how is integrating the powertrain choice into the remainder of the modeling? Co-optimization seems to be a bit of a misnomer here,

because the reporting does not really provide a synthesized co-optimization strategy. instead, it offers a serial optimization strategy, without deep interaction and feedback between components. What types of decisions are being made due to powertrain modeling? It appears selections are made from the Paccar catalog, which is not very interesting, optimization-wise. For the EVs, is there more design flexibility, a d can the user consider changes in battery and motor sizing?

Reviewer 2

The reviewer commented nice feasibility analysis from NREL. However, there was not much reported on from Ohio State University. Slide #11 states 2% fleet improvement, but Slide #3 aims at 7%? Valence built a nice dashboard and ESRI the data pipeline. Both depict some initial results, which were also seen from the last year.

Reviewer 3

The reviewer indicated good progress has been made on all tasks. A fleet partner has been identified and committed (which caused some initial delays). Telematics hardware and architecture has been finalized. Routing tools have been integrated and simulations completed. The MATLAB application for powertrain specification optimization has been developed.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer commented that all seems in order from a collaboration perspective

Reviewer 2

The reviewer noted that the researchers have yet show how it all fits together. Again, timing is expected to be the challenge.

Reviewer 3

The reviewer remarked the project has a well-balanced team led by PACCAR with Kenworth as truck OEM, NREL providing fleet data analytics and route optimization, Ohio State University conducting powertrain configuration optimization, ESRI providing cloud infrastructure and routing, and Valence FMS and IDAS; all partners are leveraging their core technology competencies to address the identified project barriers.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer observed the absence of strong documentation on the future research and the program's commitment and planning towards in-practice testing. The timeline asserts that EVs should be deployed in Q3, 2022. The FY23 work plan does not acknowledge fielding of new vehicles? It is not clear that the IDAS system considers or acknowledges that EV management will be different than ICEV management, in terms of charging, etc.

Reviewer 2

The reviewer pointed out that the project is still at the beginning (after nearly 2 years). However, the reviewer expressed doubt regarding the future work achieving project targets.

Reviewer 3

The reviewer expressed very appropriate future work in FY22 deploying all hardware on 75-80 trucks followed by FY23 testing and validation with planned improvements to ML models. FY23 will also include a workshop with fleet partners on powertrain configuration improvements to disseminate the learnings from the project.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer stated the project is relevant.

Reviewer 2

The reviewer commented this project supports the VTO goals; however, its organization appears to be a bit chaotic.

Reviewer 3

The reviewer said the project is very relevant to the VTO objectives as it targets 25% fleet freight efficiency improvement by developing, implementing, and validating an advanced connected transportation system and is powertrain agnostic. In turn, this efficiency improvement will reduce petroleum use and therefore increase energy security.

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

Reviewer 1

The reviewer deemed the resources are adequate.

Reviewer 2

The reviewer observed the budget is appropriate. However, there is a timing issue, and an extension may be in order to generate some lessons learned.

Reviewer 3

The reviewer said the overall project budget seems sufficient for the scope that is bringing together several partners and integrating a number of different connectivity systems.

Presentation Number: eems109
Presentation Title: Connected and Learning Based Optimal Freight Management for Efficiency
Principal Investigator: Ali Borhan, Cummins

Presenter

Ali Borhan, Cummins

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.

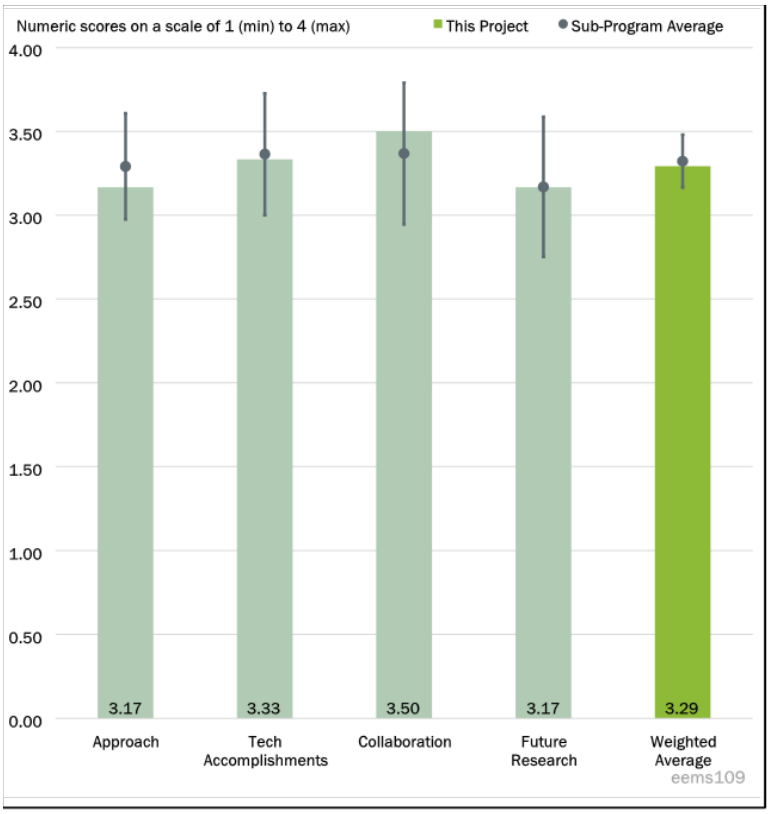

Figure 3-29 - Presentation Number: eems109 Presentation Title: Connected and Learning Based Optimal Freight Management for Efficiency Principal Investigator: Ali Borhan, Cummins

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented the reduction in driver wages, and breaking the law in terms of driver operation assumptions (Slide 13) should be reconsidered from an equity lens. It is unclear whether we should be making such inequitable assumptions in a fleet management setting. Fleet management is a multi-disciplinary decision making environment that must consider all stakeholders.

It is also not clear whether the Learning Fleet Optimizer is doing both the "planning" level and "daily" level optimization. The results on Slide 14 talk about seven ICEs and two BEVs as a case; is this the result of previous "planning" level optimization? Why does this project and the optimization model not consider BEV purchase price in determining the number of BEVs that should be in the fleet?

Reviewer 2

The reviewer said the work is nicely organized. It appears to be managed well. The tasks are clear and distributed accordingly.

Reviewer 3

The reviewer stated the project has a good approach using fleet optimizer to provide decision variables for fleet modeling to evaluate well to wheels carbon dioxide impacts while data is being provided back for learning algorithms.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed the project seems okay There are many important tasks to be implemented/integrated in 2022.

Reviewer 2

The reviewer remarked the results were presented and the project is starting to bear fruit.

Reviewer 3

The reviewer commented the team has accomplished several milestones including baseline freight system simulation modeling and its validation with fleet operational data. The project is well on the way to demonstrating 20% freight efficiency operation in simulation.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer mentioned tire connectivity is not well integrated to the rest of the project. It is not understood how the tire project connects to the remainder of the project.

Reviewer 2

The reviewer said there is good coordination between the team members.

Reviewer 3

The reviewer expressed the project team is strong including University of California-Berkley (learning algorithms for fleet optimizer), ANL (POLARIS-SVTrip-Autonomie fleet simulation and fleet optimizer integration with POLARIS), Venture Logistics (insights on freight operations and data collection), and Michelin (tire locomotion energy savings). Team members seem to be interacting frequently and appropriately in support of the 3-year project scope with numerous tasks.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer inquired whether the fleet management implementations are going to be implementing the entire suite of technologies? Does this include AVs, advanced powertrains, tires? The speaker asserts that only the fleet management tool will be implemented. It seems there is a lot of uncertainty in operating EVs using the management techniques proposed. There is a lot of uncertainty regarding the feasibility of the AV technologies proposed. One concern is that the results will not demonstrate significant efficiency improvement.

Reviewer 2

The reviewer said the next tasks and challenges are clearly stated.

Reviewer 3

The reviewer stated the proposed future research for budget period 2 to demonstrate the 20% or greater freight operation efficiency in simulation, and budget period 3, to do so with a mix of micro simulation and actual fleet operation, seem logical and appropriate based on the list of upcoming and ongoing subtasks.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said the project is relevant.

Reviewer 2

The reviewer confirmed the project is very relevant to VTO EEMS.

Reviewer 3

The reviewer observed the project is relevant to VTO subprogram objectives as it aims to demonstrate greater than 20% fleet well-to-wheel carbon dioxide reduction over a baseline fleet. This will in turn reduce trucking petroleum use through powertrain and other efficiency improvements.

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

Reviewer 1

The reviewer stated the resources are adequate.

Reviewer 2

The reviewer said the project has sufficient funding.

Reviewer 3

The reviewer commented this project seems appropriately funded given the significant scope and partnerships.

Presentation Number: eems110
Presentation Title: Human Factors and Technologies Design to Improve User Acceptance of Pooled Rideshare (PR) for Increasing Transportation System Energy Efficiency
Principal Investigator: Yunyi Jia, Clemson University

Presenter

Yunyi Jia, Clemson University

Reviewer Sample Size

A total four 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.

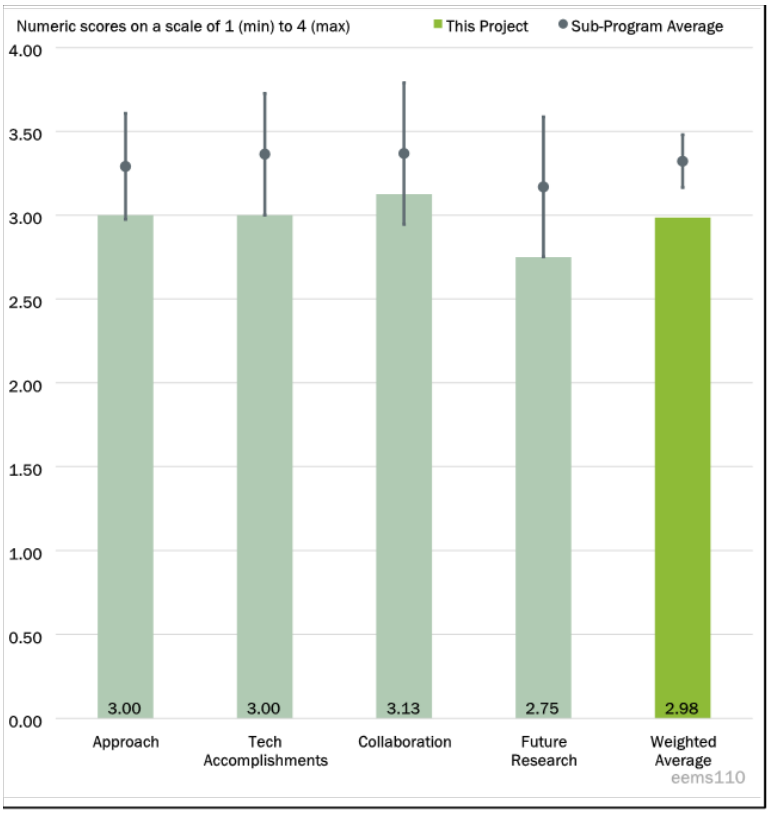

Figure 3-30 - Presentation Number: eems110 Presentation Title: Human Factors and Technologies Design to Improve User Acceptance of Pooled Rideshare (PR) for Increasing Transportation System Energy Efficiency Principal Investigator: Yunyi Jia, Clemson University

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer commented that it is not clear how technology adept the participants are for these Human Factors studies. For these types of studies, balancing based on the type of technological level is important to not skew/bias the results. For example, early technology adopters might be savvier about how to optimize use of these resources than elderly participants that have not owned a computer before. This and other factors could impact their ability to use the system or parts of the system.

Reviewer 2

The reviewer stated the project explores the relationship between human factors elements and acceptance of pooled ridesharing services, taking into account both demographic factors and elements of the service (mode, routing, human-machine interface [HMI], etc.). To this end, they have surveyed travelers and are analyzing reported travel behavior and attitudes. Since this project began in 2020 and data were collected in 2021, sentiment/hesitation related to pooled rideshare may be notably impacted by COVID-19. Having said that, the project design seems thoughtful, and the results will be of interest to MOD stakeholders and others interested in more effectively encouraging use of other shared mobility options, such as transit, in the future. The timelines for proposed research (outlined, for example, on Slide 19) seems reasonable.

Reviewer 3

The reviewer observed an approach that combines an effective public opinion and user choice survey with mode choice models and on-demand ride-share operations modeling is an important milestone toward the preparations for automated mobility systems deployment. With the unforeseeable barrier of the pandemic that affected public attitudes about rideshare options, the survey results provide a measurable benchmark from which the future development of rideshare impacts on mobility can be analyzed. The current attitudinal surveys provide both a "bottom" of the mode choice data, as well as an excellent measure of where R&D investments in vehicle technology and service approach are needed to increase the user choice of ride share transportation. By analyzing the pubic reluctance to ride-share based on key factors, the necessary steps to improving pooled rideshare prospects with future automated technologies can be better understood. However, it is noted that the presenter referenced the extended timeline becoming apparent for advanced vehicle technology deployment, and emphasized that this study's results also have high relevance to existing transportation network companies' (TNC) technology understanding and improvements.

Reviewer 4

The reviewer expressed this is a very strong social science research project. The depth and details of the community outreach is great. The team has plans for further engagement with the community and to understand the needs and reasons for why it is not choosing pooled rideshare.

However, the technical solution is not strong. It is not clear how the team is planning to address the challenge, considering COVID has made pooled rideshare less attractive. Not enough details are provided on what new pooled strategies or technologies will be used to address the challenges discovered through survey data collection. It is not clear how HMIs or multi-mode pooling can help. POLARIS is mentioned to be used for simulating the ridership experiment. It may be also good to consider BEAM (Behavior, Energy, Autonomy, Mobility—Comprehensive Regional Evaluator) as they have studied pooled rideshare and human factors.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer acknowledged that trying to do Human Factors research in the middle of the pandemic was certainly a big challenge for many. Kudos to the team for all they were able to accomplish. Certainly the results might show a bias due to the pandemic, but this is something that we need to account for moving forward since the results are very relevant to the current transportation environment.

Reviewer 2

The reviewer commented there is still significant time left in this project and already the key findings would be of interest to those in the shared-use mobility space. The project seems to be generally on track relative to the project plan, particularly given the challenges associated with trying to conduct this work during an ongoing pandemic.

Reviewer 3

The reviewer observed that based on the core aspect of completing the Task 1 studies on public attitudes on shared mobility, the impact of Covid has significantly delayed the % of project completion. A 30% complete status versus about half of the time passed has been the resulting impact to the progress. There is still time to make up the delays and recover the lagging % complete. The Task 2 and Task 3 work is only now beginning, but that work has multiple partners involved to complete the work.

As a general comment, note that a concise definition is needed for "personal ride-share" vs. " pooled rideshare". Pooled Rideshare is better understood based on Uber-Pool service and similar TNC initiatives. But

personal rideshare seems to be a contradiction in terms with no definition in the AMR materials or in the AMR presentation. Also, the acronym "PR" is easily confused with "personal rideshare" rather than the intended "pooled rideshare".

Reviewer 4

The reviewer noted that one of the major concerns from users was trust. It is not clear how the physical design mentioned as part of the solution can help with that. The team has done great work on the social science aspect of the project. The technical job needs more detailed justification on how to address the challenge of user acceptance of pooled rideshare.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated the project has great collaboration and partnerships. It seems to highlight the knowledge and expertise of all the partners and focus them in the correct portions of the tasks at hand.

Reviewer 2

The reviewer mentioned the project involves a diverse pool of partners, including Ford and well known transportation research groups. While it is uncertain how specific/distinct roles were divided up to produce the findings laid out in the slides(though some role delineation is laid out on Slide 18), the collaborative effort seems solid based on project progress/achievements this far.

Reviewer 3

The reviewer remarked the 30% project completion with only Task 1 and Task 4 showing progress on the timeline appears to indicate that Tasks 2 and 3 have not yet been fully engaged. Although the two key tasks of Task 2 and Task 3 appear to be where the work is lagging behind, the associated task collaboration and coordination can bear the most fruit in catching up on the % completion. It is noted that the collaboration/coordination between the associated partners may be a challenge that is still to be fully addressed.

Reviewer 4

The reviewer noted that five other EEMS projects are referenced in the presentation and how they can potentially leverage them. POLARIS from ANL will be used in the project.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer expressed that future work was more focused on pending tasks for the project than what should happen after the project is completed.

Reviewer 2

The reviewer comments the proposed future research seems ambitious but interesting, expanding (for instance) to explore additional pooled ride strategies and technologies including adaptive routing and shared AVs. Given the variety of variables, there may be some simulation and validation challenges. However, as outlined, the results once published will be interesting to read. The results will generally hit the targets, and there will be ample opportunities to continue to expand and build upon this work in the future.

Reviewer 3

The reviewer observed the proposed future work comprising Tasks 2, 3 and the remainder of Task 4 is essential for meeting the goals and objectives of the project. Using the survey results and analysis of Phase 1 and Phase 2 data collection, the future work can now be engaged in earnest and the project will thereby achieve its intended objectives.

Reviewer 4

The reviewer commented the challenge of lack of comprehensive understanding of human factors in pooled rideshare is addressed in the current phase. The future work to address the challenge of the pandemic impacting pooled rideshare and how technology can address it is not investigated or planned in detail.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said this is a very timely project. Shared mobility offers possibilities, but without accounting for all the Human Factors aspects it would be hard to optimize it in order to obtain the energy efficiency being sought.

Reviewer 2

The reviewer noted ride-sharing can help to reduce net vehicle miles traveled and emissions. Understanding factors that impact one's willingness to share rides, therefore, can serve to inform associated planning and service development and help to encourage/support shifts towards more energy efficient travel. As building "an affordable, efficient, safe, and accessible transportation future" is the mission/vision of VTO EEMS, this work supports DOE objectives.

Reviewer 3

The reviewer expressed accurate operational modeling of mobility systems which include ridership levels and patterns, while also deriving metrics that allow capital and operating costs and the associated ridership revenues to be calculated, is very well aligned with the VTO EEMS program objectives. This project addresses this multifaceted modeling requirement, basing it on surveys to obtain a thorough understanding of user choices and the related human factors of ride-share services. This project has a good balance of these aspects and is very important to complete.

Reviewer 4

The reviewer said this project can potentially increase energy efficiency of transportation by increasing the pooled rideshare user acceptance.

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

Reviewer 1

The reviewer stated the resources seem reasonable and sufficient.

Reviewer 2

The reviewer commented that while more time and resources could help to further gather data and look at it through different lenses, the resources seamed overall to be sufficient.

Reviewer 3

The reviewer observed the resources to complete the remaining work appear to be sufficient if the cost share for Tasks 2 and 3 and the remainder of Task 4 is about half of the budget allocation.

Reviewer 4

The reviewer said the team has sufficient resources for the project.

Presentation Number: eems111
Presentation Title: Contextual Predictions and Eco Services for Electrified Vehicles
Principal Investigator: Jacopo Guanetti, AV-Connect, Inc.

Presenter

Jacopo Guanetti, AV-Connect, Inc.

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.

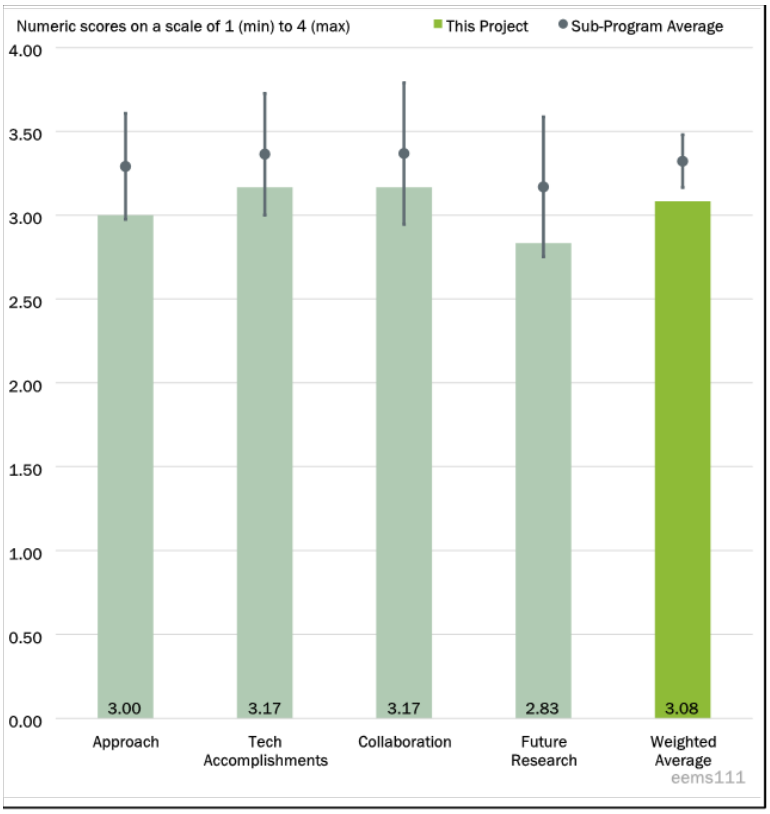

Figure 3-31 - Presentation Number: eems111 Presentation Title: Contextual Predictions and Eco Services for Electrified Vehicles Principal Investigator: Jacopo Guanetti, AV-Connect, Inc.

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer remarked the technical approach and schedule are sound. The team should be careful with jointly minimizing charging time. Studies are showing that direct-current fast charging for all charging can reduce battery life to 1/3 (a 2/3 reduction). That would impose significant capital and environmental costs for replacing a battery pack. Although a detailed model might not be available, consider a literature review and then a crude model integrated into the cost function. Perhaps certain users just want to minimize charging time, but likely will not require this to always be the case. Fleets may be a different story, and the GHG savings of EVs might be better than the cost of swapping packs. That could be investigated.

Reviewer 2

The reviewer commented it is not clear that the barriers of the project are entirely novel, eco-routing and many of the design elements pointed to in the presentation are present in existing applications (or are actively being pursued). It seems a stretch to claim that eco-routing can lead to higher adoption of electric vehicles: 1.) why would this be exclusive to EVs? and 2.) how many people think about eco-routing when purchasing an EV (and even if they did, it would not be exclusive to the technology). On Slide 6, the team points to several challenges for why the approach is difficult, but it does not seem to me that the work actually addresses any of these problems.

Reviewer 3

The reviewer stated the project aims to overcome barriers of range anxiety for EV drivers, as well as overall energy efficiency of drivers, by suggesting routes that are likely to save energy when compared to the time-optimal route. The results then present the operator with a route that has energy savings, alongside the time/travel difference in taking that route. The Phase I efforts were focused on demonstrating the cloud infrastructure and working with OEMs and partners in order to acquire data and constraints. While the efforts make progress, there are project scope concerns regarding how the project will scale as the number of vehicles that would use this technology would scale. The proposers recognize that there are limits to the side roads that could be used by large portions of the traffic, but this should be quantified so as to understand the technical market cap of using this solution.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed that technical progress and milestone accomplishments are on plan. The routing app and multiple driving demonstrations are encouraging.

Reviewer 2

The reviewer asserted progress seems adequate given what is proposed. However, the validation portion of the project with measurement of real world vehicles seems rather limited. With only four EVs, and a planned four EV buses, it is uncertain how a project of this scale can compete against algorithms that learn off much higher volumes of vehicle trip data such as from Google Maps, Waze, Apple Maps, or ABRP.

Reviewer 3

The reviewer noted the project has created models for the vehicle's operation as well as its charging, alongside models and maps for charging stations and types. The technical work in using these strategies is interesting, and especially the mapping that encourages driving styles/distances alongside charging locations. This could help in reducing total cost of ownership by ensuring battery ranges and charging points stay within long-term use guidelines. There are challenges in justifying the behavioral model through Neural Networks, namely that more data will be needed than are perhaps feasible. Why is a neural network approach required, when first order or second order models may be sufficient, and would not require the kinds of data needed to build a model that avoids overfitting?

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer deemed collaboration is good with an OEM (HATCI), a complementary commercial partner and municipalities. The need and opportunity for a fleet customer is correctly recognized.

Reviewer 2

The reviewer stated the collaboration seems reasonable, and the contributions of stakeholders to provide data is fine. The only suggestion is to try to partner with an institution/entity that can provide substantially more data.

Reviewer 3

The reviewer mentioned the project includes partners from Hyundai, NNG, Capital District Transit Authority in Albany New York, and SouthWest transit. While these are provided in the slides, the details of milestones

and tasks related to these partners could be strengthened in order to ensure that the engagement is meaningful in the sense that transition of results to practice is more feasible.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the proposed work is internally consistent with project objectives.

Reviewer 2

The reviewer commented the future work is somewhat ambiguous; for data collection efforts, it would be beneficial to provide a better understanding of the scope of data collection. This is an important portion of the project that helps inform calibration and validation tasks. Future work should include plans for increasing stakeholder engagement and expansion of these activities.

Reviewer 3

The reviewer observed the proposed work is largely continuing along existing lines. One item that may be of importance would be to understand how validation tests should be captured/recorded/designed so as to maximize probability of transition of the results. Namely, what is the plan for transition? Is the goal to have algorithms be transitioned to EV OEMs, or be integrated into navigation applications already available? The approach there will dictate what kinds of artifacts from testing would be needed to justify that organization pursuing the technology for transition.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer stated the energy savings objective is clearly aligned with VTO and EEMS objectives. The reviewer further suggested that we are at the beginning of a messy transition to EVs, and that this technology has merit in that it can help ease the transition period.

Reviewer 2

The reviewer commented the project lines up with VTO objectives.

Reviewer 3

The reviewer said the project is relevant to VTO EEMS goals.

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

Reviewer 1

The reviewer deemed funding seems appropriate for the plan.

Reviewer 2

The reviewer remarked the budget seems to excessively grow between phases. It is uncertain if the effort and outcomes from the second phase warrant a 5-10x increase in budget.

Reviewer 3

The reviewer said the funds are sufficient.

Presentation Number: eems112
Presentation Title: National Renewable Energy Laboratory Core Modeling & Decision Support Capabilities, Route Energy Prediction Model (RouteE), Future Automotive Systems Technology Simulator (FASTSim), OpenPATH, and Transportation Technology Total Cost of Ownership (T3CO)
Principal Investigator: Jeff Gonder, National Renewable Energy Laboratory

Presenter

Jeff Gonder, NREL

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.

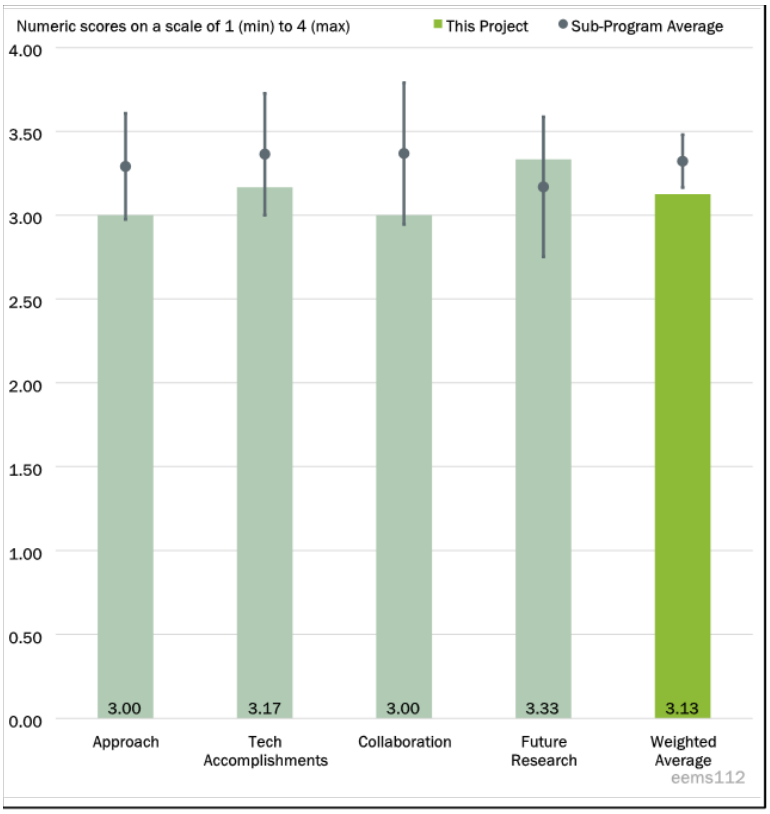

Figure 3-32 - Presentation Number: eems112 Presentation Title: National Renewable Energy Laboratory Core Modeling & Decision Support Capabilities, Route Energy Prediction Model (RouteE), Future Automotive Systems Technology Simulator (FASTSim), OpenPATH, and Transportation Technology Total Cost of Ownership (T3CO) Principal Investigator: Jeff Gonder, National Renewable Energy Laboratory

Question 1: Approach to Performing the Work: Is the project well designed, and is the timeline reasonably planned?

Reviewer 1

The reviewer observed the technical barriers seemed a bit broad, although this might be reasonable given the breadth of this project and the variety of models that it covers. Nevertheless, it might be helpful to provide a bit more detail on what these impacts might be (costs, emissions, etc.).

Reviewer 2

The reviewer asserted this is a potentially very impactful project. There is high confidence in the team addressing all technical barriers, but the project effectively just started.

Reviewer 3

The reviewer commented the team's approach is good and involves the use of FASTSim for real-world fuel economy modeling, route energy prediction, transportation technology total cost of ownership modeling, and instrumenting human mobility with OpenPATH.

Question 2: Technical Accomplishments and Progress: Comments on the technical progress that has been made compared to project plan.

Reviewer 1

The reviewer observed that given the very brief implementation period, the progress described in the presentation is very impressive. There are no directed comments on progress, but the results from the numerous modeling efforts under the umbrella of this project are eagerly awaited until next year's update.

Reviewer 2

The reviewer remarked the project team is effective in overcoming barriers, such as improving models and data availability to support research and development of advanced mobility solutions. Examples of the prior accomplishments are evident in propagation of FastSim to many users globally. The Google decision to employ the project's results to allow Google Map users to make informed decisions about less GHG producing routes is an excellent example of how to achieve high impact quickly and at the same time cope well with high uncertainty and rapid changes in mobility technology and behaviors. The developments of NREL's web-API and smart device app are commendable too.

Reviewer 3

The reviewer said the team has the following significant accomplishments: Numerous EEMS application examples (BEAM CORE, Optimizing regional mobility, big data solutions for Mobility, etc.); broader VTO/DOE applications to decarbonization, energy analytics, and total cost of ownership; industry users including Google Maps, GM, Toyota, and DOE 21st Century Truck Partnership; and other users such as the Colorado Energy Office, etc.

Question 3: Collaboration and Coordination Across Project Team: Are there specific contributions made by industry, national laboratories, or other external entities? Are there areas where more collaboration is needed?

Reviewer 1

The reviewer stated the project clearly demonstrates a wide array of collaborative activities given the scope and breadth of modeling efforts being covered. There are many examples throughout the presentation of engagement with partners and stakeholders. One suggestion would be to improve Slide 21 to explicitly show the connection of each entity with project activities (e.g., X,Y,Z were involved with FastSIM and A,B,C were involved with OpenPATH etc.).

Reviewer 2

While the project team is no stranger to establishing effective collaborations and delivering useful results collaboratively, the reviewer commented that a clearer coordination plan is needed at least for main/primary collaborators. Perhaps, the lack of such a plan is because the project is in its very beginning stages and that FastSim is so popular among many R&D teams, but a clear plan is still recommended.

Reviewer 3

The reviewer said this project involves numerous collaborations across national labs and industry partners/stakeholders.

Question 4: Proposed Future Research: Has the project clearly defined a purpose for future work? To what extent will future work likely achieve its targets?

Reviewer 1

The reviewer stated the description of future work was well done, which included both technical aspects of the modeling but also potential engagement activities that demonstrate alignment with the stated objectives of the project.

Reviewer 2

The reviewer remarked the project is almost all in the future since it has barely started. The examples of implemented results so far suggest that the future goals will be more clearly defined this year and will be refined every year accordingly.

Reviewer 3

The reviewer observed the proposed future work plan includes eco-routing approaches, documentation, vehicle updates, and enhancements to OpenPATH. This plan is well-motivated.

Question 5: Relevance: Does the project support the overall VTO subprogram objectives?

Reviewer 1

The reviewer said the project lines up with VTO objectives.

Reviewer 2

The reviewer commented the relevance of this project to the overall VTO subprogram objectives is very clear.

Reviewer 3

The reviewer found the project supports the VTO subprogram's stated goal of modeling transportation systems with a view to reducing energy use and improving mobility.

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

Reviewer 1

The reviewer stated the amount of funding seems reasonable for the scope and size of the project.

Reviewer 2

The reviewer concluded the project has sufficient resources to achieve and even exceed its goals. The project team plans to have extensive outreach to many organizations (albeit with a yet to be clarified plan), and that is the reason the milestones could be exceeded.

Reviewer 3

The reviewer stated the approved budget for 3 years is appropriate.

Acronyms and Abbreviations

ACC	Adaptive cruise control
ACEEE	America Council for an Energy-Efficient Economy
ACM	American Center for Mobility
AMR	Annual Merit Review
ANL	Argonne National Laboratory
ARPA-E	U.S. Department of Energy Advanced Research Projects Agency-Energy
BEAM	Behavior, Energy, Autonomy, and Mobility
BEAM CORE	Behavior, Energy, Autonomy, and Mobility Comprehensive Regional Evaluator
BEV	Battery electric vehicle
CAN	Controlled area network
CARMA	Cooperative automation research mobility applications
CAV	Connected and automated vehicle
CAVE	Connected and Automated Vehicle Environment
CDA	Cooperative driving automation
CMU	Carnegie Mellon University
HDOT	Hawaii Department of Transportation
COVID-19	Coronavirus disease 2019
CRADA	Cooperative research and development agreement
CV2X	Cellular vehicle-to-everything
DOE	U.S. Department of Energy
DOT	[state or city] Department of Transportation
DOT	U.S. Department of Transportation
DSRC	Dedicated short-range communication
Eco ATCS	Ecological Adaptive Traffic Control System
EEMS	Energy Efficient Mobility Systems program
EPA	U.S. Environmental Protection Agency
EV	Electric vehicle
FHWA	Federal Highway Administration
FM/LM	First mile/last mile
FTE	Full-time equivalent
FY	Fiscal Year

GHG	Greenhouse gas
GM	General Motors
HIL	Hardware-in-the-loop
HMI	Human-machine interface
HPC	High-performance computing
IARIA	International Academy, Research and Industry Association
ICE	Internal combustion engine
IIT	Illinois Institute of Technology
IMU	Inertial measurement unit
INEXUS	Individual Experienced Utility-based Synthesis
INL	Idaho National Laboratory
ITS	Intelligent Transportation Systems
JPO	Joint Programs Office
LBNL	Lawrence Berkeley National Laboratory
LiDAR	Laser imaging, detection, and ranging
MEP	Mobility Energy Productivity
ML	Machine learning
MOTION	MObility Technology Interstate Observation Network
MOVES	MOtor Vehicle Emission Simulator
MPO	Metropolitan planning organization
MTU	Michigan Technological University
NEMA	National Electrical Manufacturers Association
NHTSA	National Highway Traffic Safety Administration
NREL	National Renewable Energy Laboratory
ODD	Operational design domain
OEM	Original equipment manufacturer
ORNL	Oak Ridge National Laboratory
PATH	Partners for Advanced Transportation Technology
PHEV	Plug-in hybrid electric vehicle
PI	Principal Investigator
PNNL	Pacific Northwest National Laboratory
POLARIS	Planning and Operations Language for Agent-based Regional Integrated Simulation

R&D	Research and development
RDD&D	Research, development, deployment, and demonstration
SAE	Society of Automotive Engineers
SMART	Systems and Modeling for Accelerated Research in Transportation
SSAM	Surrogate Safety Assessment Model
SUMO	Simulation of Urban MObility
SVTRIP	Stochastic vehicle trip prediction
TAT	Traffic Analysis Toolbox
TNC	Transportation network companies
TNC	Transportation network companies
U.S. DRIVE	United States Driving Research and Innovation for Vehicle efficiency and Energy sustainability
UAV	Unmanned aerial vehicle
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
V2X	Vehicle-to-anything
VIL	Vehicle-in-the-loop
VOICES	Virtual Open Innovation Collaborative Environment for Safety
VTO	Vehicle Technologies Office
VTOL	Vertical take-off and landing
XIL	Everything-in-the-loop

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