4. Energy Efficient Mobility Systems

The Vehicle Technologies Office (VTO) supports research, development, demonstration, and deployment (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 innovations in connected infrastructure for significant systems-level energy efficiency improvement); innovative powertrains to reduce greenhouse gas (GHG) and criteria emissions from hard to decarbonize off-road, maritime, rail, and aviation sectors; and technology integration that helps demonstrate and deploy new technology at the community 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), VTO 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 RDD&D 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 populations and energy communities, benefit from the development and deployment of clean transportation technologies.

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

Project Feedback

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

Table 4-1 – Project Feedback

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaboration	Future Research	Weighted Average
EEMS013	ANL Core Tools-Simulation	Phil Sharer (Argonne National Laboratory)	4-7	3.20	3.30	3.20	3.10	3.24
EEMS041	ANL Everything-in-the-loop (XIL) Capabilities	Kevin Stutenberg (Argonne National Laboratory)	4-11	3.50	3.63	3.75	3.63	3.61
EEMS066	Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing	Lauren Spath-Luhring (National Renewable Energy Laboratory)	4-14	3.50	3.38	3.50	3.38	3.42
EEMS089	Energy Efficient CAVs, Workflow Development and Deployment	Dominik Karbowski (Argonne National Laboratory)	4-17	3.75	3.63	3.88	3.67	3.69
EEMS090	Applying Artificial Intelligence (AI) Based Signal Coordination and Controls for Optimized Mobility for the Nimitz Highway	Hong Wang (Oak Ridge National Laboratory)	4-20	3.25	3.13	3.50	3.25	3.22
EEMS092	BEAM CORE	Anna Spurlock (Lawrence Berkeley National Laboratory)	4-23	3.00	3.10	3.30	3.10	3.10
EEMS093	Transportation System Impact, POLARIS Workflow Development, Implementation and Deployment	Joshua Auld (Argonne National Laboratory)	4-28	3.50	3.75	3.8	3.50	3.67

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaboration	Future Research	Weighted Average
EEMS094	Development and Validation of Intelligent Connected and Automated Vehicle (CAV) Controls for Energy-Efficiency	Dominik Karbowski (Argonne National Laboratory)	4-32	3.30	3.40	3.60	3.20	3.38
EEMS095	Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use	Jinghui Yuan (Oak Ridge National Laboratory)	4-37	2.58	2.67	3.42	2.33	2.70
EEMS096	Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies and Sensors	Thomas Wallner (Argonne National Laboratory)	4-42	3.00	3.10	3.20	2.90	3.06
EEMS097	Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE)	Andrew Duvall (National Renewable Energy Laboratory)	4-47	3.60	3.60	3.50	3.40	3.56
EEMS098	Optimizing Drone Deployment for More Effective Movement of Goods	Victor Walker (Idaho National Laboratory)	4-51	3.25	3.38	3.50	3.13	3.33
EEMS099	Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems (EEMS)	Venu Garikapati (National Renewable Energy Laboratory)	4-55	3.67	3.50	3.67	3.67	3.58
EEMS100	Dynamic Curb Allocation	Nawaf Mohammed (Pacific Northwest National Laboratory)	4-58	2.90	2.90	3.00	2.60	2.88
EEMS101	RealSim, An Anything-in-the-loop Platform for Mobility Technologies	Yunli Shao (Oak Ridge National Laboratory)	4-63	3.63	3.88	3.63	3.63	3.75
EEMS102	AI-Engine for Optimizing Integrated Service in Mixed Fleet Transit Operations	Philip Pugliese (Chattanooga Area Regional Transportation Authority)	4-66	3.10	3.20	3.30	3.00	3.16

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaboration	Future Research	Weighted Average
EEMS103	Transit-Centric Smart Mobility System for High-Growth Urban Activity Centers, Improving Energy Efficiency through Machine Learning	Jinhua Zhao (Massachusetts Institute of Technology)	4-70	3.25	3.38	3.38	3.25	3.33
EEMS104	Increasing Affordability, Energy Efficiency, and Ridership of Transit Bus Systems through Large-Scale Electrification	Ziqi Song (Utah State University)	4-73	3.40	3.30	3.30	3.10	3.30
EEMS105	Energy Optimization of Light and Heavy Duty Vehicle Cohorts of Mixed Connectivity, Automation and Propulsion System Capabilities via Meshed V2V-V2I and Expanded Data Sharing	Darrell Robinette (Michigan Technological University)	4-77	3.50	3.30	3.20	3.00	3.30
EEMS106	Developing an Energy-Conscious Traffic Signal Control System for Optimized Fuel Consumption in Connected Vehicle Environments	Mina Sartipi (University of Tennessee)	4-82	2.90	3.10	3.50	2.90	3.08
EEMS107	Improving network-wide fuel economy and enabling traffic signal optimization using infrastructure and vehicle-based sensing and connectivity	Joshua Bittle (University of Alabama)	4-87	2.90	3.10	3.10	2.90	3.03
EEMS108	Co-Optimization of Vehicles and Routes	Nick Hertlein (PACCAR)	4-92	2.70	2.80	2.90	2.80	2.79
EEMS109	Connected and Learning Based Optimal Freight Management for Efficiency	Ali Borhan (Cummins)	4-96	3.50	3.50	3.40	3.30	3.46

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaboration	Future Research	Weighted Average
EEMS110	Human Factors and Technologies Design to Improve User Acceptance of Pooled Rideshare (PR) for Increasing Transportation System Energy Efficiency	Yunyi Jia (Clemson University)	4-100	3.38	3.63	3.63	3.38	3.53
EEMS111	Contextual Predictions and Eco Services for Electrified Vehicles	Jacopo Guanetti (AV-Connect, Inc.)	4-104	2.88	2.88	2.75	2.83	2.85
EEMS112	NREL Core Modeling & Decision Support Capabilities (RouteE, FASTSim, OpenPATH, T3CO)	Jeff Gonder (National Renewable Energy Laboratory)	4-108	3.00	3.20	3.40	3.00	3.15
EEMS113	Testing and Evaluation of Curb Management and Integrated Strategies to Catalyze Market Adoption of Electric Vehicles	Lauren Harper (Los Angeles Cleantech Incubator)	4-112	3.38	3.38	3.38	3.38	3.38
EEMS114	Real Twin	Yunli Shao (Oak Ridge National Laboratory)	4-116	3.33	3.00	3.00	3.00	3.08
EEMS115	Modeling Connected and Automated Vehicles (CAV) Compute Power	Ben Feinberg (Sandia National Laboratories)	4-119	2.75	2.88	2.63	2.88	2.81
EEMS116	High-Quality Perception Data	Zach Asher (Western Michigan University)	4-122	3.25	3.25	3.13	3.25	3.23
EEMS117	Visual-Enhanced Cooperative Traffic Operations (VECTOR) System	Cami Qianwen (University of South Florida)	4-126	2.83	2.83	3.33	2.83	2.90
EEMS118	AI-Based Mobility Monitoring System and Analytics Demonstration Pilot	Scott Samuelson (University of California, Irvine)	4-129	2.75	3.25	3.00	2.88	3.05

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaboration	Future Research	Weighted Average
EEMS119	Improved Mobility and Energy Savings Through Optimization of Cooperative Driving Automation (CDA) Application for Signal Controls for Arterial Mixed Traffic Scenarios	Xiao-Yun Lu (Lawrence Berkeley National Laboratory)	4-133	3.50	3.00	3.17	3.33	3.19
EEMS120	A Cooperative Driving Automation (CDA) Framework for Communications	Adian Cook (Oak Ridge National Laboratory)	4-136	3.30	3.00	3.20	3.10	3.11
EEMS121	Decentralized and Cooperative Traffic Signal Network for Freight Energy Efficiency, Safety, Sustainability, and Public Health	Michael Lim (Xtelligent)	4-140	3.25	3.00	3.38	3.25	3.14
Overall Average				**3.21**	**3.24**	**3.33**	**3.14**	**3.23**

Presentation Number: EEMS013
Presentation Title: ANL Core Tools-Simulation
Principal Investigator: Phil Sharer (Argonne National Laboratory)

Presenter

Phil Sharer, Argonne National Laboratory

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.

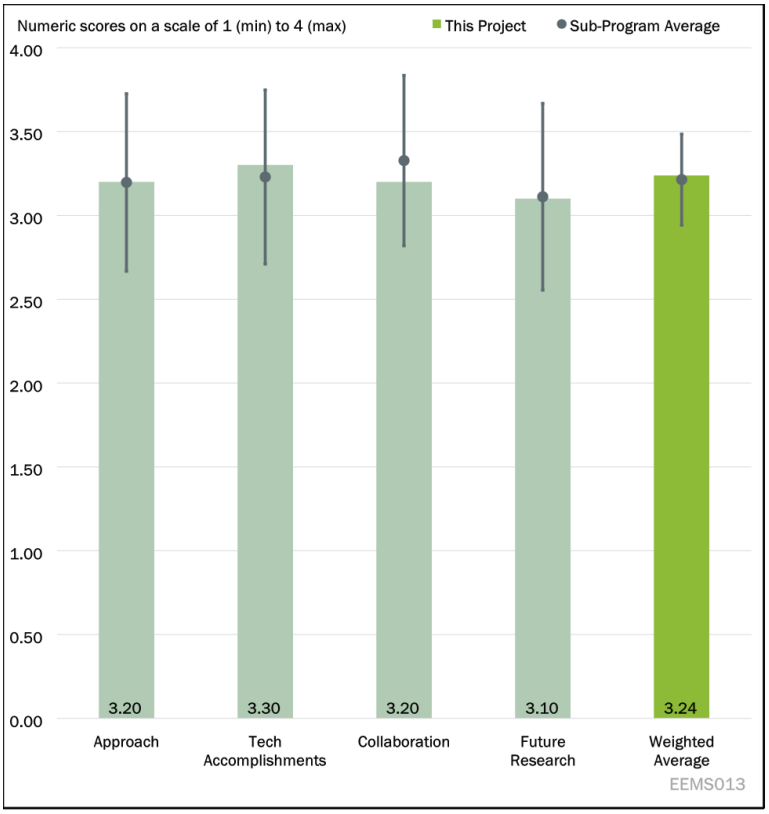

Figure 4-1 - Presentation Number: EEMS013 Presentation Title: ANL Core Tools-Simulation Principal Investigator: Phil Sharer (Argonne National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the approach to modeling and tool development is sound with Advanced Model Based Engineering Resource (AMBER) being used as a framework for model-based systems engineering workflows and with ongoing integration of data and inputs from public and private sources.

Reviewer 2:

The reviewer commented that the work approach is solid. The remaining challenges are non-trivial and overcoming them is essential to achieving the intended outcome. Work should prioritize usability of the software over chasing precision.

Reviewer 3:

The reviewer stated that the project addresses all technical barriers, is well designed with a well-planned timeline.

Reviewer 4:

The reviewer commented that the technical barriers were addressed and described sufficiently. There were plans for overcoming them, noting the uncertainty involved in some cases. This indicates a well-designed project and milestone plan. Integrating and synchronizing metadata from various files is a significant undertaking which will accelerate future progress, as well as make the final product(s) more user friendly. It is

unclear how updated version releases of the subcomponent software applications will be handled to sustain future support and enhancements.

Reviewer 5:

This reviewer described the work as more academic and less industrial oriented.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that Autonomie AI and Aeronomie are new developments allowing faster computation and non-traditional battery electric vehicle (BEV) architecture studies.

Reviewer 2:

The reviewer commented that clear progress has been made across the areas. Consistent with work approach, overcoming the remaining barriers must be the dominant priority moving forward.

Reviewer 3:

The reviewer stated that this project demonstrated good technical progress.

Reviewer 4:

The reviewer noted that the progress, in comparison to the plan timeline, appears to be excellent. This is largely due to the extensive effort in stakeholder outreach. The complex nature of the work, with an eye toward anticipated users helps ensure buy-in from stakeholders, more licenses to support future maintenance and product implementation and adoption.

Reviewer 5:

The reviewer said that there was scattered incremental progress.

Question 3: Please comment on the collaboration within the 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 "Core" tools are tightly integrated across multiple projects and government agencies such as National Highway Traffic Safety Administration (NHTSA), Driving Research and Innovation for Vehicle Efficiency and Energy Sustainability (U.S. DRIVE), EcoCAR, 21st Century Truck Partnership (21CTP), etc.

Reviewer 2:

The reviewer commented that the projects are clearly coordinated across projects. The interdependence can be a problem as the embedding, layering, and handoff compounds errors and uncertainties that inherently and naturally exist in models. More emphasis needs to be on ensuring the usefulness of the models vs. complexity.

Reviewer 3:

The reviewer stated that this project has well planned collaboration and coordination across its members.

Reviewer 4:

The reviewer observed that the presentation demonstrated a significant collaboration with various vendors, data sources, other national laboratories, DOT NHTSA and industry. It is good to cite related VTO projects and which ones this project supports. It would be helpful to list the projects and the specific links in objectives between them. The reviewer is not sure if or why there was not interaction with DOT/FHWA because of their previous and planned investments in electrification through charging corridors Federal Aviation Administration (FAA) because of airspace regulation, and the Federal Railroad Administration (FRA) because

of railroad regulation. Also, the American Association of State Highway and Transportation Officials (AASHTO) and interaction with the National Academies would be good objective criticism and exposure and perhaps participation/assistance from some state highway agencies.

Reviewer 5:

The reviewer commented that close collaboration amongst partners is not visible and there is uncoordinated independent research and results.

Question 4: Please comment on the 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 proposed future research involving extensions to other transportation modes and incorporating very large datasets is well-motivated and will be useful when completed.

Reviewer 2:

The reviewer said the proposed work is what should be expected but does not offer any remarkable or breakthrough ideas.

Reviewer 3:

The reviewer noted that the proposed future research is clearly defined, will likely achieve its targets.

Reviewer 4:

The reviewer commented that the future research in terms of aviation and rail are ambitious. Since the design and operational parameters are highly proprietary and there are strict regulations in place that must be considered, these potential barriers could hinder future research with the funding and timeline available. Assuming revenue from the licensees and federal agencies involved, the continued stakeholder outreach and expanded outreach to standards organizations, like AASHTO, it may be possible.

Reviewer 5:

The reviewer said that a re-assessment of original goals and assessment of gaps/resources might be valuable. It requires consideration for a zero-emission future transportation that could challenge the potential application of the outcome of this research applicable to internal combustion engines or plug-in hybrid transportation.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that the tools and datasets developed as a result of this project will be very useful for setting the policy and developing strategies for carbon dioxide (CO_2) reduction in future years.

Reviewer 2:

The reviewer noted that as established projects, each project has a history of supporting the VTO subprogram objectives. The merit of those objectives is a separate question.

Reviewer 3:

The reviewer said that this project supports VTO project objectives very well.

Reviewer 4:

The reviewer commented that the project is highly relevant to the VTO subprogram objectives, and they appropriately cite related projects. If these projects are encouraged to share expertise and resources, the chances of success are improved. It would also be helpful for the VTO office representative overseeing this project make an effort to coordinate with other agencies (e.g., DOT) to see where interests overlap and where

resources (funding, facilities, data, etc.) may be shared symbiotically. There should be funding available through the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA) to support this research.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that this is a broad and comprehensive activity and the allocated funds of $5.4 million ($3.6 million received) from October 2021 to September 2024 are just right to get the tasks done.

Reviewer 2:

The reviewer said that overall, the resources are sufficient. Moving forward, the program should look to ways to reduce the financial resources needed and set clearer timelines and more specific goals for the funding allocated.

Reviewer 3:

The reviewer noted that provided the total funding is provided, the stated milestones should be achievable based on current progress. However, additional time and funding will be required for the recommended future research.

Reviewer 4:

The reviewer said that funding is sufficient but appears uncoordinated.

Presentation Number: EEMS041
Presentation Title: ANL Everything-in-the-loop (XIL) Capabilities
Principal Investigator: Kevin Stutenberg (Argonne National Laboratory)

Presenter

Kevin Stutenberg, Argonne National Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

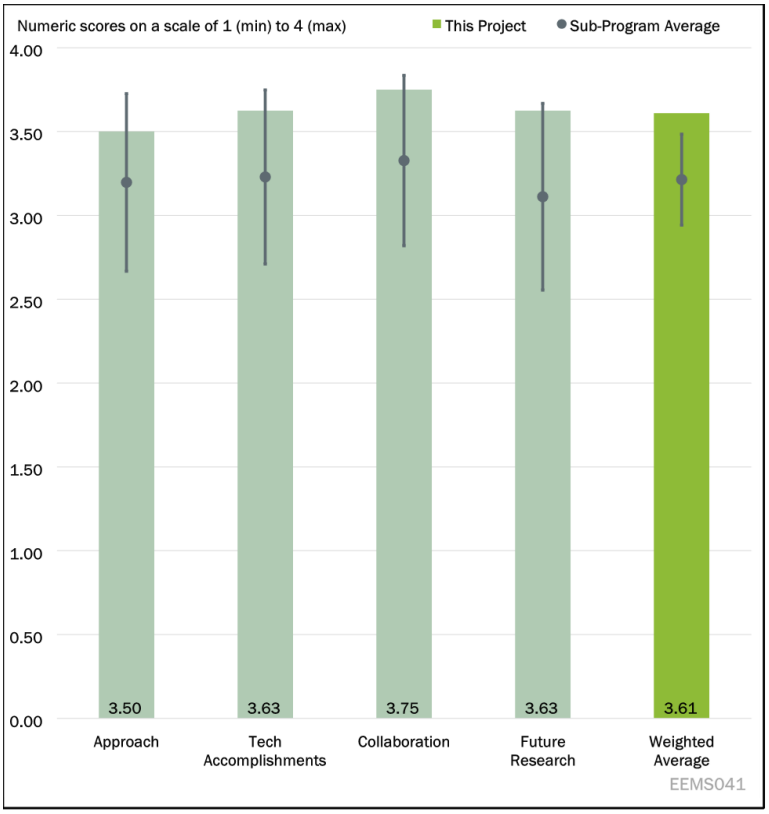

Figure 4-2 - Presentation Number: EEMS041 Presentation Title: ANL Everything-in-the-loop (XIL) Capabilities Principal Investigator: Kevin Stutenberg (Argonne National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that there is an intrinsic difficulty in trying to get the fundamental information that underpins this research since original equipment manufacturers (OEMs) are very proprietary about their system data and behavior. This is a difficult barrier to overcome.

Reviewer 2:

The reviewer commented that the project addresses all technical barriers, well designed and well planned.

Reviewer 3:

The reviewer stated that there was an excellent integration of experimental, modeling and controls. Good progress has been made on all the objectives. The researchers understand issues with vehicle complexity, ability to manipulate vehicle controls, and that OEM support will likely be necessary going forward.

Reviewer 4:

The reviewer stated that the approach of everything-in-the-loop (XIL) is a very good approach to reduce closed track testing and allows for controlled environment and conditions. Track testing is time and money consuming. Excellent vision to setup this project and other complimentary DOE projects to support the XIL initiative.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the team has done a tremendous job in getting the data with ingenious workarounds. The virtual vehicle-to-everything (V2X) work is quite impressive.

Reviewer 2:

The reviewer noted that the progress is good, but it is only 30% done. Good new vehicles are to be included (this year: Ford F150 Lightning, Cadillac Lyriq, Fiscal Year (FY) 2024: Additional two new XIL research vehicles), which is good.

Reviewer 3:

The reviewer stated that the extensive development and integration is complete demonstration of integrated controls with virtual scenarios. The reviewer was unclear on the ten multi-vehicle scenarios completed whether these were "virtual" vehicles or data recorded from real vehicles. A need going forward is to have realistic, probabilistic interaction with vehicles, traffic, and uncertainty in inputs and signals. If utilizing virtual vehicles, the reviewer suggested specifying what driver model is used and whether in the micro traffic scenarios it is representative of human and other connected and automated vehicles (CAVs).

Reviewer 4:

The reviewer said that the ability to have the dynamometer adjust road grade to the profile of real-world road and infrastructure is an awesome feature that will aid in future CAV research and testing.

Question 3: Please comment on the collaboration within the 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 there is a great mix of university, government laboratories and agencies. The reviewer commented that the team would be improved with some sort of OEM collaboration but realizes that this is difficult to arrange.

Reviewer 2:

The reviewer noted that the collaboration and coordination is well planned.

Reviewer 3:

The reviewer commented that there was excellent coupling and coordination between hardware, controls and software teams.

Reviewer 4:

The reviewer noted there was great collaboration with other national laboratories and universities.

Question 4: Please comment on the 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 next steps are meaningful to advancing XIL research capabilities. With increased OEM concern about hacking cars, it seems there is a risk of the work becoming more difficult with ever increasing security measures.

Reviewer 2:

The reviewer commented that the proposed future research is well planned and will very likely achieve its targets.

Reviewer 3:

The reviewer stated that the integration of XIL research vehicles is a good selection. The team has commitments from OEMs for assistance which is important going forward. With respect to XIL workflow, possible to data mine the DOE EEMS projects for road data.

Reviewer 4:

The inclusion of newer vehicles—such as the Ford F150 Lightning and Cadillac Lyriq—was mentioned in the context of hurdles of getting connectivity to the vehicle controls. The inclusion of lateral loading will help in fully representing the dynamics of the vehicle but is not sure if it will lead to more accurate energy consumption relative to longitudinal dynamics, but nonetheless, will make the whole of XIL more representative. It would be really neat to see distributed XIL demonstration of multiple laboratory locations and vehicles operating cooperatively connected to the XIL platform.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted that the project is highly relevant to quantifying performance of V2X technologies which is a key technology research area.

Reviewer 2:

The reviewer commented that this project supports the VTO objectives very well.

Reviewer 3:

The reviewer believes that this project supports the overall VTO EEMS subprogram.

Reviewer 4:

The reviewer commented that this project and related ones will help in making the case to OEMs to develop cooperative connected control and automation to reduce fuel consumption. Without all OEMs getting onboard the fleet would not get there, thus this and associated projects will help steer legislation that incentivizes OEMs to work towards hardware and software that will enable functionality across multiple vehicle brands.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said resources appear adequate. The work is on schedule and on budget.

Reviewer 2:

The reviewer commented that the resources are well aligned with the project.

Reviewer 3:

The reviewer stated that yes, the project has sufficient computer, software, vehicle, dynamometer, measurement, and road/closed track facilities to execute with the necessary instrumentation and vehicle interfacing abilities to conduct the work on time and budget.

Presentation Number: EEMS066
Presentation Title: Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing
Principal Investigator: Lauren Spath-Luhring (National Renewable Energy Laboratory)

Presenter

Lauren Spath Luhring, National Renewable Energy Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

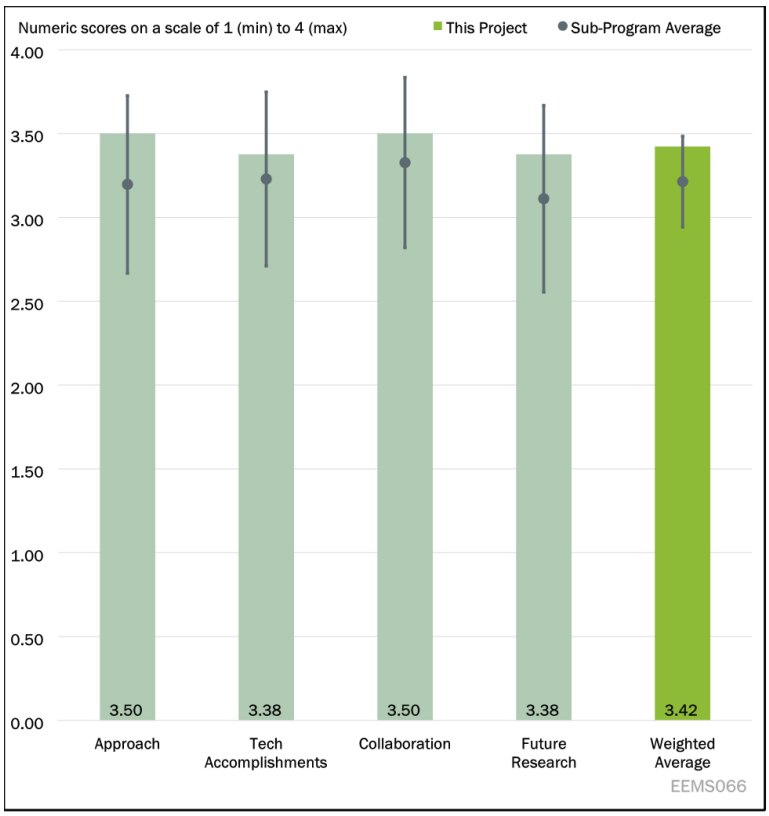

Figure 4-3 - Presentation Number: EEMS066 Presentation Title: Livewire Data Platform-A Solution for Energy Efficient Mobility Systems (EEMS) Data Sharing Principal Investigator: Lauren Spath-Luhring (National Renewable Energy Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the Livewire project approach focuses on platform development and security, data quality characterization, catalog growth and user support. These are all excellent focus areas for this type of work.

Reviewer 2:

The reviewer said that initiated in 2019, the Livewire Data Platform (LDP) provides for the sharing, preserving, and discovering of energy efficiency and mobility research data. The basic approach is to build off other successful data platforms focusing upon platform development and security, data quality characterization, catalog growth, and user support. The Livewire Data Working Group (DWG) was established in 2021 to provide a forum for feedback and input from data owners and data users, which is good. Overall, a reasonable approach. A fundamental deficiency is the lack of robust metrics to truly assess the "value" and return on investment of the LDP. The present metrics, such as number of projects, users, datasets, and files stored do not truly assess "value."

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that the Livewire team has accomplished the following: (1) self-service data upload capability; (2) user access validation for privileged data; (3) whitepaper publication, describing platform enhancements; (4) development of reference document categories; and, (5) publication of detailed metadata and quality characterization for 32 datasets and several additional noteworthy deliverables.

Reviewer 2:

The reviewer stated that the technical accomplishments and progress outlined in their presentation qualifies them for "outstanding" scoring.

Reviewer 3:

The reviewer said that during the past year, the project has achieved an acceptable list of technical accomplishments, mostly information technology related in nature. These include self-service upload capability, validation of user access to Tier 3 datasets, and addition of reference document categories. Most importantly was the accomplishment that the LDP was enabled to support cross-federation of datasets to/from other similar catalogs (e.g., DOT's data.transportation.gov). Overall, however, accomplishments specifically enhancing hard value appear to be lacking.

Question 3: Please comment on the collaboration within the 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 Livewire is based on a strong collaboration between Idaho National Laboratory (INL), NREL, and Pacific Northwest National Laboratory (PNNL), plus partnerships with EEMS Systems and Modeling for Accelerated Research in Transportation (SMART), and VTO Technology Integration (TI) subprogram.

Reviewer 2:

The reviewer stated that the Livewire platform interface and quality demonstrates the coordination and integration between teams. Similarly, the variety of datasets hosted by it. Indeed, our performer used this platform for one of our program projects.

Reviewer 3:

The reviewer noted that the project team is sound incorporating three national laboratories and solid communications/coordination with the EEMS research community, VTO-funded funding opportunity announcement (FOA) awardees, and mobility researchers. Data has been incorporated from more than 60 organizations, DOE, national laboratories, and many research partners. Consideration of industry involvement may be good to gain additional insights, perspectives, and recommendations.

Question 4: Please comment on the 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 future research plan is sound, including (1) development of a pipeline to standardize and curate metadata and data; (2) elimination of manual processes for creating and submitting high level metadata; (3) distribution of a quarterly email newsletter re: updates; (4) data quality analysis; and, (5) demonstration of growth and continued impact of NREL's Transportation Secure Data Center (TSDC) and Fleet DNA tool.

Reviewer 2:

The reviewer stated that there does not seem to be a robust plan for making this platform/data available and helpful to other researchers outside EEMS, much less to practitioners in the field. The reviewer understands this is a relatively new aspect of the work, but this seems to be a critical area that needs more focus and attention. Simply creating a periodic newsletter and asking people to forward it is not a strategy. The reviewer would like to see a fully developed marketing and communication plan that includes proactive outreach to transportation researchers, academics, consulting firms, industry, local transportation planners, other NGOs, and more.

Reviewer 3:

The reviewer noted that it is integral for enhancing the full capabilities of the platform.

Reviewer 4:

The reviewer very much liked the proposed future research with regards to the "data analysis center." This could enhance interest, user-friendliness, and overall impact. Moving forward it is recommended that the LDP work to enhance its value and return on investment. Consideration could be given to several items including (1) identifying / instituting new metrics to more accurately determine the value of the LDP; (2) enhancing the utilization of the DWG; (3) instituting requirements for cost share; and, (4) consideration of migration of the LDP to an industry host for further development, management, and user support.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that this data is key to modeling studies on transportation, mobility, and CO_2. Hence Livewire plays a key role towards achieving the overall VTO program objectives.

Reviewer 2:

The reviewer commented that yes, it does have relevance.

Reviewer 3:

The reviewer noted that in general, there is a need for a secure, accessible data repository to facilitate the RDD&D of advanced transportation technologies. This can accelerate the pace of RDD&D and leverage/lead to more expeditious use of funds.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the allocated budget of $5.1 million over approximately 3 years is just right for the list of milestones planned for Livewire.

Reviewer 2:

The reviewer commented that the funding resources for this project seem excessive and there is no cost share. Consideration could be given to requirements for cost share for project continuation.

Reviewer 3:

The reviewer commented that yes, the resources are sufficient.

Presentation Number: EEMS089
Presentation Title: Energy Efficient CAVs, Workflow Development and Deployment
Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

Presenter

Dominik Karbowski, Argonne National Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

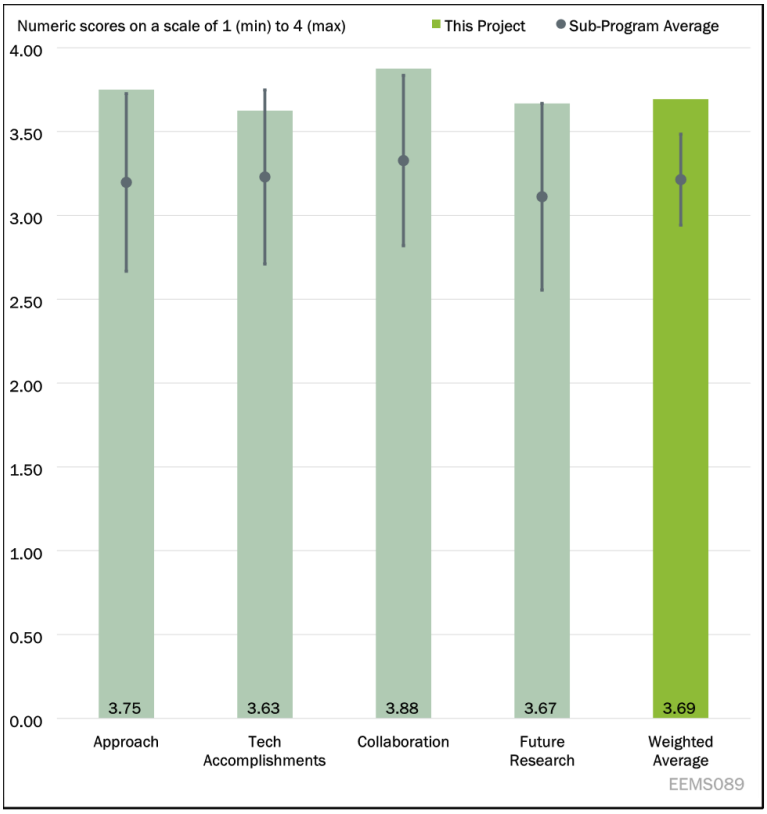

Figure 4-4 - Presentation Number: EEMS089 Presentation Title: Energy Efficient CAVs, Workflow Development and Deployment Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the project is very effective, showing excellent progress in addressing tech barriers in a well-planned timeline.

Reviewer 2:

The reviewer stated that the work performed by lead and partner organizations related to models, workflows, and software has been performed in a logical manner and takes advantage of the strengths of each partner/collaborator. The integration of Development and Validation of Intelligent CAV Controls for Energy Efficiency (EEMS094), Argonne National Laboratory (ANL) Core Tools-Simulation (EEMS013), and ANL everything-in-the-loop (XIL) Capabilities (EEMS041), into this program seems to optimize the project's timeline.

Reviewer 3:

The reviewer commented that the approach is outstanding.

Reviewer 4:

The reviewer said the approach is strong and links together four other EEMS projects, pulls in other national laboratories and vehicle OEMs. The technical approach to CAV workflow is solid.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the project has excellent developments, all according to the plan.

Reviewer 2:

The reviewer said that most of the work is finalized, so this shows that the team was able to overcome barriers and produce the needed outcomes. Note that the comment made about developing a human model based on Hyundai's data is not trivial, this model needs to be validated with other vehicles and types of drivers in future projects to ensure it is representative of the current driving population.

Reviewer 3:

The reviewer said that the technical accomplishments and progress are outstanding.

Reviewer 4:

The reviewer said that the team has accomplished significant milestones and technical works. Of particular interest is the AI vehicle speed prediction for vehicle profiling and the deployment of the human driver model to an OEM. The demonstrations of CAVs under virtual traffic conditions are a great step for XIL on a dynamometer.

Question 3: Please comment on the collaboration within the 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 the collaboration and coordination across the project team is excellent.

Reviewer 2:

The reviewer commented that the project having General Motors (GM)/Nissan as stakeholders is important given the need for use and validation of the developed products/deliverables of these projects. For further projects, it would be important to have a larger stakeholder group for feedback on validation and implementation.

Reviewer 3:

The reviewer said that the collaboration and coordination across the project team was outstanding.

Reviewer 4:

The reviewer commented that the team has pulled in all the right stakeholders to maximize project outcomes, from other national laboratories to vehicle OEM's who are actually taking and utilizing project technical work and tools.

Question 4: Please comment on the 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 believes that the project has good plan on the future research.

Reviewer 2:

The reviewer said that it meets the expectation of what will occur at the conclusion of the project and including additional scenarios and an additional validation of a CAV model.

Reviewer 3:

The reviewer stated that the proposed future research is outstanding.

Reviewer 4:

The reviewer said that no future research was discussed in the released materials or during the presentation given the project is close to the end of its period of performance.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer said that yes, it is a very good match with the VTO objectives.

Reviewer 2:

The reviewer commented that this is a very relevant project for VTO. Future projects to expand the different capabilities of the models, workflow, and software should branch out into other types of vehicles to ensure mobility is optimized (i.e., heavy vehicles).

Reviewer 3:

The reviewer stated that this project in combination with other EEMS is an integrated approach to showing how connectivity and automation can reduce energy consumption and improve traffic throughput all while trying to do it without costly and time-consuming closed test track testing—all pillars of what VTO is about.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer believes that the resources are sufficient.

Reviewer 2:

This project will end in September 2023. The funding allocation for the project seemed reasonable and sufficient given it takes advantage of several other related projects.

Reviewer 3:

The reviewer commented that the resources are sufficient and well spread out between collaborating partners. It is great to see what Clemson University was able to do with the digital twin and virtual track demonstration.

Reviewer 4:

The reviewer commented that the resources are sufficient.

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, Oak Ridge National Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

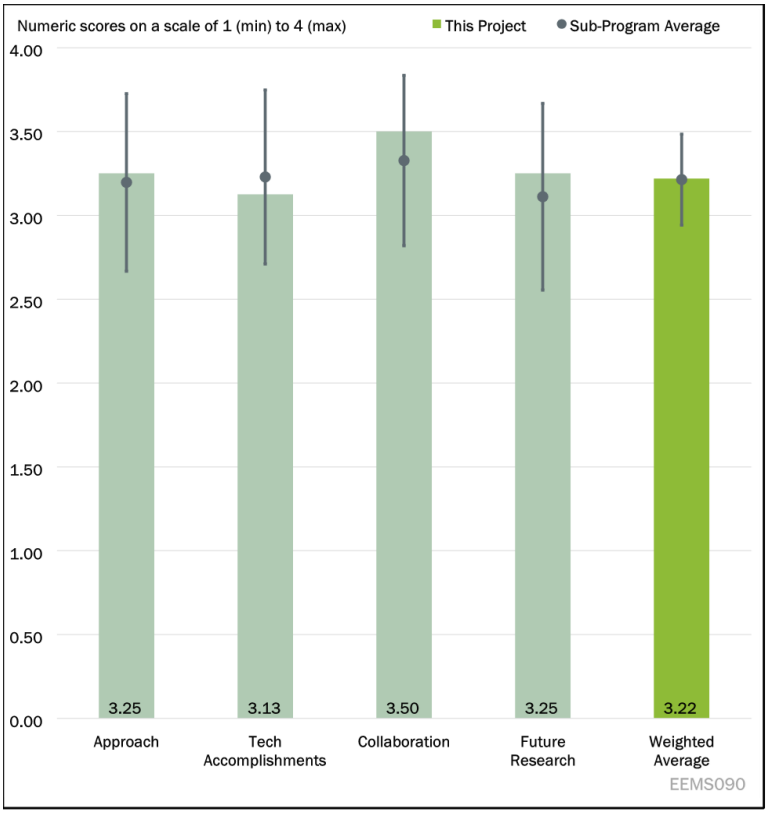

Figure 4-5 - Presentation Number: EEMS090 Presentation Title: Applying Artificial Intelligence (AI) Based Signal Coordination and Controls for Optimized Mobility for the Nimitz Highway Principal Investigator: Hong Wang (Oak Ridge National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer noted that the project is mostly complete, most testing has been completed, but is still awaiting some longer-term, whole system testing. The project uses AI to make better control algorithms for traffic flow. The energy model is based on fleet average, could these be leveraged to prioritize higher-emitting vehicle types or other goals (e.g., prioritize public transit weight times with potentially more passengers than personal/light duty vehicles)?

Reviewer 2:

The reviewer commented that considering that the only available information for this review is the presentation slides it is hard to understand how technical barriers were addressed. It is unclear from the presentation how the neural network (NN) was implemented in the process. The reviewer understands the role of the offline optimization through the microsimulation which produces optimal split is for the fixed cycle length, but it is not clear what nodes the NN control in real-time. Regardless, given that the project is almost complete, timeline was reasonably planned, and difficulties encountered were handled successfully.

Reviewer 3:

The reviewer noted that the project is 90% complete and is not listing remaining issues and need to complete remaining work.

Reviewer 4:

The reviewer indicated that the approach is acceptable and met the objectives.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that the team has completed the design of the algorithm and has completed several multi-day tests.

Reviewer 2:

The reviewer believed that as the project plan is assumed from the presentation, technical progress was steady and effective.

Reviewer 3:

The reviewer stated that the optimization of traffic flow is good. The energy saved estimation is very simplistic, but it is also good to evaluate the benefit of this project. BEV, Hybrid, and internal combustion engine (ICE) will all have different energy savings value to rate against the optimization of flow, but that is not likely needed here as the optimization of flow will likely be the dominant factor weighted against any balance of fleet.

Reviewer 4:

The reviewer noted that the project has good results.

Question 3: Please comment on the collaboration within the 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 team includes industry, university, and national laboratory partners. Industry support has provided computational resources and control technology of traffic lights to allow research to focus on developing algorithms/control strategies.

Reviewer 2:

The reviewer commented that the project has collaborations between industry, government, a national laboratory, and academia. The project performance and accomplishments show a very good coordination between the different actors.

Reviewer 3:

The reviewer noted that the oral presentation was handed off between partners well. The University of Hawaii with ORNL look to be completing the work together and on time.

Reviewer 4:

The reviewer expressed interest in seeing it applied to larger urban areas and a variation of drive conditions.

Question 4: Please comment on the 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 reported that the project is nearly complete, with some final testing to be performed ahead of licensing of technology by industry partner. Project resources are in place to complete the longer-scale testing.

Reviewer 2:

The reviewer stated that no description of future research was offered.

Reviewer 3:

The reviewer noted that the project is past 90% complete.

Reviewer 4:

The reviewer suggested it needs to be tested in different urban areas for further applications.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted that the project is aligned with program objectives to use AI/machine learning (ML) methods to improve the efficiency of the overall traffic system. By developing and implementing algorithms that are able to take real-time data inputs and appropriately time traffic lights, they are able to reduce the wait times of vehicles at intersections, reducing idling time.

Reviewer 2:

The reviewer commented that traffic control is necessary for the safe and efficient operation of a road network. There is not a single optimal solution since it is impossible to know each individual's cost in energy and time. Any methodology that utilizes available traffic data and given the level of information provides even a local optimal solution that is capable of adapting in the changing nature of traffic has the promise of gains. Therefore, this project is extremely relevant to operational improvement of current traffic control methodologies and technologies. Given that the methodology is utilizing AI, the reviewer felt researchers did not really learn anything new regarding the traffic system, therefore when new data sources and technologies become available the exercise will need to be repeated.

Reviewer 3:

The reviewer stated that the project looks to integrate future transportation technologies and reduce overall vehicle fleet energy use.

Reviewer 4:

The reviewer noted real world applications.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer believed the resources for this project are sufficient for the size of the team and scope of work.

Reviewer 2:

The reviewer noted that very good collaboration of the research team with the industry seems to have provided all necessary resources the project needed.

Reviewer 3:

The reviewer stated that the $2 million listed on Slide 2 should be sufficient to complete the entire project.

Reviewer 4:

The reviewer stated that the resources met the objectives.

Presentation Number: EEMS092
Presentation Title: BEAM CORE
Principal Investigator: Anna Spurlock (Lawrence Berkeley National Laboratory)

Presenter

Anna Spurlock, Lawrence Berkeley National Laboratory

Reviewer Sample Size

A total of five reviewers evaluated this project.

Project Relevance and Resources

80% of reviewers felt that the project was relevant to current DOE objectives, 20% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 60% of reviewers felt that the resources were sufficient, 0% of reviewers felt that the resources were insufficient, 40% of reviewers felt that the resources were excessive, and 0% of reviewers did not indicate an answer.

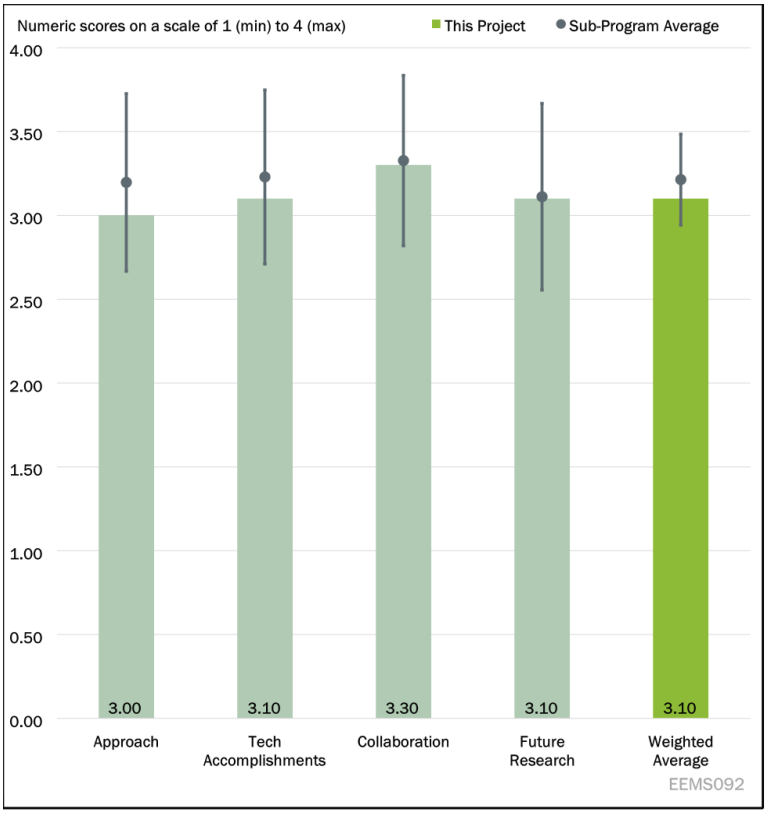

Figure 4-6 - Presentation Number: EEMS092 Presentation Title: BEAM CORE Principal Investigator: Anna Spurlock (Lawrence Berkeley National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer felt the project overall is challenging. There is a large amount of complexity and embedded parameters that make it hard to trace causes and provide transparency. Making the code available may make it transparent but it does not make it or the output practically traceable. As conveyed, there are a lot of exogenously defined inputs that seem to drive the output. This is where these inputs have little uncertainty or variability in the uncertainty which does not appear to be the case.

Reviewer 2:

The reviewer stated that this is a tremendous effort to model a very complex system of systems, with a lot of uncertainty.

Reviewer 3:

The reviewer commented that this is a great project with potentially huge impact. While some barriers are addressed, it is not clear how a couple of remaining barriers mentioned in the slides will be addressed: computational need for processing and knowledge of the existing MPO/ city employees to deploy this software.

Reviewer 4:

The reviewer's predominant concerns with Behavior, Energy, Autonomy, and Mobility Comprehensive Regional Evaluator (BEAM CORE) were centered around longevity/future usage of the tool. The reviewer did

not hear the team talking about many technical challenges that need to be addressed (outside of continuing to explore ways to increase the speed of the model). The reviewer heard more challenges related to documentation and transferring the product into the hands of future users of the tool once DOE's funding to develop the tool concludes at the end of the fiscal year. Right now, the tool is being applied for DOE analyses/talking points. The reviewer sought to understand how the tool sustains itself once DOE funding ends in September and who might be targeted to use this tool, such as metropolitan planning organizations (MPO)as part of their analyses. Also unclear was whether users will have access to high-performance computing resources at the national laboratories as well as the staff support to run the models. The reviewer further asked whether MPOs need to come with their own funding for this service. Lastly, with the model applications in Austin and San Francisco presented as part of this AMR, the reviewer inquired what relationship local agencies would have with the BEAM CORE team.

Reviewer 5:

The reviewer commented that the work developing, applying, and running studies with the BEAM CORE platform are focused on barriers around understanding large-scale transportation impacts of new mobility technologies and services. The project team has faced some challenges in addressing these barriers, which has resulted in a timeline that is longer than the results/progress of the development would indicate.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the technical accomplishments are dependent on the approach which has noted flaws, notably the lack of transparency and dependence on exogenous variables. In Slide 16, the reviewer notes a need to prove the range and median (or distribution), not the income mean. The averages can be biased by some segments, especially on the high end. Slide 20 output for example seems highly dependent on the input and underlying assumptions. Concurrently, it is not clear that there is real-world feedback captured in the model such as limits and balancing effects. The output on Slide 25, specifically the hitch in the "prediction" highlights this weakness. The work is generating output. Greater emphasis needs to be on the insight and fundamentals that lead to those outcomes given the assumptions inherent to the scenarios. It is unclear how to use the output or make the outputs highly actionable or useful at this stage. Sensitivities are not shown and need to be. This is problematic given the levels of dependency and multitude and range of stochastic outcomes. An alternative given the scenario approach is to have a good set of parameter inputs and show the type of outcomes so insights can be generated.

Reviewer 2:

The reviewer stated that the progress on this project is rated outstanding based on task completion and the number of excellent studies that have been completed using BEAM CORE.

Reviewer 3:

The reviewer commented that progress has been great in the past year and the addition of Cruise is great.

Reviewer 4:

The reviewer noted that Slide 11 shows the technical milestones identified for the project. The project appears to be making adequate progress on the identified milestones and on track to complete the project by the September 2023 deadline.

Reviewer 5:

The reviewer stated that the presentation provided a great overview of various components of the BEAM CORE model. One of the stated goals for BEAM CORE development is workflow automation and a reduction

in computation time, but no progress towards either (in terms of how many scenario runs can be done, for example) was discussed. The presentation provided many examples of results from several studies, but the causation (e.g., why was there a change in transit ridership, why does fleet adoption change under different scenarios) was not explained.

Question 3: Please comment on the collaboration within the 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 the collaboration is sufficiently covered. The problems of connecting and depending on so many other models is addressed in the approach.

Reviewer 2:

That reviewer stated that given all the moving parts, collaboration has to be nearly flawless for everything to work smoothly. Team is commended for managing the complexity.

Reviewer 3:

The reviewer stated that the team is well qualified and has shown a strong collaboration in the past years.

Reviewer 4:

The reviewer felt the collaboration is strong within the national laboratory development community. They do not see evidence that the team is building a community of tool users, which is where they think there is the most opportunity. The reviewer suspects that the most likely future users of this tool are MPOs, but MPOs were not listed as part of the project team to understand the needs/barriers to real world deployment of the tool.

Reviewer 5:

The reviewer commented that the collaboration between national laboratory team members appears tight and highly coordinated. The project may benefit from additional collaboration with on-the-ground stakeholders, as most of the studies highlighted are based on questions from just a few San Francisco Bay area partners.

Question 4: Please comment on the 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 that creating documentation is necessary. However, the computational complexity and expertise required to use the tool suggests the tool is targeting the wrong audience or is likely to misinform or be misinterpreted by it.

Reviewer 2:

The reviewer stated that the planned future work is appropriate follow-up. It is unclear how much time or resources are required for some of the work.

Reviewer 3:

The reviewer commented that the plan is clear. To make this tool impactful the computation need and/ or usability of it needs to be improved.

Reviewer 4:

The reviewer commented that based on the material presented at AMR; the team has a reasonable approach for future work they've identified as a team. However, the reviewer did not see how the future research addresses the concerns identified last AMR, which the reviewer thinks are all still highly valid.

Reviewer 5:

The reviewer commented that the proposed future research is planned to focus on increased tool deployment resources and documentation, and on extended stakeholder engagements. While these two foci are important (especially expanded stakeholder outreach), it is not evident that the BEAM CORE platform is in a "final" enough state to switch from tool development to documentation.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that it is not easy to select "no" as there is potential merit. The current weaknesses noted in this review must thoroughly be addressed for the project to meaningfully support program objectives.

Reviewer 2:

The reviewer noted that the project supports the VTO EEMS objective of characterizing transport system energy use and system usage due to the impact of technology and population change.

Reviewer 3:

The reviewer said that this project is very relevant to EEMS.

Reviewer 4:

The reviewer commented that BEAM CORE supports VTO EEMS goals of: (1) develop new tools, techniques, and core capabilities to understand and identify the most important levers to improve the energy productivity of future integrated mobility systems; and, (2) share research insights, and coordinate and collaborate with stakeholders to support energy efficient local and regional transportation systems.

Reviewer 5:

The reviewer stated that the development and application of the BEAM CORE workflow is relevant to overcoming VTO/EEMS program barriers. The insights and findings shown in the presentation are starting to address key questions posed by the project team's partners and the transportation research community.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the funding makes sense given the large team. Unfortunately, this results in an overlay complex and burdensome project that is not efficiently using resources.

Reviewer 2:

The reviewer noted that the project is on track with current level of resources.

Reviewer 3:

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

Reviewer 4:

The reviewer stated that the resources provided are sufficient for the project to achieve the stated milestones on Slide 11.

Reviewer 5:

The reviewer commented that although the scope and scale of a project to develop a large-scale, open-source comprehensive transportation modeling framework such as BEAM CORE requires significant resources, it is not evident that the current state of development for this modeling platform reflects the significant funding

resources that have been provided. It may be beneficial to conduct a full portfolio review to determine if a different resource allocation would be more efficient.

Presentation Number: EEMS093
Presentation Title: Transportation System Impact, POLARIS Workflow Development, Implementation and Deployment
Principal Investigator: Joshua Auld (Argonne National Laboratory)

Presenter

Joshua Auld, Argonne National Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

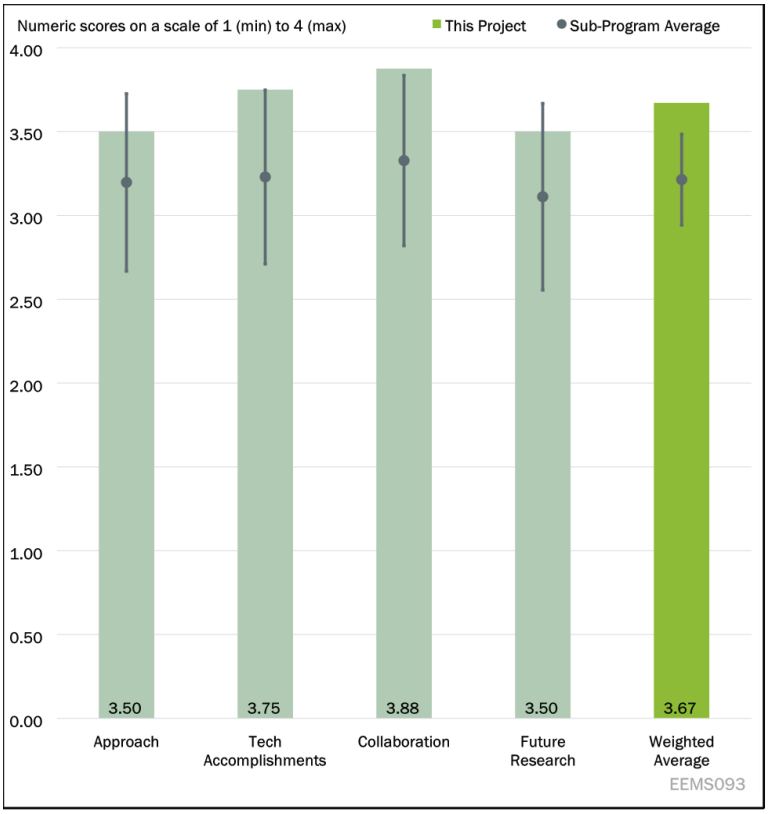

Figure 4-7 - Presentation Number: EEMS093 Presentation Title: Transportation System Impact, POLARIS Workflow Development, Implementation and Deployment Principal Investigator: Joshua Auld (Argonne National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer noted that the project design does very well at modeling a very complex system of systems, with appropriate integration of data from different system operational scales.

Reviewer 2:

The reviewer commented that while some barriers are addressed, the uncertainty in deployment isn't fully addressed. Is there a challenge in terms of getting the data needed? How easy/ hard is it for cities to deploy this? What resources/ knowledge the employees would need.

Reviewer 3:

The reviewer stated that based on the material presented at AMR, the project approach seems solid for this stage of the project and the reviewer does not have any concerns about the project team's approach to addressing the identified technical barriers. The reviewer mentioned really appreciating the efforts that have been made to pull local agencies (North Central Texas Council of Governments [NCTCOG], Atlanta Regional Commission, Chicago Transit Authority [CTA], Chicago Metropolitan Agency for Planning [CMAP], Puget Sound Regional Council, Southern California Association of Governments, Capital Area Metropolitan Planning Organization) onto the project as partners to understand their barriers with using/applying the models and addressing those concerns. The reviewer also really appreciated the conversation about how the best

solutions are different for different cities/network structures. The reviewer mentioned thinking this speaks to how transportation solutions are context sensitive solutions, and one size fits all approaches do not work. The reviewer would encourage continued exploration as to what it is about the different cities that enable certain strategies to work better than they do in other cities/land use/network designs. The reviewer suggested connecting with Mona Asudegi of the Federal Highway Administration's (FHWA) Transportation Typology Explorer.

Reviewer 4:

The work developing, automating, and deploying the POLARIS workflow is sharply focused on addressing critical barriers related to understanding and quantifying the potential impacts of future mobility technologies and services on transportation energy and efficiency. The presenter explained the complexities that require application of the model to explore the impact of technologies and policy levers both individually and together, and in different contexts. POLARIS appears well positioned to provide broad capability to assist decision-makers in making technology deployment and policy decisions.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that the scheduled tasks have been completed on time, which is a tremendous accomplishment given the complex modeling tasks. Many excellent studies have been completed, showing the utility of the software tools.

Reviewer 2:

The reviewer stated that the results show great progress. The team has accomplished quite a bit in the past year.

Reviewer 3:

The reviewer commented that the technical progress against the project plan appears to be sufficient. The reviewer does not have any comments about possible barriers to the project reaching completion in September 2023. The reviewer would encourage the project team to continue thinking about what's next for POLARIS in the last two months of the project. If DOE does not supply more funding to the project, has the project team identified future users of the tool? Are appropriate documentation/resources in place for MPOs or other future tool users so that these agencies can pick up and apply the tool without a dedicated DOE funding stream to support application of the model?

Reviewer 4:

The reviewer stated that although the timeline for this project is significant, it is indicative of the significant barriers to large-scale agent-based transportation simulation that robustly incorporates a variety of mobility technologies, modes, and services. The team has made significant progress in automating the POLARIS workflow and engaging with important stakeholders, enabling them to simulate hundreds of future scenarios guided by input from transit agencies, MPOs, and other partners.

Question 3: Please comment on the collaboration within the 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 a very large number of inputs is well managed, and needs must be communicated clearly given the system's complexity. An outstanding job by the team.

Reviewer 2:

The reviewer noted that the team has shown good collaboration.

Reviewer 3:

The reviewer really appreciated the efforts that the team has made to pull local agencies (NCTCOG, ARC, CTA, CMAP) onto the project as partners to understand their barriers with using/applying the models and addressing those concerns. The reviewer would think those are the agencies that are most likely to use these tools in the future. The reviewer hopes that their participation has helped increase understanding to the barriers to deploying POLARIS in practice.

Reviewer 4:

The reviewer commented that the POLARIS team has engaged with a large community of stakeholders: other national laboratories and universities for workflow improvement; multiple universities to incorporate new features; and multiple industry, academic, governmental, and trade organizations to conduct studies. The level of collaboration is impressive and is required to successfully complete a project of this scale.

Question 4: Please comment on the 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 it was an excellent list of proposed studies and upgrades to software usability and utility.

Reviewer 2:

The reviewer stated that the proposed future research is defined clearly.

Reviewer 3:

The reviewer commented that based on the material presented at AMR, the team has a reasonable approach for future work. The reviewer does not have any concerns with the remaining milestones on Slide 5 or bold future research on Slide 31.

Reviewer 4:

The reviewer noted that a fully featured urban/regional-scale transportation model such as POLARIS may never fully incorporate every possible technology/feature. The project's plan is to continue automating, validating, and deploying the workflow, and conducting studies with stakeholders—all very important. The presentation also shows numerous new features (in terms of EV Charging & Grid, Multimodal, Freight, Behavior, Connectivity, and Land use) that could be added, though it is unclear if all of these will be added. The project team should prioritize which new features will be added in the future.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that POLARIS is a key software system for modeling the impact of VTO technologies on a transportation system. It allows characterization of effects which may be otherwise difficult to measure.

Reviewer 2:

The reviewer stated that the project is very relevant to EEMS. It would be great to see the actual deployment of this tool and see the impact.

Reviewer 3:

The reviewer noted that the project contributes to two VTO EEMS Strategic goals: Strategic goal #1: Develop new tools, techniques, and core capabilities to understand and identify the most important levers to improve the energy productivity of future integrated mobility systems. Strategic goal #3: Share research insights, and coordinate and collaborate with stakeholders to support energy efficient local and regional transportation systems.

Reviewer 4:

The reviewer commented that the development and application of the POLARIS workflow is highly relevant, evidenced by the number of stakeholders that the project team has collaborated with. The insights and findings shown in the presentation have answered key questions posed by federal, state, and local government agencies, transportation agencies, transit agencies, and other stakeholders.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the work is on track with current budget and people resources.

Reviewer 2:

The reviewer stated that the team has enough resources to carry out the project.

Reviewer 3:

The reviewer commented that the resources appear sufficient for the project to achieve the stated milestones.

Reviewer 4:

The review stated that the POLARIS project team has enjoyed significant funding resources throughout SMART Mobility 1.0 and 2.0. The progress shown in development and deployment of the modeling platform justify the level of funding received. The team has demonstrated good stewardship of their research dollars. While it is likely the project team could accomplish even more with additional funding, a full portfolio review is required to make any necessary changes to resource allocation.

Presentation Number: EEMS094
Presentation Title: Development and Validation of Intelligent CAV Controls for Energy-Efficiency
Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

Presenter

Dominik Karbowski, Argonne National Laboratory

Reviewer Sample Size

A total of 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.

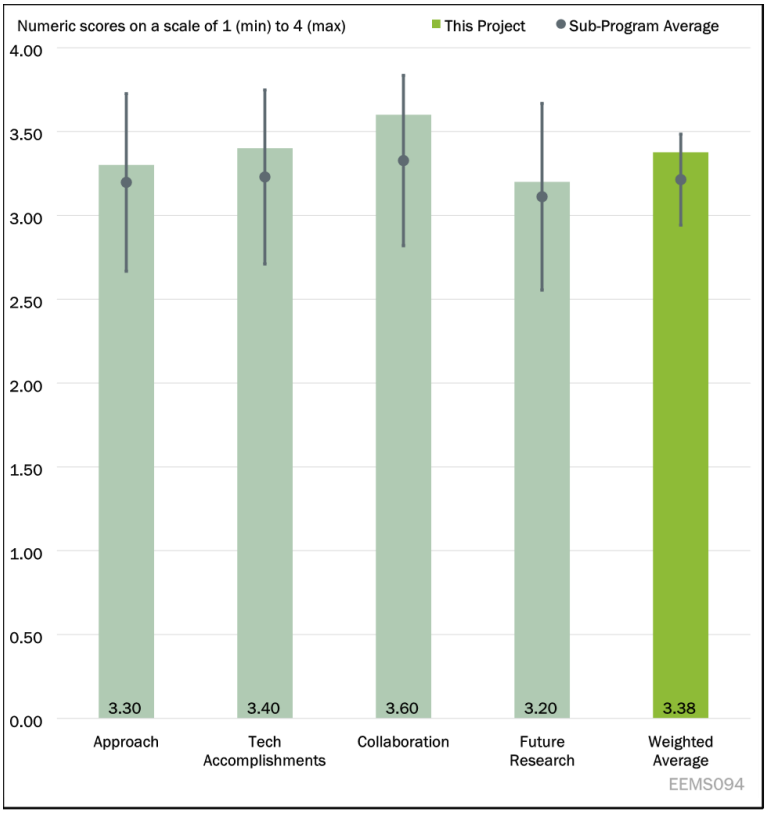

Figure 4-8 - Presentation Number: EEMS094 Presentation Title: Development and Validation of Intelligent CAV Controls for Energy-Efficiency Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer noted that trying to characterize "future" systems is inherently challenging, especially when working in an environment where much info is proprietary. The team does a good job of taking existing resources and adapting them to assess performance in a practical way.

Reviewer 2:

The reviewer commented that Barrier 1 (Slide 2) (CAV development not driven by energy-efficiency) is not addressed well during the presentation. Could address by discussing OEM motivations or how energy-efficiency might piggyback off other benefits that incentivize adoption of these technologies. Barrier 3 (defining representative scenarios) also was not clearly conveyed in the brief— a scenario was defined, though it was not clear how or why it was representative. There is mention of multiple routes; may have been worth elaborating how those were defined and why they were significant. Even with the increasing fidelity of tools (from sim to laboratory XIL to track XIL), the use of a single vehicle with no traffic results in likely overly optimistic energy results. The additional realism introduced by including even simulated micro-traffic may be more valuable than the realism by adding vehicle physics. Great to see overlays (Slide 14) showing how sim results were validated by both laboratory and track XIL. This would allow future work to take place predominantly in sim rather than XIL, thereby saving time and cost. Was the University of Wisconsin testing

on public roads? Was there any live traffic? Slide 17 says everything is real, but without any traffic, this isn't quite true.

Reviewer 3:

The reviewer commented that several concerns arise regarding the logical consistency of the findings. For instance, the claim suggesting that having two connected signals in the horizon leads to maximum energy savings appears doubtful. In reality, when signals are positioned within a mile or less of each other, they are typically coordinated and actuated. The coordination ensures that the traffic signal timing fluctuates within certain boundaries. If signals are not properly coordinated, it becomes difficult to assert that the presence of two signals in the horizon results in the highest benefit. Moreover, there is currently no scientific evidence available to substantiate this claim, further casting doubt on its validity.

Reviewer 4:

The reviewer stated that the approach is technically sound, and the project is well defined and designed for execution and the team has demonstrated successfully the technology and results are highly relevant to DOE VTO.

Reviewer 5:

The reviewer noted that the overarching technical barrier is the development of energy saving CAV controls in vehicles that can be measured and then applied to save energy in the fleet. The team's experimental setups—Lab XIL, Track XIL, and Real Track, were well designed and provided a variety of experimental setups that address the complexities of CAVs in multiple scenarios. Their designs have shown results in a variety of experiments. The reviewer appreciated the robustness and considerations in the Full CAV Demo phase of the project. This phase joined the laboratory experiences with real world, real track, situations. The reviewer believes their work is a great foundation for future work and evaluations.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that the team has done an excellent job of executing the tasks defined in the project. The work contributes new techniques that are particularly useful in mixing virtual and real systems.

Reviewer 2:

The reviewer stated that the project is well-planned, and execution has been according to plan. It is a little unclear how planned deliverables may be useful to external stakeholders.

Reviewer 3:

The reviewer commented that the work is progressing according to the established schedule, however, the chosen technical approach for this project raises some concerns. Check my comment in the future work section.

Reviewer 4:

The reviewer stated that the long range V2I results are interesting and come out as expected, but nonetheless an amazing demonstration of technology integration and execution. Testing of the new hybrid electric vehicle (HEV) powertrain in the XIL workflow yielded good results and energy savings. Track XIL proved to be a success from an execution and energy reduction perspective. Interesting to note that real world testing consistently produced better results than XIL. Ran into similar results as well. Tough to explain. The reviewer noted track/virtual demonstration with Clemson was "really neat" and applicable to developing and demonstrating the technology more efficiently than large, closed test track facilities and multiple vehicles.

Reviewer 5:

The reviewer commented that over the past 2 years the team has made significant progress in demonstrating energy efficiency savings with CAVs. The team has achieved and hit all milestones in their work plan.

Question 3: Please comment on the collaboration within the 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 on an excellent mix of partners, with clear communication needed to execute the various project elements. Well handled by the team.

Reviewer 2:

The reviewer commented that the partners are making substantive contributions to the project. For standardization of energy methods—OEM cooperative research and development agreement (CRADA) is an excellent opportunity. The reviewer was glad to hear during presentation that the OEM partner is willing to be open with results and share with a standards development organization (SDO) and not end up siloed in proprietary ecosystem.

Reviewer 3:

The reviewer said that good coordination is demonstrated.

Reviewer 4:

The reviewer stated that the project pulled in an amazing amount of collaboration from laboratories, universities and OEM(s). This clearly highlights the relevance and potential impact of the project on CAV development and advancing to production.

Reviewer 5:

The reviewer commented that the project team is robust with representation from key industry (GM) and research partners (Clemson, ANL, Michigan Tech). The contributions of GM are particularly helpful in this project by providing driving data and information. Each of the research partners also brought valuable insights and resources to this project. Additional partners may include municipalities or states to gain further insights into real world driving situations and data.

Question 4: Please comment on the 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 next steps are appropriate follow-up.

Reviewer 2:

The reviewer commented that the plan to study CAV controls with traffic flow simulators will hopefully improve realism of the scenarios. Validating models requires closely controlled scenarios and conditions, but afterwards, traffic is required to predict realistic energy savings.

Reviewer 3:

The reviewer noted that while this project's emphasis on energy efficiency in CAVs is commendable, it is important to recognize that energy efficiency is just one piece of a larger puzzle. Key aspects such as active safety systems, perception algorithms, and machine vision are not included in the project's scope. These factors are crucial for the overall functionality and acceptance of CAVs. Therefore, while the project will likely make important contributions to energy efficiency, its impact might be limited without addressing these additional factors.

Reviewer 4:

The reviewer commented that the dynamometer XIL for evaluating "powertrain+speed" co-optimization should yield fruitful results. Other research work is on a similar path for CAV on dynamometer, and the reviewer encouraged comparing notes, setup, testing scenarios and results with those efforts. The reviewer is looking forward to this team's outcomes.

Reviewer 5:

The reviewer noted that this project will serve as a good foundation for future work—well done.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that the project is highly relevant to understanding "how" to best control CAVs for optimal energy consumption. Efficient energy use is a key metric for DOE VTO.

Reviewer 2:

The reviewer commented that the project is relevant to VTO EEMS and demonstrates energy savings from connected and automated driving, with simulation results validated by laboratory and track testing.

Reviewer 3:

The reviewer commented that the project is relevant.

Reviewer 4:

The reviewer commented that the program is very supportive and has excellent collaboration with OEM.

Reviewer 5:

The reviewer stated that the project is relevant to the VTO portfolio. The intersection of CAVs and energy efficiency is important and an area that more information and implementation is needed.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the tasks have been completed on time, with excellent results given the resources available.

Reviewer 2:

The reviewer stated that the resources appear sufficient.

Reviewer 3:

The reviewer commented that while the project's pursuit of energy efficiency in CAVs is indeed noteworthy, my primary concern lies in the limitations of the technical approach adopted. The project does not seem to address integral aspects such as active safety systems, perception algorithms, and machine vision. These components are essential to ensure not only the efficiency but also the safety and reliability of CAVs. Original Equipment Manufacturers (OEMs) might find it challenging to implement the tools and methodologies proposed by this project, considering these safety aspects are not included in the project's scope. Based on this, the reviewer believes there is high risk in allocating funds researching this area.

Reviewer 4:

The reviewer noted that the team has every resource needed and support from OEMs and excellent collaboration with universities with distributed resources for execution of various aspects of the project.

Reviewer 5:

The reviewer believed the budget is sufficient for the research.

Presentation Number: EEMS095
Presentation Title: Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use
Principal Investigator: Jinghui Yuan (Oak Ridge National Laboratory)

Presenter

Jinghui Yuan, Oak Ridge National Laboratory

Reviewer Sample Size

A total of six reviewers evaluated this project.

Project Relevance and Resources

83% of reviewers felt that the project was relevant to current DOE objectives, 17% 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.

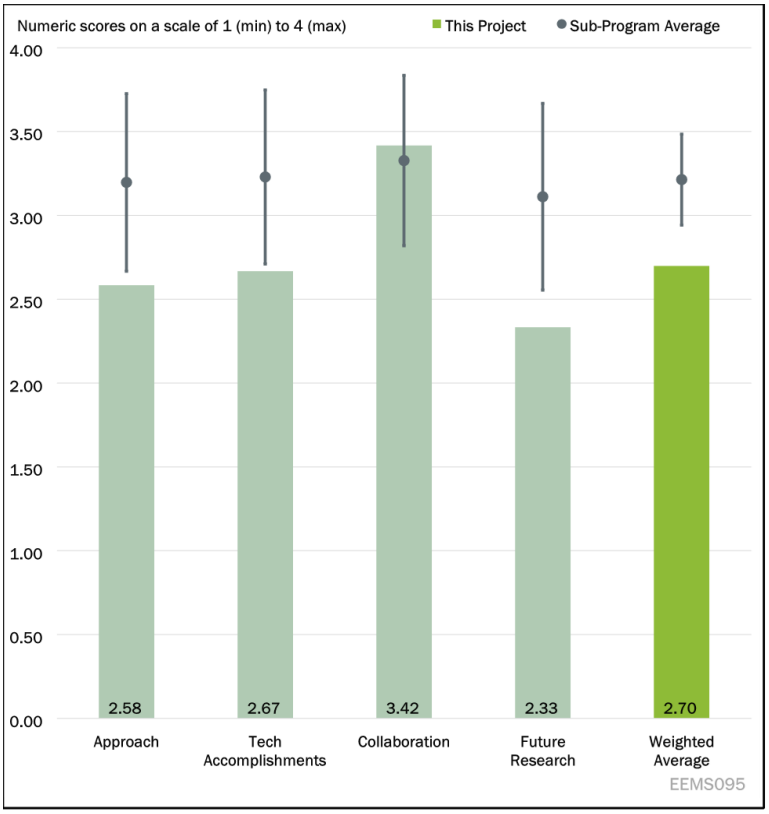

Figure 4-9 - Presentation Number: EEMS095 Presentation Title: Integrated Control of Vehicle Speeds and Traffic Signals for Reducing Congestion and Energy Use Principal Investigator: Jinghui Yuan (Oak Ridge National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer noted that the Connected and Automated Vehicle Environment (CAVE) dynamometer work is delayed. It is unclear if this work will be completed before the project end, and if there will be enough correlation and fidelity in the system to provide meaningful results. In addition, the % efficiency gains need to be allocated between signal control and connected vehicle changes, since both can be implemented exclusively.

Reviewer 2:

The reviewer referenced the use of simulation, dynamometer, and on-road testing. The reviewer also noted the use of Gridsmart (minute-by-minute) and National Transportation Communications for Intelligent Transportation System Protocol (NTCIP) controller data to connect to the cloud and use of cellular for messaging. The reviewer also noted the use of global navigation satellite system (GNSS) in vehicle for localization and the use of Vissim software for simulation and mentioned aggregating minute-by-minute traffic data by 5-minute averages may miss much of the important traffic dynamics. Finally, the reviewer emphasized the inclusion of microscopic traffic modeling and vehicle sensor data for signal control, with change splits only.

Reviewer 3:

The reviewer stated that it is reasonable to start with theory before proceeding to real-world. However, given the objective is to solve real-world conditions not incorporating low-hanging fruit into the modeling to capture the most relevant types of real-world factors that undermine theoretical ideal case is a flawed approach. The work plan does not appear to offer differentiated value add over a suite of other similar and related work.

Reviewer 4:

The reviewer commented that the study has identified and addressed many of the complexities in using communications to reduce energy consumption in the interaction between vehicle speed and traffic signal timing. The study demonstrates the benefits of vehicle connectivity even when the CAV penetration rate is low. The remaining barriers and challenges identified note that human interactions with drivers are not examined; to this the reviewer recommends adding pedestrian interaction, which often substantially increases the cycle length for traffic signals, sometimes substantially reducing highway traffic signal efficiency.

Reviewer 5:

The reviewer stated that the partnership with Toyota is excellent, but this is one of many OEMs that will need to adopt and adapt their vehicles to be able to implement and validate something like this at a larger scale. Having other industry groups involved would give a better understanding and representation of what is feasible in order for the proposed approach to work.

Reviewer 6:

The reviewer observed that the degree to which technical barriers were addressed was satisfactory. The reviewer is very curious as to why a phone app was chosen rather than a cellular-vehicle-to-everything (C-V2X) solution with the SAE standard, which includes security protocols.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that the technical progress is satisfactory but appears to be behind compared to the original project plan.

Reviewer 2:

The reviewer noted that the project team has seen 9% energy savings from signal control algorithm alone (compared to semi-actuated). Integrated with vehicle control gets up to 27% efficiency for a vehicle, nearly 25% for system improvement with 100% CAV. At 20% CAV, closer to 7% system improvement. Had a delay in CAVE laboratory but are back on track and testing traffic signal controls end of this month and then in early August on-road testing.

Reviewer 3:

The reviewer commented that the work is largely disconnected from the real-world and factors that lead to difficulty in optimization. The five-minute average speed is problematic, and the researchers did not have an adequate response. The model does not appear to incorporate many relevant factors such as people, bikes, and their variability on how or when a vehicle can proceed. The major barriers and remaining challenges noted by the research team are problematic and unless overcome will preclude achieving the objective. Results so far have no practical use and may not unless the barriers are overcome. It was not sufficiently made clear how this will be accomplished.

Reviewer 4:

The reviewer stated that the efforts to develop algorithms ready for field testing in a Toyota test vehicle with communications to the Chattanooga traffic signals demonstrate progress toward field implementation and evaluation.

Reviewer 5:

The reviewer noted that based on the timeline, this project is close to completion. However, the barriers that are left to accomplish still seem significant. Will the rest of the project objectives (ending Dec 2023) be able to successfully be accomplished without an extension? This is a very complex project and topic, potentially showcasing the results as a proof proof-of-concept might be appropriate given the objectives are currently stated more globally and this does not include a mixed fleet set of results just one type of vehicle.

Reviewer 6:

The reviewer wrote: Good. The project outlined what it was going to do, and then set accomplishments to that goal. Although, the reviewer does wonder, "So what?", the reviewer was optimistic that there was 100% CAV penetration rate versus something perhaps as to what the market would actually be during a forecasted timeframe. Also, again there is a C-V2X protocol, which also includes the Road Side Unit Protocol, and the reviewer was wondering why that was not chosen either. The reviewer commented that this also could have been optimized, if there had been a focus on "latency" with needed cell phone towers, and finally asks which GNSS was chosen (e.g., GNSS L1, or other?).

Question 3: Please comment on the collaboration within the 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 collaboration appears to be well coordinated. It is welcome to see the regular interactions with Toyota.

Reviewer 2:

The reviewer commented that the project team is working with Toyota on algorithm, vehicle testing, and integration. Collaboration and leveraging other DOE work and collaborators.

Reviewer 3:

The reviewer commented that the collaboration is effective in achieving the intended support.

Reviewer 4:

The reviewer stated that the full involvement of both vehicle and highway traffic signal stakeholders was demonstrated and is exemplary.

Reviewer 5:

The reviewer stated that the topic has a lot of implications for OEMs, Toyota is included, and it is a great starting point. However, having more representation of industry in the concept and validation process would be beneficial. Investing resources of this magnitude might call for a stakeholder's group or some type of peer review before the end of the project.

Reviewer 6:

The reviewer observed excellent collaboration within the project team, as a city and an OEM were included. The reviewer commented that they would have taken this further as written, but including an LTE provider, cell phone towers, (4G, 5G?), noting GNSS and noting even the cloud provider. The reviewer expressed less enthusiasm about using a phone app.

Question 4: Please comment on the 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 since on-road work and field evaluation is yet to be started, it will be difficult to complete this work by the end of the project. There will likely be continual integration work and correlation work between the road, laboratory and simulation which will extend the expected testing period.

Reviewer 2:

The reviewer stated that there are clearly defined next steps for project work. No detail was provided on potential "icing on cake" future work or additional applications.

Reviewer 3:

The reviewer noted that the proposed future research does not sufficiently make clear how barriers and challenges will be overcome to achieve useful or practical real-world application as stated in the objective.

Reviewer 4:

The reviewer stated that the lack of a specific control for interactions with other road users is concerning. These interactions may be with other drivers, pedestrians, commercial vehicles, and buses. These interactions may be lurking in the results of the field evaluations; understanding them may be important.

Reviewer 5:

The reviewer commented that it is not clear that the future work and the barriers that still need to be overcome will prove fully transferable to other vehicle models. The suggested leveraging of other projects Virtual and Physical Proving Ground (VPPG) for Development and "Validation of Future Mobility Technologies" (EEMS067) and "Scaling up the Realtime Data, Simulation and Artificial Intelligence (AI) and Control for Optimizing Regional Mobility" (EEMS061) seem like a great way to ensure this project can accomplish the remaining work by December 2023.

Reviewer 6:

The reviewer commented that they think the project team needs to look at what other technologies are out there, to do something similar, and drill down on the "communication aspects" as well as the "real world" penetration of CAVs.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that this project solidly supports EEMS objectives.

Reviewer 2:

The reviewer commented yes, aiming for energy efficiency improvement through CAV/CDA system. Includes real-world demonstration and validation.

Reviewer 3:

The reviewer stated that as explained, the concept has merit, but there is not a clear pathway to achieve the goals—in supporting vehicle and system efficiency.

Reviewer 4:

The reviewer noted that subject to limits from the interactions with other road users, the work demonstrates that CAVs may be able to reduce the transportation energy consumption associated with the interactions of vehicles and traffic signals.

Reviewer 5:

The reviewer stated that the topics covered in this project are very important and relevant to VTO. This project assists and expands on the need to be able to use real-world data for validation purposes. Using it to optimize models and other unique types of vehicles (e.g., commercial vehicles) is something that VTO could expand and use in future projects.

Reviewer 6:

The reviewer noted that they would just approach this differently, technically, based on where the OEMs are going, and also based on SAE standards in this space.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources appear to be sufficient. Readiness of the CAVE laboratory should be accounted for in future work/projects.

Reviewer 2:

The reviewer noted that the project team has appropriate equipment for simulation, dynamometer, and deployment testing with real vehicles.

Reviewer 3:

The reviewer stated that the resources are appropriate.

Reviewer 4:

The reviewer commented that the project team demonstrated progress in developing and evaluating algorithms, working with Chattanooga on signal communications, and working with Toyota on vehicle implementation, including dynamometer testing and developing field testing. This indicates that resources are sufficient for the project. Additional funds might be used to analyze user interactions and widen field testing if the initial tests prove successful.

Reviewer 5:

The reviewer stated that it seems that the current funds should be sufficient to complete the remaining tasks by December 2023.

Reviewer 6:

The reviewer commented that the resources are just okay.

Presentation Number: EEMS096
Presentation Title: Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies and Sensors
Principal Investigator: Thomas Wallner (Argonne National Laboratory)

Presenter

Thomas Wallner, Argonne National Laboratory

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, 20% 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.

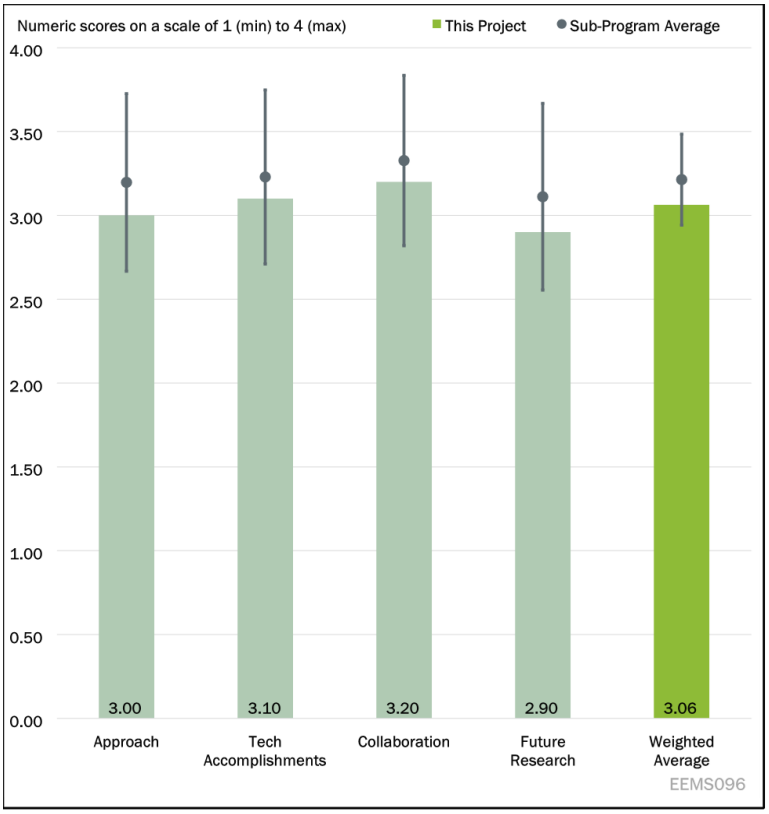

Figure 4-10 - Presentation Number: EEMS096 Presentation Title: Characterizing Behaviors and Capabilities for Emerging Connected and Automated Vehicle Technologies and Sensors Principal Investigator: Thomas Wallner (Argonne National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the project and its data collection, though challenging, seems to have been approached thoughtfully. It is also 80% complete. Attention has also been given to addressing review comments in a proactive way—for example, previously a reviewer commented that the team should strengthen their SAE standards participation and since that time the PI was appointed to chair a related task force.

Reviewer 2:

The reviewer felt the project was well designed to address advanced driver assistance system (ADAS) data collection barrier described.

Reviewer 3:

The reviewer stated that the project seems to be focused on the data collection from sensors in production vehicles, but at the same time the group is adding further off-the-shelf sensors to the production vehicles. The reviewer finds this slightly confusing as it conflates the situation on the true data collection capability of a given vehicle. Furthermore, the researchers mention that the software algorithm significantly affects the quality of the data for real-world use, but they then aim to separate the algorithm from the sensor performance. This seems like a huge gap in the approach, and the reviewer wonders about the utility of the final results in

evaluating the capabilities of current production CAVs. The pace of sensor development is also quite fast, so the relevance of the collected data for future systems might also be called into question.

Reviewer 4:

The reviewer commented that the "Traffic interferes with advisory," (Slide 8) presentation, mentions use of a green light speed advisory (GLOSA) coast request. While this may be feasible for an individual vehicle request, the reviewer asks whether it is viable if multiple vehicles are requesting. To be operationally viable, how would the infrastructure adjudicate many requests? Would they need to be coordinated across multiple intersections as well? For the Tesla Full Self Driving (FSD) data set, is the objective to improve FSD using the additional instrumentation and algorithms (Slide 10)? Or is the new capability confined to only assessing CAV performance? For the medium-duty (MD) and heavy-duty (HD) data collection, was the vehicle obviously a CAV? Curious if that would change human driver behavior. Also, were the platooning algorithms developed by the private sector? If so, were they different across the two companies (Locomation and Cummins)? CAV sensor data collection in snow and rain helps fill the technology gap and the demonstrated benefit is from incorporating road weather data. Also, a good independent verification of sensor manufacturer performance claims. Excellent presentation with clear identification of major takeaways.

Reviewer 5:

The reviewer suggested that the project could add clarity to its data collection. The reviewer thinks the data itself needs to be clearly noted as to what is collected, why it is collected, and how it ties into an overall framework of data required for analysis.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that in spite of COVID, prior to this year it appears that they continued to make progress on their project. Moreover, since the last AMR many milestones have been completed and, though September is quickly approaching, it seems strong progress was made over the past year towards advancing and working towards wrapping up the work.

Reviewer 2:

The reviewer commented that the team has done very well in acquiring data from vehicle systems under the constraint that no invasive modifications could be made. The adaptations required to get the relevant data are well executed.

Reviewer 3:

The reviewer commented that the amount of data collected in this project is okay, but it really is quite modest relative to the huge amounts of data being collected by OEMs. So, it is a valid question whether the accomplishments are enough and really meaningful in influencing the trajectory of the R&D for CAVs.

Reviewer 4:

The reviewer noted that the project execution has been timely, and deliverables are relevant to external stakeholders.

Reviewer 5:

The reviewer considered this overall project as satisfactory, but noted that some of the same issues raised in the 2022 AMR presented here as this project continued.

Question 3: Please comment on the collaboration within the 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 project has engaged and dedicated different tasks to a diverse range of collaborating partners representing industry, national laboratories, and other external entities. Discussions also appear to be underway with an additional partner (Plus AI), which could add another dimension. It is good to see they have connected with SAE as well.

Reviewer 2:

The reviewer noted that there was a good mix of collaborators from industry, government, and standards orgs. Would be improved with greater vehicle OEM participation but it is understandable that this is difficult given the proprietary nature of much of the systems being assessed.

Reviewer 3:

The reviewer stated that this project would clearly benefit from greater collaboration and coordination with OEMs to enhance data collection.

Reviewer 4:

The reviewer commented that the partnerships with other national laboratories and industry appear strong and relevant. It is helpful to have multiple partnerships in case companies (e.g., Locomation) drop out. What is the nature of the partnership with Waymo for sensor characterization? Are they just providing data? Are they also planning to test with the new characterization to determine benefit? Between the industry partnerships and ANL staff's newly appointed role on SAE committee, this project now has immediate and direct relevance to industry.

Reviewer 5:

The reviewer stated that the project team notably was working on reaching out and doing more collaboration, but the review did not discern from the project a clear overall strategy for collecting data.

Question 4: Please comment on the 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 not only did the project lay out a number of opportunities for future work (such as developing and testing weather-specific sensor degradation error models) but they have also appeared to have taken steps to further explore/advance these efforts. For example, they mentioned that they are proposing to develop a traffic-aware GLOSA and are now in talks with Traffic Technology Services to build such a system.

Reviewer 2:

The reviewer commented noted there are an excellent set of follow-up tasks, possibly hampered by limited data sources.

Reviewer 3:

The reviewer commented that again, the evaluation of data quality in absence of algorithm seems a little off target. The effect of the algorithm is huge. Raw data may be significantly enhanced.

Reviewer 4:

The reviewer stated that please see comment above about traffic-aware GLOSA—a single vehicle demonstration would be valuable but not representative of reality. It may be more valuable to mature with

multiple vehicles in pure simulation (which could lead to a simpler but realistically technically viable product) rather than do a physical demonstration with just one vehicle (great research but potentially a point source rather than systemic solution). "Sensor agent data standards"—The presentation described this as an "integrated way of reviewing sensor performance and processing to provide more realistic assumptions so others can use in their modeling efforts." There may be overlapping equities here with multiple DOT efforts and is an opportunity for future collaboration.

Reviewer 5:

The reviewer scored the project as "satisfactory" but strongly felt the team should recalibrate what they are trying to do with "collecting data.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted that the EEMS Program conducts early-stage R&D at the vehicle, traveler, and system levels, creating new knowledge, tools, insights, and technology solutions that increase mobility energy productivity for individuals and businesses. CAV technology presents potential to impact transportation energy consumption and emissions. This project aims to fill gaps in performance data regarding CAV technologies which could be valuable potentially, looking forward.

Reviewer 2:

The reviewer stated that how an ADAS-equipped vehicle "sees" the world is critical information in understanding how to model and assess ADAS effectiveness. The technology is one of the key levers for improving overall transport energy system efficiency, which is a key DOE VTO goal.

Reviewer 3:

The reviewer commented that the scope of this project is too small. Greater amounts of data and evaluation of algorithms under normal and adverse conditions would benefit this project.

Reviewer 4:

The reviewer stated that the project is relevant to VTO EEMS program. The ADAS data collection can help inform existing questions about traffic impacts, and the HD truck data from Cummins and Locomation are excellent collaborations with industry.

Reviewer 5:

The reviewer believes the project needs a better strategy as to what this project is really trying to do, and why.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that there are a few milestones remaining but if things continue on schedule, funding is likely sufficient based on current plans.

Reviewer 2:

The reviewer noted that the scheduled tasks are on track with the resources available.

Reviewer 3:

The reviewer commented that the scope of this project is too small. Greater amounts of data (through a larger scope or collaborations with industry), and evaluation of algorithms (in addition to data) under normal and adverse conditions would significantly benefit this project.

Reviewer 4:

The reviewer stated that the resources appear sufficient.

Presentation Number: EEMS097
Presentation Title: Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE)
Principal Investigator: Andrew Duvall (National Renewable Energy Lab)

Presenter

Andrew Duvall, National Renewable Energy Laboratory

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.

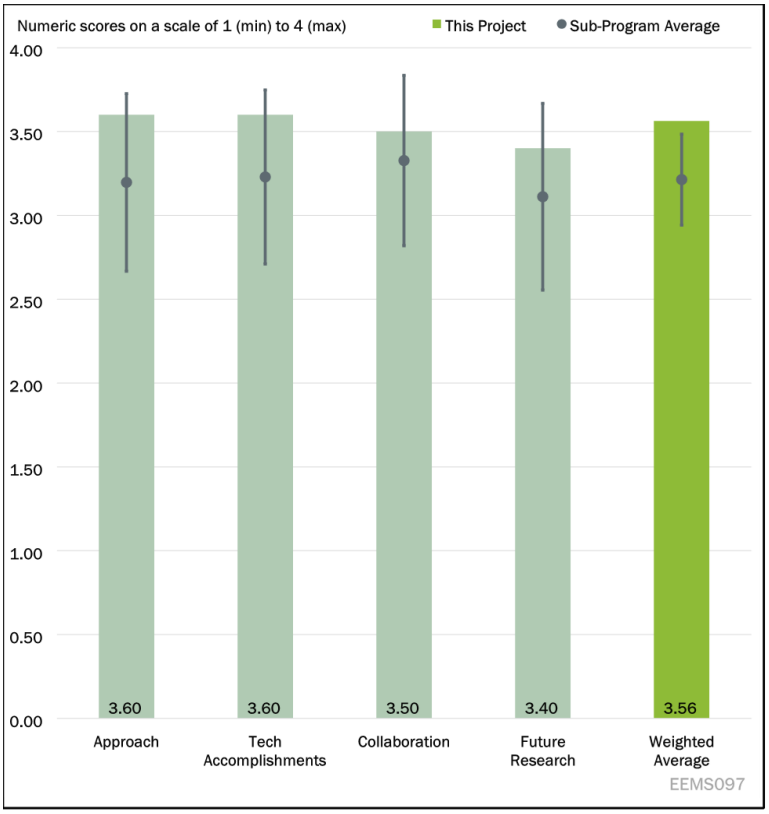

Figure 4-11 - Presentation Number: EEMS097 Presentation Title: Micromobility-Integrated Transit and Infrastructure for Efficiency (MITIE) Principal Investigator: Andrew Duvall (National Renewable Energy Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the project approach is appropriately broad to address the objectives of a comprehensive set of micromobility scenarios to be integrated into workflows including micromobility and microfreight operations. The approach includes energy estimates of micromobility for workflow scenarios, multimodal connection with transit, mode choice, induced demand, and infrastructure, energy optimization of micromobility operations, and microfreight.

Reviewer 2:

The reviewer noted that the researchers are conducting research in an area that has not been extensively studied in the past. So, the research is addressing an area where information is still limited, and as such represents a barrier. The research is reasonably well designed, and the researchers have made good progress in reaching the project objectives.

Reviewer 3:

The reviewer stated that the study undertook to address important questions regarding the potential energy savings from micromobility devices. The research approach and resulting evaluation contributed importantly to our knowledge of micromobility in the context of roadway users' travel decisions.

Reviewer 4:

The reviewer commented that this work is excellent because it analyzes micromobility in the context of the mobility energy production (MEP) metric and is making progress in developing and analyzing data about micromobility.

Reviewer 5:

The reviewer commented that over the course of this project the team has addressed the challenges of understanding the intersections and integration of e-mobility systems into the larger transportation system. The team has partnered with a variety of partners including research institutions, varying levels of government, and providers to test real world usage and application of micromobility into transportation systems. Their research and techniques will help to gain more understanding of how micromobility is reshaping transportation and transportation options.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that the technical accomplishments noted were MEP analysis of e-bike mode and energy estimation of dockless micromobility. E-bike program data showed that more than 34% of trips replace single occupancy car trips and can provide as much as 80% of the quality of mobility of a much faster mode such as driving. Dockless micromobility energy and trip attribute data yield insights on system performance.

Reviewer 2:

The reviewer commented that the researchers have conducted modeling runs and have estimates on micromobility efficiencies. They are coordinating with the MEP team, which is now incorporating micromobility into its toolset. The researchers are now disseminating the results.

Reviewer 3:

The reviewer noted that the study importantly contributed to our understanding of energy use of micromobility devices vis-a-vis other travel modes. Using recently developed MEP measures, the study demonstrated that the quality of the mobility provided by micromobility devices can sometimes approach that of automobiles.

Reviewer 4:

The reviewer commented that the technical progress is excellent since they have already produced meaningful insights and are on schedule with respect to their project plan.

Reviewer 5:

The reviewer stated that the team has made remarkable progress on this project. This includes integration of this data into MEP as well as multiple manuscripts being produced by this work. The reviewer concluded, "Well done."

Question 3: Please comment on the collaboration within the 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 good collaboration among NREL as a lead and LBNL, PNNL, and ANL as project partners. Complimentary research is being carried out by EPA and several universities. Numerous industry stakeholders have participated to inform the project approach, share their micromobility use data and relevant program insights.

Reviewer 2:

The reviewer observed the team incorporates a good group of researchers from national laboratories, non-lab/academic partners, cities, and associated industry partners. This is critical, as information in this area is still sparse, and the connection with cities can be important in incorporating micromobility into city planning.

Reviewer 3:

The reviewer noted that the study demonstrated wide consultation. A clearer explanation of how the consultation influenced the study might be helpful.

Reviewer 4:

The reviewer commented that collaboration and coordination across the project team is excellent because they have collaborated with a set of interested organizations for data collection and are leveraging the EEMS expertise on MEP to enhance their team's effectiveness and productivity.

Reviewer 5:

The reviewer felt the partnerships on this project are outstanding. The team has governmental, non-governmental and industry partners participating on this project. The collaborations in this project have helped the team obtain key user data as well as data in cities across the U.S. The reviewer mentioned also appreciating that the partners, especially city partners, are varied and from multiple geographic and sociodemographic areas.

Question 4: Please comment on the 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 that the proposed future research covers the 3rd and last year of the project (FY 2023). Remaining milestones in FY 2023 are appropriate and include final project documentation, presentation and publications.

Reviewer 2:

The reviewer commented that this research is near completion, so the future work is primarily dissemination related. The researchers appear to be staying connected with partners and stakeholders, which will provide for opportunities to put this research into practice, and it appears that the researchers are actively looking for additional funding in the area.

Reviewer 3:

The reviewer noted that the current phase of the work is wrapping up. One unaddressed issue that the study noted was the lack of use data; is there a technical way to address this that might be the subject of future research? How does the service model for shared devices impact energy savings?

Reviewer 4:

The reviewer commented that the near-term future work makes sense since they have useful results and getting those results disseminated and socialized will maximize DOE's return on investment. The longer term future work makes sense since the project has shown that micro mobility offers energy efficiency advantages, and the development of practical enabling strategies is a logical next step.

Reviewer 5:

The reviewer stated that the project has clearly outlined future work and research opportunities.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that the MITIE project supports the EEMS subprogram objectives by advancing technologies and systems to improve MEP when adopted at scale and exploring modes that have not been well studied in the context of energy impacts.

Reviewer 2:

The reviewer commented that the area of micromobility is going to be an importance 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. This research could also help to guide in planning at a more local/city level.

Reviewer 3:

The reviewer noted that the study demonstrated the potential energy savings from micromobility devices.

Reviewer 4:

The reviewer stated that the project supports the EEMS Program objectives by analyzing micromobility transportation using the MEP metric.

Reviewer 5:

The reviewer stated that this project is key to VTO objectives. Mode shift and micromobility are a growing component of the transportation landscape and understanding the infrastructure, energy needs and energy efficiency benefits are essential to the overarching work of eliminating emissions in the transportation sector.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that DOE is funding 100% of the project with a total of $2.68 million. Given the broad scope, partners, and barriers (uncertainty of future mobility systems and evaluating MEP at scale) the overall project budget seems appropriate.

Reviewer 2:

The reviewer noted that the project is near completion, and it appears that there were sufficient resources to accomplish the current scope of work. It will be interesting what resources might be available through future funding opportunities.

Reviewer 3:

The reviewer stated that the study seems to have progressed with available resources, with meaningful results demonstrated.

Reviewer 4:

The reviewer commented that the project has been productive with the resources provided.

Reviewer 5:

The reviewer commented that the resources are sufficient for achieving the milestones in the project.

Presentation Number: EEMS098
Presentation Title: Optimizing Drone Deployment for More Effective Movement of Goods
Principal Investigator: Victor Walker (Idaho National Laboratory)

Presenter

Victor Walker, Idaho National Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

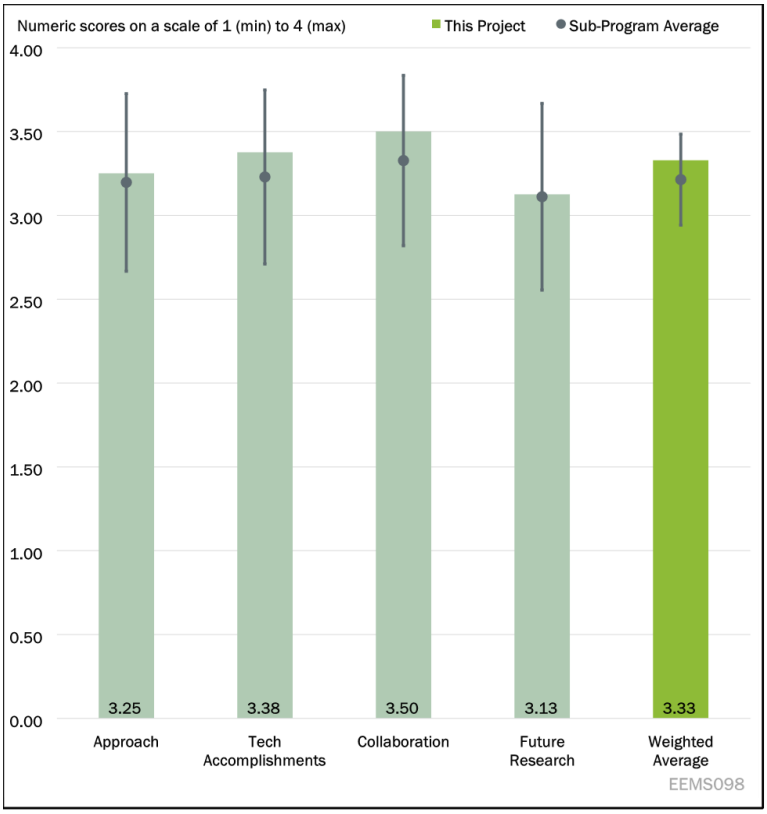

Figure 4-12 - Presentation Number: EEMS098 Presentation Title: Optimizing Drone Deployment for More Effective Movement of Goods Principal Investigator: Victor Walker (Idaho National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the team's approach of combining, open environment testing, laboratory-based testing, simulation & optimization, and validation to study the energy impacts and performance of drone-based delivery of goods, is a sound one.

Reviewer 2:

The reviewer noted that the project identified a number of barriers but could do a better job of explaining how the specific project research addresses them. For example, looking at routing options and weather impacts has some impact on sound and safety and "secrecy," but those are only obliquely touched on, and it is not clear how this project addresses standards. The project would be stronger if it connected the dots more clearly.

Reviewer 3:

The reviewer stated that the results of the project in addressing the barriers are good in that they have provided insights into the energy use and performance of drone delivery systems. The results are also good in illuminating risk factors associated with each drone delivery mode.

Reviewer 4:

The reviewer commented that the project has maintained a solid progressive research approach for a five year timeframe for better understanding the energy impacts and performance attributes of drone technology and to accelerate drone technology development for select delivery applications. The research progressed from

laboratory-based testing in controlled environments, to open environment testing to gain insights on flight operations and climatic affects, to simulation and optimization of operations, to scaled testing and validation of deployment scenarios, and finally industry tool development to assist in planning and assessment. The five year timescale seems appropriate and well planned for the tiered research approach.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that the accomplishments on the project include: 1. Extensive tests to validate drone models; 2. Study of drone/electric vertical takeoff and landing (eVTOL) type and number to complete 58 deliveries with a per delivery time window of 20 minutes. Quantification of kilowatt-hour and delivery minutes; and 3. Study of mixed vehicle fleets (Hyundai Accent + drone/eVTOL) to deliver to more distant destinations.

Reviewer 2:

The reviewer commented great data on weather, delivery times, etc.

Reviewer 3:

The reviewer commented that the analysis domain of this project has a lot of variables which makes the analysis challenging. The project team has made good technical progress in the sense that they are producing some practical insights even while they wrestle with the complexities.

Reviewer 4:

The reviewer stated that the project appears to be slightly ahead of schedule given the stated 75% completion and anticipated project end date of October 2025. Several insights were gained from the research in the reporting period. The research continued new validation testing on rotary drones to support model optimization. The research investigated weather impacts on different drone type operations. Through direct-to-consumer delivery testing, the team determined small batteries reduce energy needs but also reduce range and increase battery mgt needs; and drone integration with ground vehicles may be needed to meet all delivery requirements due to drone range and weather limitations. The team also made progress on tool/energy calculator development.

Question 3: Please comment on the collaboration within the 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 collaboration with primary and supporting industry and academic partners is quite impressive. Also, this is a partnership between INL and ANL.

Reviewer 2:

The reviewer commented that this was a good team, but they would still love to see more private sector partners, particularly end users of the delivery technologies.

Reviewer 3:

The reviewer noted that the collaboration with industry appears to be excellent as they are able to focus on real-world scenarios.

Reviewer 4:

Collaboration on this project is terrific. The researcher team is working with a variety of collaborators including other national laboratories (INL and ANL), industry, manufacturers, service providers, and academia

(The University of Texas at San Antonio and Carnegie Mellon). The collaboration provides comprehensive stakeholder coverage of drone research in the context of real-world delivery operations.

Question 4: Please comment on the 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 future work plan which includes tool development, testing, working with regulations and needs, etc., is well-motivated and sound.

Reviewer 2:

The reviewer noted that they would like to see more discussion/explanation of future applications and research directions. For example, it sounds like these tools could be used to develop an application programming interface (API) to allow optimized technology selection and dispatching based on various factors, but that was not entirely clear or explained.

Reviewer 3:

The reviewer commented that the focus on working with industry for future research is excellent since it will influence the work to focus on practical issues and scenarios.

Reviewer 4:

The reviewer stated that the future research is clearly defined and builds nicely off the previous work under the project. The remaining research involves completing the energy use and operational impacts analysis of the mixed fleet scenarios and software tool development for supporting industry drone decision-making and operations planning.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that this project studies the energy impact and performance of drone-based delivery of goods. This approach could lead to more efficient transportation of goods and thus reduce CO_2. This aligns with VTO program objectives.

Reviewer 2:

The reviewer noted that the project helps clarify when, whether, and how drone technology can contribute to EEMS.

Reviewer 3:

The reviewer stated that this work is highly relevant to understanding the energy efficiency of emerging mobility solutions.

Reviewer 4:

The reviewer noted that this project is very relevant for the EEMS program area. The project supports research on drones for supporting a variety of practical delivery applications and their positive energy use implications.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the allocated resources of $1.85 million over 5 years for this project are adequate.

Reviewer 2:

The reviewer said that there is nothing further to add here.

Reviewer 3:

The reviewer stated that the project team is being productive with the resources that they have been allocated.

Reviewer 4:

The reviewer noted that the PI indicated the project is scheduled to be completed by October 2025. The PI stated that the project research is about 75% complete. The total resources available for the project appear sufficient for completing the remaining work.

Presentation Number: EEMS099
Presentation Title: Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems (EEMS)
Principal Investigator: Venu Garikapati (National Renewable Energy Laboratory)

Presenter

Venu Garikapati, National Renewable Energy Laboratory

Reviewer Sample Size

A total of three reviewers evaluated this project.

Project Relevance and Resources

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

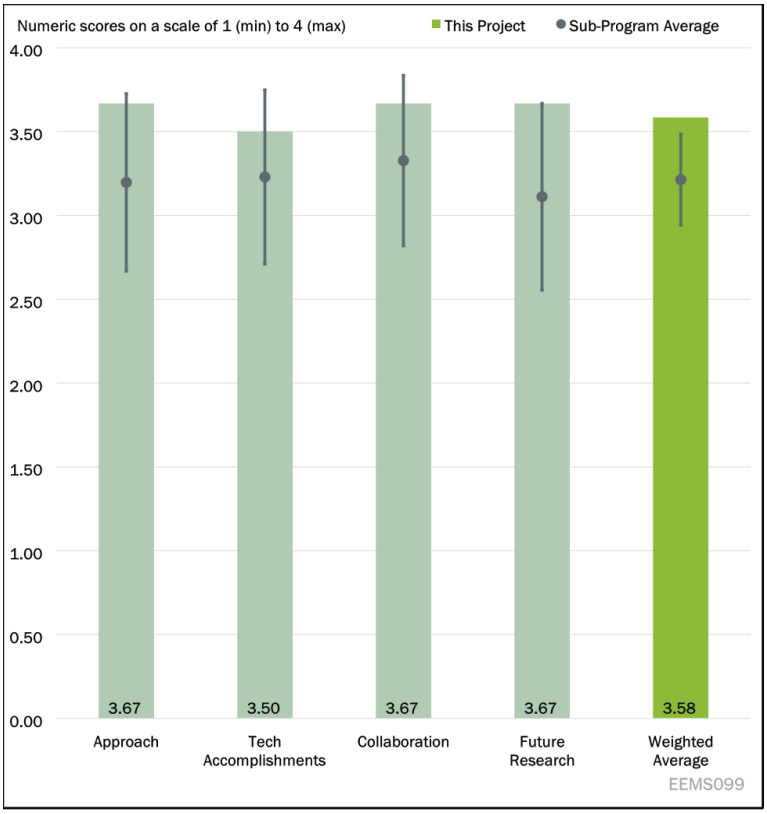

Figure 4-13 - Presentation Number: EEMS099 Presentation Title: Metrics for Assessing the Impacts of Energy-Efficient Mobility Systems (EEMS) Principal Investigator: Venu Garikapati (National Renewable Energy Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that understanding the impacts of different mobility options can be an important barrier to overcome in developing comprehensive strategies for transportation. The authors have used a reasonable approach in enhancing the development of their MEP calculations and are on track to complete the technical tasks as planned.

Reviewer 2:

The reviewer stated that the approach to addressing the barriers is outstanding since it is effectively developing and enabling deployment of practical and cohesive metrics to evaluate new mobility technologies.

Reviewer 3:

The reviewer commented that the PI has excellent understanding of the topic, and the three year period seems to be a reasonable timeline. The reviewer is a bit worried about the percentage complete (80%), as there is only about 3 months till the end of project.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that this project is nearly completed, and it appears that most of the technical tasks have been completed or are on track for completion. The remaining milestones for the third year appear to be focused on summarizing the results and disseminating the results, which is in progress.

Reviewer 2:

The reviewer commented that the technical accomplishments are effective as evidenced by deployment within and outside DOE.

Reviewer 3:

The reviewer stated that based on the milestones listed in the presentation, it seems that everything is on track.

Question 3: Please comment on the collaboration within the 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 team has good coordination and cross collaboration, a strong team of national laboratories, as well as departments of transportation and industry partners. The number of cities that the researchers are collaborating with or in discussions for collaboration is impressive. It is also useful that the researchers are looking for ways to broaden access/lower the threshold for adoption for the MEP model, including the multi-tier approach to coordinating with collaborators.

Reviewer 2:

The reviewer noted that this project appears to have an impressive set of collaborations ongoing.

Reviewer 3:

The reviewer highlighted the lack of partnership of industry and continued that this topic might be a bit less relevant to industry but more public agency. Maybe the research team could consider some consulting companies if they count.

Question 4: Please comment on the 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 this research is near completion, and the authors are on target with their investigations. The future research plans for path-based MEP calculations, developing MEP scorecards for different cities, and using OpenStreetMap within the application seem to be useful augmentations to the work.

Reviewer 2:

The reviewer noted that the future work appears to focus on increasing the availability of tools and data that everyone can use to apply the metrics to evaluate real-world transportation applications which is excellent because it will allow the work to be used for practical benefit. It also has potential to provide insights to researchers that will improve their metrics.

Reviewer 3:

The reviewer commented that the proposed future research is clear. A standardized procedure would be much more effective to propagate the research results. It would be great if weather information can be integrated into the calculations of MEP.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that overall, it appears the MEP is a leading model that is being adopted more widely. With DOE funding, the MEP model appears to have been extended and broadened in its usefulness. Overall, this project appears to be a strong piece of work in support of the mobility subarea.

Reviewer 2:

The reviewer noted that the project supports the EEMS subprogram objectives and provides an essential cohesive metrics framework for evaluating mobility technologies.

Reviewer 3:

The reviewer commented that the project is highly related to the EEMS area. MEP does provide a quantitative measure useful for public agencies, especially on planning purpose.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the project is near completion, and it appears that there were sufficient resources to accomplish the current scope of work. It appears that the researchers have some additional ideas that would be good candidates for future funding.

Reviewer 2:

The reviewer stated that the organizational and geographic surface area of the impacts of this project are growing each year, it likely deserves more resources to deliver its potential benefits.

Reviewer 3:

The reviewer commented that from the time, funding, and partnership perspective, the reviewer thinks the resources of this project is sufficient. It would be great if some transportation data providers and public (not agencies) can be involved to provide some feedback.

Presentation Number: EEMS100
Presentation Title: Dynamic Curb Allocation
Principal Investigator: Nawaf Mohammed (Pacific Northwest National Laboratory)

Presenter

Nawaf Mohammed, Pacific Northwest National Laboratory

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.

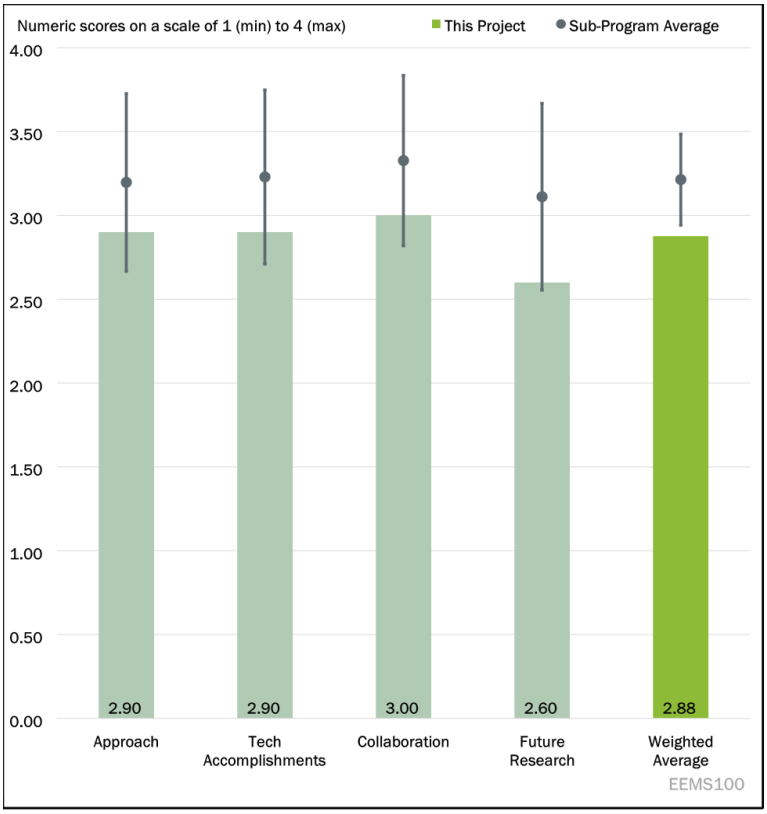

Figure 4-14 - Presentation Number: EEMS100 Presentation Title: Dynamic Curb Allocation Principal Investigator: Nawaf Mohammed (Pacific Northwest National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the loss of real-world validation opportunities in Seattle and San Francisco seems to be a major blow. The reviewer mentioned appreciating the pivot to use SeaTac data, but it is still limited. The reviewer stated that curbside charging is mentioned several times but sees nothing in the project design that would help address where/whether/how curbside charging in the right of way should be encouraged.

Reviewer 2:

The reviewer stated that the approach is well designed with implementations for centralized curb control complete as well as integration with communications platform for tech demo. Outreach to new curb stakeholders interested in results successful.

Reviewer 3:

The reviewer commented that a lot of work has been done to overcome the fact that obtaining the level of data for this type of project is very difficult. Due to all the changes, it is clear that project had to accomplish a lot in a compressed timeline. However, the foundation for the work, which is data, doesn't seem to be well understood. If the data is not well understood assumptions could be made as well as interpretations of the final results that might be inaccurate. For example, in the area of commercial vehicles, the characteristics of those

vehicles do not seem to be clear to the researchers. Implications for delivery vans, local short haul, and Class 8 tractor trailer deliveries are completely different and should be accounted for.

Reviewer 4:

The reviewer commented that the project combines an interesting combination of micro and macro scale curb simulation development, optimal online/market-based curb allocation controller development and validation through municipal operator and traffic sensor stakeholder engagement, and integration with communications platforms to provide real-time curb occupancy information. The project is well planned over a three year completion duration. The project addresses the need for data-driven curb management assessment and mitigation tools.

Reviewer 5:

The reviewer stated that the project is well-designed to quantify and understand how curb use and management may impact overall transportation efficiency and energy consumption. This is a potentially important but not fully understood part of the larger mobility system.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that the modeling seems useful, but it seems this project is still a long way from providing actionable tools for local governments. The optimization algorithm is opaque (e.g., how is climate valued? how are economic values of different curb uses valued?) and would need to be much clearer for local governments to be willing to use these tools.

Reviewer 2:

The reviewer commented that the web-based communications platform developed to display curb occupancy in real-time as well as curb value function models demand in time and space. Identified key inputs for objective function on destinations of interest or centers of demand and arrival rate of vehicles. Optimal curb allocation controller integrated with communications platform as a servable model to display curb allocation based on vehicle type. Also developed model predictive control-based automation of diversionary signs at airports. Automated interventions can save 20 to 80 cumulative vehicle-hours every hour where deployed.

Reviewer 3:

The reviewer noted that the project is close to completion, per timeline, but there are a lot of data verification and validation that is needed (based on the question-and-answer session). The objectives of the project are important to accomplish, so they might benefit from additional time to ensure the data is verified properly (e.g., vehicle type implications) and accurately validated.

Reviewer 4:

The reviewer commented that the research team achieved several accomplishments in the last reporting period. They have revealed that that optimal, dynamic curb zoning is a mixed integer dynamic programming problem. The team also demonstrated a web-based communications platform that displays curb occupancy in real-time. The results also included a curb space value function to model demand in time and space, with curb space value prediction over time and curb locations for three different types of allocations. The team also developed an optimal curb allocation controller integrated with a communications platform as a servable model to display curb allocation based on vehicle type and demonstrated a model predictive control (MPC) based automation of diversionary signs at airports.

Reviewer 5:

The reviewer noted that the project team has made good progress in this project and has successfully mitigated issues such as the unavailability of validation data (by pivoting to alternate ground-truth data). However, it is not evident that planned integration of different components of the project (e.g., VISSIM micro-simulation and BEAM meso-simulation) has been successful. This integration was planned to be through the development of new fundamental diagrams, which was not adequately discussed in the presentation. Additionally, it is not clear that data from the specific use-case addressed by the project (i.e., airport traffic) is extrapolatable to other locations.

Question 3: Please comment on the collaboration within the 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 this project would be much stronger and more actionable, in my opinion, if it had been built with strong participation from local governments and appropriate local government organizations of local planners and officials. Their omission feels like a major oversight. The reviewer would also like to have seen stronger industry engagement from companies using the curb (gig delivery companies, parking management firms, commercial delivery companies, etc.) as well as other connected city technology providers beyond just Lacuna.

Reviewer 2:

The reviewer noted that the collaborating institutions form a uniquely broad set of curb stakeholders (cities, commercial fleets, and startups). Having project-wide biweekly meetings with high frequency task-specific meetings between collaborators as needed. Strong team members and task: Pacific Northwest National Laboratory is responsible for developing fundamental diagram learning techniques, research and implementation of dynamic curb control algorithms, communications platform development, and managing systems integration. University of Washington Urban Freight Lab & Penn State are responsible for microscale simulator design. Lacuna is an urban mobility startup developing the communications systems and data pipeline utilizing an open-source Mobility Data Specification (MDS). Lawrence Berkeley National Laboratory are the developers of the mesoscopic transportation system simulator, which will accept contextual delay diagrams to measure system wide energy impacts of curb configuration. National Renewable Energy Laboratory are the developers of SMART 1.0 curb performance metrics that form the basis of an objective function for online optimization of curb allocation.

Reviewer 3:

They stated that great work has been performed in many aspects of the project and among the current collaborators given the importance of data as the foundation for the full project. Having several locations (once San Francisco and Seattle were not able to continue) included as part of the project and pay for the installation and pilot data might have assisted in the process of securing the data as well as ensuring the information obtained was the one needed for the models. Working together with the locals to develop a data dictionary of what is needed vs obtained ahead of time is very important for the success of this type of project.

Reviewer 4:

The reviewer commented that the project maintains a strong partnership of collaborators made up of other national laboratories (PNNL, LBNL and NREL), academia (University of Washington Urban Freight Lab and Penn State University) and industry (Lacuna, and urban mobility start-up). The researcher provided a nice description of partner roles on the project, and the partners provide collaborative value in terms of project objectives.

Reviewer 5:

The reviewer stated that collaboration within the project team is strong, with close coordination between PNNL, other national laboratories, universities, and an industry partner. Collaboration with stakeholders is limited to Miami International and Seattle-Tacoma International airports. Additional collaboration with local municipalities would strengthen the impact of the research.

Question 4: Please comment on the 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 suggested that future research include developing more user-friendly and user-adjustable tools, and outreach to test the attractiveness of such tools with local governments. The reviewer also feels renewing efforts to validate model results with more robust data sets, not just one airport's data, would be critical for these models to be credible.

Reviewer 2:

The reviewer commented that this project is well positioned to consider multiple curb use cases such as speed-flow results suggest curb activity may only impact traffic flow in extreme cases, such as in ports, transit hubs, sporting events. They have considered speed-flow impacts in cases such as airport terminal-ways, as illustrated in the work on signs, by bringing the Port of Seattle and SeaTac on as working group members and analyzing their traffic flow and use data, to which our control solution is applicable. Currently they are coordinating with SeaTac in deploying the automated control to reduce congestion at the airport terminals. Curbside EV charging can also have substantial impacts on traffic as it may change drivers' routes to access EV charging. Utilizing cost-effective ways to detect curb occupancy and enforce curb management policies, reducing the need to deploy costly sensing equipment.

Reviewer 3:

The reviewer commented that too many questions remain in the current scope to expand the scope to other topics. The future research is focused on expansions instead of optimizing and overcoming the currently proposed work.

Reviewer 4:

The reviewer stated that proposed future research is leveraging prior work and will be considering several curb use scenarios, including airport terminal-ways based on SeaTac deployment of variable message signs control, curbside EV charging impacts on traffic, and cost-effective curb occupancy detection methods.

Reviewer 5:

The reviewer commented that several remaining areas for which there is limited information were highlighted in the presentation, suggesting that there are opportunities for additional research. As this project comes to completion, it is unclear if the team intends to pursue any additional work.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that curb management is a critical issue that EEMS should continue to address.

Reviewer 2:

The reviewer noted that most technical deliverables are on schedule and municipal engagement continues at an aggressive pace. The Optimal Curb allocation controller has been integrated with a web-based communications platform as a servable model to display dynamic curb allocation based on vehicle type. The curb working group has grown to include Miami, Portland, and the Port of Seattle. The project team is working directly with

SeaTac airport to validate microsimulation model and deploy automated control to reduce traffic congestion. Reduced traffic congestion always improves the air quality and fuel economy of the vehicles affected.

Reviewer 3:

The reviewer stated that this topic is extremely important and could assist greatly in the future as more information (e.g., EV charging) is connected to the parking spaces for dynamic curb allocation. The reviewer suggests investing in it, but instead of looking at quick expansion focus for now, on ensuring that the existing work and capabilities are accurate and build on that.

Reviewer 4:

The reviewer commented that this project is relevant to the VTO EEMS program research portfolio involving transportation systems, traveler choice, and mobility energy productivity. The project focuses on trying to better understand urban curb management from the prospective of new users and new technologies and its impacts on urban congestion.

Reviewer 5:

The reviewer noted that the project addresses a research topic that is highly relevant to the EEMS portfolio, and endeavors to both understand the impacts of curbspace allocation, and design solutions to optimize it.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the budget seems large for what is primarily a modeling exercise without equipment investments—and for the products produced to date.

Reviewer 2:

The reviewer noted that all the objectives appear to have been met.

Reviewer 3:

The reviewer commented that this project is towards the end of its performance period. It still has significant work ahead. If a follow-up project is considered the reviewer mentioned to focus on ensuring the data is appropriately collected and understood to ensure the goals for the project are appropriately accomplished. The reviewer stated this is a very hard topic and finding partners to produce the appropriate dataset is not trivial. Treating this as a pilot and now trying to build on those lessons learned would be appropriate.

Reviewer 4:

The reviewer commented that project resources appear to be sufficient for completing the remaining 15% of project activities by the end of the fiscal 2023 year. Milestone 9 was delayed due to data limitations, but the team shifted to available data from airports to allow for completion of the validation work.

Reviewer 5:

The reviewer stated that given the scale and scope of the project, the funding resources allocated to the work are appropriate.

Presentation Number: EEMS101
Presentation Title: RealSim, An Anything-in-the-loop Platform for Mobility Technologies
Principal Investigator: Yunli Shao (Oak Ridge National Laboratory)

Presenter

Yunli Shao, Oak Ridge National Laboratory

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

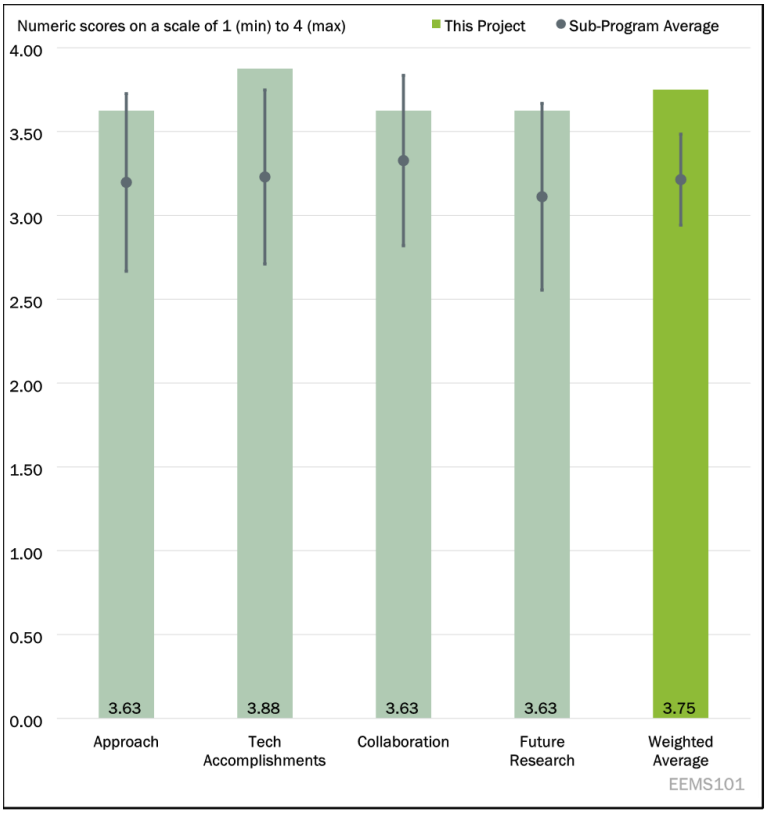

Figure 4-15 - Presentation Number: EEMS101 Presentation Title: RealSim, An Anything-in-the-loop Platform for Mobility Technologies Principal Investigator: Yunli Shao (Oak Ridge National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the team's approach includes the following key building blocks: (1) Sensor development for XIL and virtual environment 2.0; (2) VPPG XIL co-simulation; (3) ANL Perception and Connectivity Activity; (4) RealSim platform development and digital twins; and, (5) Validation using current on-road EEMS projects. These are all well-motivated and the approach is sound.

Reviewer 2:

The reviewer commented that the project is well designed to accomplish the task of creating higher fidelity virtual environments.

Reviewer 3:

The reviewer believed the technical tasks outlined and the work performed so far are addressing technical barriers related to this problem adequately.

Reviewer 4:

The reviewer commented that overall, the approach of emulating infrastructure and traffic to test vehicles or optimization techniques virtually is the way to go as fielding multiple test CAV's with real time control and coordination is difficult. The research team has taken a good approach on digital twin, virtual sensors and robot operating system (ROS) bridge over to hardware. Just great to see all the pieces come together and show a successful demonstration.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that the team's key technical accomplishments may be summarized as follows:1. Fully operational raw sensor emulation of lidars, radars, cameras, etc.; 2. Interface to XIL has been developed as an open-source tool with plug-and-play co-simulation capabilities with VISSIM/SUMO, IPG/CARLA, etc.; 3. ANL's APaCK-I/V units are actively gathering on-road data for digital twin creation.; 4. A streamlined workflow has been established to create digital twins using on-road data and existing databases.

Reviewer 2:

The reviewer noted that the tasks are complete or on-track. Key techniques like virtual sensing and combining real and virtual data have been demonstrated.

Reviewer 3:

The reviewer commented that the work seems progressing as scheduled.

Reviewer 4:

The reviewer stated the so many tools combined and homologated into a coherent and unified workflow for CAV demonstration is very difficult to do and the team has done this and demonstrated success virtually and physically in small road experiments. This is fantastic to see. The collaborations and connections with other EEMS projects no doubt helps to make this a success and is a reflection of the project leadership team.

Question 3: Please comment on the collaboration within the 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 partnerships and collaborations have been healthy between ANL, ORNL, IPG Automotive, and Ford Motor Company. ANL is strongly focused on the prototype ALPACA unit. ORNL is executing numerous EEMS projects (Real-Twin, various FOAs, Integrated Speed & Signal Control, Virtual Physical Proving Ground, Regional Mobility Ctwin). IPG is collaborating with ORNL via software support for sensor modeling & emulation, as well as ROS and Autoware for XIL. Ford is in a CRADA with ORNL to use real-sim capabilities and XIL testing to provide feedback to the rest of the project.

Reviewer 2:

The reviewer noted there was an excellent mix of collaborators from industry and national laboratories.

Reviewer 3:

The reviewer stated that having IPG and Ford as partners on this project is vital. Coordination with them is demonstrated in their contribution to the performed and on-going tasks.

Reviewer 4:

Good to see IPG and Ford as collaboration partners and consumers/users of the real-sim technology.

Question 4: Please comment on the 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 proposed future research plan is sound and involves the following objectives:1. Fully integrate sensor emulation and XIL with CARLA; 2. Refine Real-Sim XIL interface and release as an open-source XIL toolchain for mobility studies; .3. Data collection for digital twin for Greater Chicagoland Roadways; 4. Exercise real-sim for experimental validation on various EEMS projects; and 5. Run verification test of Real-Sim XIL with on-road vehicle testing in various EEMS projects.

Reviewer 2:

The reviewer commented that the appropriate follow-on tasks to show off the digital twin capabilities are being developed.

Reviewer 3:

The reviewer stated that yes, the project clearly defined the purpose of future work.

Reviewer 4:

The reviewer commented that the proposed research work related to project tasking is appropriate and has a purpose to fully accomplish the project goals. The likelihood of success is high, and the team will achieve their targets. The synergy with other EEMS projects helps to ensure this success.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that this project enables a system of systems approach for understanding vehicles equipped with ADAS and "autonomous" driving in various traffic environments. These types of studies can lead to novel strategies for transportation/mobility efficiency optimization, thereby reducing CO_2.

Reviewer 2:

The reviewer commented that the digital twin of the vehicle environment is a key tool for assessing CAV technologies in a safe realistic environment. CAVs are a key technology for potential transport system energy reductions, a key DOE VTO goal.

Reviewer 3:

The reviewer identified relevance to EEMS, Analysis and Electrification.

Reviewer 4:

The reviewer stated that the work aims to provide sensor emulation and digital twin in support of other EEMS XIL initiatives to demonstrate CAV operability for energy savings, so it clearly is aligned with DOE VTO objectives.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that total funding of $3.58 million for 3 years is adequate for the stated objectives.

Reviewer 2:

The reviewer noted that the tasks are complete or on schedule with the available resources.

Reviewer 3:

The reviewer commented that the project resources seem adequate, and the team has been well integrated with current EEMS projects throughout.

Reviewer 4:

The reviewer commented that the resources are sufficient.

Presentation Number: EEMS102 Presentation Title: AI-Engine for Optimizing Integrated Service in Mixed Fleet Transit Operations Principal Investigator: Philip Pugliese (Chattanooga Area Regional Transportation Authority)

Presenter

Philip Pugliese, Chattanooga Area Regional Transportation Authority

Reviewer Sample Size

A total of five reviewers evaluated this project.

Project Relevance and Resources

80% of reviewers felt that the project was relevant to current DOE objectives, 20% 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.

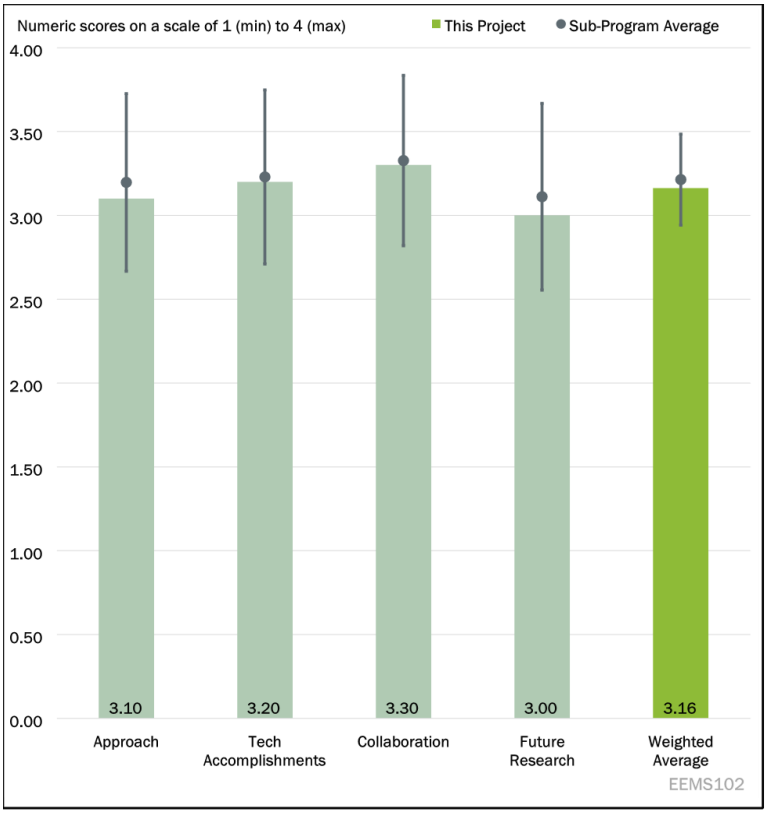

Figure 4-16 - Presentation Number: EEMS102 Presentation Title: AI-Engine for Optimizing Integrated Service in Mixed Fleet Transit Operations Principal Investigator: Philip Pugliese (Chattanooga Area Regional Transportation Authority)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the optimization of transit activities can be important in reducing energy use through improved mobility. The potential application of AI in this area is an interesting topic. This project has a lot of different elements to it, but it appears that the design is coming together/completion, and that the timeline for the remainder of the project is doable.

Reviewer 2:

The reviewer noted that only one of the three specific milestones were completed.

Reviewer 3:

The reviewer commented that this project is complex with several considerations being made in order to ensure that the technical barriers are addressed. The project is end-user-focused and careful thought has been given to developing the outreach and education based on survey results that were administered in 2022. Twenty-five percent (25%) of the project remains and the team has 1 year to complete it. The timeline seems reasonable.

Reviewer 4:

The reviewer stated that the study laid out ambitious objectives for solving many of the routing problems for a mixed-service transit system. And while some of the data points to potential savings from the approach used in

the study, the presentation of data wasn't comprehensive enough to clearly understand whether the study's approach generates enough savings to merit replication in other settings. Next year's presentation should include more service metrics. The most interesting findings were on the technical backup slides. The analysis demonstrated that services designed to serve those with the greatest needs can be less efficient. We've known this intuitively for decades, but it is good to see support in this research. It will be interesting to see how this issue is addressed in the last year of this project.

Reviewer 5:

The reviewer noted that based on the material presented at AMR, the project approach seems solid for this stage of the project, and the reviewer does not have any concerns about the project team's approach to addressing the identified technical barriers.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that this project is about 75% complete, and it appears that the plans for the final elements are nearly approved for implementation. It appears to be reasonable that the project will be completed over the next year.

Reviewer 2:

The reviewer commented that from the results it seems that the team has simulated a reduction to energy use that is in line with their goal. However, the reviewer would agree with one of the respondents of the survey that an overall energy reduction on the transit system shouldn't be the goal but an overall reduction in energy per user should be.

Reviewer 3:

The reviewer stated that for the most part, the team seems to be moving the project along. The reviewer mentioned it seems as though the team is experiencing some difficulties with origin-destination (OD) data collection and operational constraints. The reviewer mentioned not seeing a description of the resolution for this but did see that there is a pending resolution to address this issue.

Reviewer 4:

The reviewer noted that it seems that some critical information about the operating results is missing, including those items identified as under development in the presentation.

Reviewer 5:

The reviewer stated that the project appears to be on-track compared to the project plan on slide 5. Their only concern is related to the challenges with data collection. How will challenges with OD data collection be addressed? Is there a way to complete the project if only data are collected on only 50% of the fleet?

Question 3: Please comment on the collaboration within the 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 the team has good coordination and cross collaboration, including a transit agency, community groups, and universities and national laboratories. It appears that the researchers have done solid work in engaging in the community to determine the needs and who most requires the services.

Reviewer 2:

The reviewer commented that one of the major milestones is incomplete due to "vehicle data transfers." My assumption is this transfer is from one of the members of the project team to another.

Reviewer 3:

The reviewer stated that team collaboration seems strong despite the size of the team. The partners in this project are all high-profile entities. It was not apparent which partner made which contributions to the project.

Reviewer 4:

The reviewer noted that a different reviewer last year asked about community collaboration. It might be more helpful if the actual results of that collaboration were laid out.

Reviewer 5:

The reviewer stated that there seems to be adequate collaboration across the project team. The reviewer mentioned, moreover that they applaud the efforts to understand community needs through community engagement.

Question 4: Please comment on the 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 it will be interesting to see the potential benefits that might be achieved as the group continues to implement this program into the transit fleet and the more complete integration and intervention strategies for Budget Plan 3. It appears that the future research should be completable within the timeframe, given the time extension noted.

Reviewer 2:

The reviewer stated that the future research is not clear beyond the implementation of paratransit. The parking and Siemens integrations aren't clear. The reviewer would also not consider micro transit and fixed route as multimodal.

Reviewer 3:

The reviewer commented that while there were some pending accomplishments and future research listed, it was difficult to distinguish what was a pending accomplishment and what was future research. It would have been helpful to provide additional context to future research and what the goals are for that.

Reviewer 4:

The reviewer noted that the future research slide lays out a path toward project completion.

Reviewer 5:

The reviewer commented that in the reviewer only slides one of the remaining challenges is that the intervention strategy success will be subject to public acceptance. The project team did a good job of going out of their way to meet the community where it was for the survey (e.g., available online and paper format, recruiting at bus shelters, and through different organizations that tend to serve low-income community). But the presentation also mentions the CARTA GO app. Has the project team thought about whether or not the community they are targeting will have access to a smartphone (or data plan) that enables them to use an app like CARTA GO? Or are there other ways to reach them with intervention strategies if they do not have access to technology solutions?

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted that the application of computer modeling to mobility problems is center piece of DOE objectives in the mobility area. Overall, the project appears to align well with the overall VTO subprogram objectives.

Reviewer 2:

The reviewer commented that this project contributes to the VTO EEMS strategic goal of Identify and support early-stage R&D to develop innovative technologies that enable energy efficient future mobility systems.

Reviewer 3:

The reviewer stated that this project supports the overall VTO subprogram objectives.

Reviewer 4:

The reviewer noted that the project aims to develop improved energy efficiency for transit agencies with multiple services.

Reviewer 5:

The reviewer was not clear as to why this project was funded utilizing a customized routing algorithm. There are commercialized products that optimize routing. If VTO wanted to understand the energy savings of using something that is already readily commercially available or benchmarking a commercially available product against something more optimized that might make more sense.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that the project is near completion, and it appears that there were sufficient resources to accomplish the current scope of work. It is noteworthy that the researchers have co-funding at a 20–25% level of DOE funds. The researchers provide some ideas for future work, but it would be interesting to see if these efforts can be expanded to other areas throughout the country.

Reviewer 2:

The reviewer stated that there is not much information on resourcing here, but it seems to be sufficient.

Reviewer 3:

The reviewer commented that the project team has put together an impressive number of resources and a website. Several members of the team have published papers that relate to this project and its outcomes. Additionally, the project team has a website with additional resources and updates.

Reviewer 4:

The reviewer noted that the resources appear to be sufficient to complete the project, though some delays in technical activities may lead to concerns that resources are insufficient for the technical needs.

Reviewer 5:

The reviewer commented that the resources available for this project appear sufficient to meet the stated milestones.

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 four reviewers evaluated this project.

Project Relevance and Resources

75% of reviewers felt that the project was relevant to current DOE objectives, 25% 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.

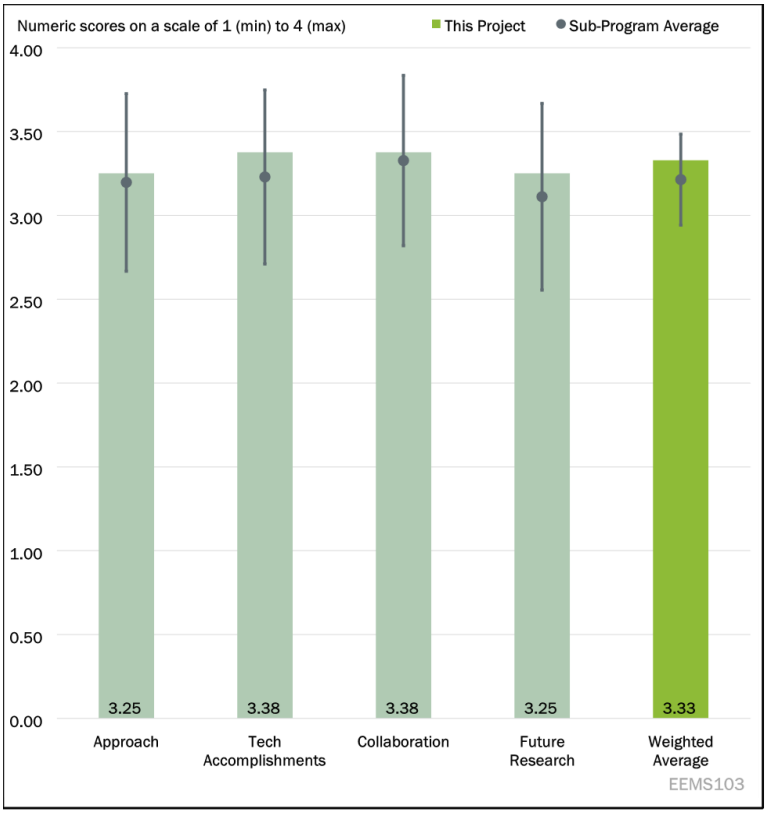

Figure 4-17 - Presentation Number: EEMS103 Presentation Title: Transit-Centric Smart Mobility System for High-Growth Urban Activity Centers, Improving Energy Efficiency through Machine Learning Principal Investigator: Jinhua Zhao (Massachusetts Institute of Technology)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the Transit-Centric Smart Mobility System (TSMS) approach seems like a small variable in the larger problem of increasing ridership satisfaction, driver training and promoting transit solutions. The presenter did little to communicate the benefits on a larger scale.

Reviewer 2:

The reviewer noted that all objectives are 100% complete.

Reviewer 3:

The reviewer commented that this study is endeavoring to use technological advances to address long standing bus transportation issues. The research to date has great merit and an approach that is producing measurable benefits. The reviewer will be keenly interested in seeing the results of an expanded pilot.

Reviewer 4:

The reviewer stated the proposed math and solutions appear to be addressing real issues within the public transportation sector.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the project has made progress to plan which has resulted in progress, although would also like to see a statistical analysis of the TSMS data gathering process.

Reviewer 2:

The reviewer commented that the project team provided detailed outcome-based achievements for the users of the transit system. These improvements will help both users and Chicago Transit Authority (CTA). The only thing that kept this from being outstanding is that the presentation did not discuss or provide examples of interventions that were made. It said the system made recommendations to supervisors but did not say what the recommendations were that caused such a dramatic improvement.

Reviewer 3:

The reviewer stated that by working effectively with stakeholders, the study appears to be developing algorithms and communications protocols that are substantially improving transit service on a test CTA bus corridor. Expansion to other CTA corridors is planned.

Reviewer 4:

The reviewer noted that the material addressed concerns of the previous reviewers.

Question 3: Please comment on the collaboration within the 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 number of partners is limited, however it appears collaboration with CTA is excellent.

Reviewer 2:

The reviewer stated that the team was heavily embedded with the partner agency in their operations center.

Reviewer 3:

The project demonstrated effective regular communication with key stakeholders, especially the CTA. Consultation with low-income and minority communities might be helpful as expansion to other travel corridors is contemplated.

Reviewer 4:

The reviewer noted that the presentation successfully addressed previous reviewer comments.

Question 4: Please comment on the 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 a good list of future research is provided for this activity, but perhaps a deeper understanding of the issues is required to generate a more robust solution to transit bus issues.

Reviewer 2:

The reviewer would have liked to have seen more details about exactly which routes and weeks were going to be used in the future. The reviewer would have liked to have known based on the lessons learned from the pilot period, what recommendations did the team have to CTA as to how to best select the next locations to either test the impact or maximize the total impact of the project.

Reviewer 3:

The reviewer noted that future planned work will lead to project completion and dissemination of the information to national stakeholders.

Reviewer 4:

The reviewer appreciated the statistics provided on Slides 7 and 8. While the system and math on Slides 9–12 are addressing the problems seen at the intended user.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that there was a good list of future research provided for this activity, but perhaps a deeper understanding of the issues is required to generate a more robust solution to transit bus issues.

Reviewer 2:

The reviewer commented that this project not only meets VTO goals but is still very relevant to the circumstances on the ground for transit agencies.

Reviewer 3:

The reviewer commented that the project demonstrates improved transit customer service with lower energy consumption.

Reviewer 4:

The reviewer noted that relevance is well defined on Slide 3.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The commented that the resources appear adequate since no issues were highlighted.

Reviewer 2:

The reviewer stated that the future work plan is scalable to achieve the goals of the project.

Reviewer 3:

The reviewer stated that the resources for the project seem to be sufficient for project completion.

Reviewer 4:

The reviewer commented that the $1.75 million for total project funding listed on Slide 2 should be sufficient to complete the remaining 35% of 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 five reviewers evaluated this project.

Project Relevance and Resources

80% of reviewers felt that the project was relevant to current DOE objectives, 20% 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.

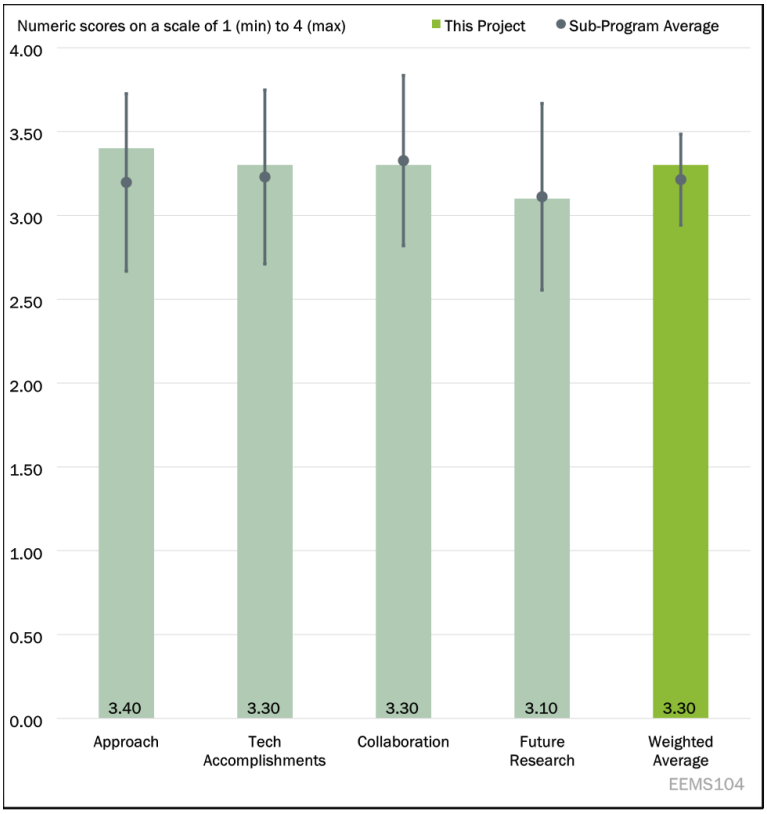

Figure 4-18 - Presentation Number: EEMS104 Presentation Title: Increasing Affordability, Energy Efficiency, and Ridership of Transit Bus Systems through Large-Scale Electrification Principal Investigator: Ziqi Song (Utah State University)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented the approach is multi-dimensional and should have impact for improving bus service cost.

Reviewer 2:

The reviewer stated that the three-pillar approach: affordability, mobility, and efficiency, includes initial modeling and refinement with real-world data. Initial implementation has two phases of refinement with partners and external entities. Discussion with electric utilities which have a major impact on demand charge (and charging cost in general) and therefore cost per mile. The reviewer suggests including an alternative scenario or two for demand charge configurations and comparing them to the optimization results. Continued discussion with electric utilities would be beneficial. Lack of analysis for how fuel cell electric bus (FCEB) adoption by transit agencies might affect the distribution of routes that battery electric buses (BEBs) are expected to take. A bit out of scope perhaps, but important to keep FCEBs in mind as they are an option for transit agencies that could help with longer routes (or backup as the speaker noted).

Reviewer 3:

The reviewer commented that the project demonstrated electrified bus operations, and strategies to reduce operating costs, measure grid impact, and measure transit rider perceptions. The study is contributing meaningfully to our understanding of bus electrification. Including into the approach, both technical innovation

and a better understanding of customer needs, is probably the best direction toward successful transit adoption of electrification.

Reviewer 4:

The reviewer commented that given the project's focus on creating a planning model to help transit agencies deploy electric buses, the barriers addressed in the approach seem sound. The model created considers the total cost of ownership, from purchase price to charging considerations which can help transit operators understand the full investment of making the switch.

Reviewer 5:

The reviewer noted that the approach is well thought out.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that the project is on schedule.

Reviewer 2:

The reviewer commented that there were some delays from COVID but are back on track analyzing survey data. Modeling has been conducted and awaiting survey analysis for refinement before implementation in real world. Planning implementation with three different types of bus chargers and two locations with multiple bus routes and over 10 BEBs.

Reviewer 3:

The reviewer stated that the project has made substantial progress toward addressing the issues transit agencies are identifying as electrification accelerates. The project appears on track to address the technical issues identified in the presentation.

Reviewer 4:

The reviewer commented that the progress made in the planning modeling tool has been significant and has exceeded the milestones set by the project in terms of the number of routes and buses planned for as well as the reduced cost of ownership. Refinement and analysis of the outputs has also been successful in meeting or exceeding project milestones. The reviewer believes the work around bus rider surveys seems important but wasn't able to obtain enough information about the methodology to assert whether the approach and resulting outcomes were aligned with what was intended.

Reviewer 5:

The reviewer noted that there was a well detailed plan.

Question 3: Please comment on the collaboration within the 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 a good list of partners is provided, however the collaboration, communication and responsibilities are not clearly discussed.

Reviewer 2:

The reviewer commented that the project team has partnered with NREL/ANL/Purdue who are leading different aspects. Seem to coordinate well with clear differentiation of tasks.

Reviewer 3:

The reviewer stated that the study is fostering coordination across a variety of stakeholders, notably including support for grid analyses. Inclusion of both transit-user and general-population surveys is an important step in improving transit agencies responses to emerging transit agency-energy system issues.

Reviewer 4:

The reviewer noted that the mix of partners (national laboratories, transit agencies, research universities, utilities) is appropriate and given the small team on this project, they all contribute significantly to the project overall. The reviewer would have liked to see additional partners involved that represent riders such as those that work to improve ridership on transit and understand the barriers to riding that might have contributed to the analysis completed by the project team.

Reviewer 5:

The reviewer suggested that the project team consider a larger fleet and test cases to demonstrate real world applications.

Question 4: Please comment on the 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 given the size and complexity of the problem, the list of proposed future research should be better documented and contain more ideas.

Reviewer 2:

The reviewer stated that integrating real-world data will be a good benefit to the project and the project is set up to include this. Further long- and short-term economic and energy analysis is also germane. Marketing plans are a nice addition, though it is unclear what skills or experience the team has in this area. Commendable task, though.

Reviewer 3:

The reviewer noted that expansion of the pilot and the results of the general population survey are important future steps for the project.

Reviewer 4:

The reviewer would have liked to have seen more collaboration with potential transit partners in other cities. The reviewer was pleased to hear that the presentation mentioned that the team is working to expand the model with more data inputs and are talking with utility NV Energy to do so. The reviewer mentioned that the presenter did not have time to go into much detail about the other future plans for research but those provided on the slide are appropriate. The reviewer is curious about the one to "Design marketing activities in partnership with new mobility providers." The reviewer is not clear on how this connects to the modeling work or other project tasks.

Reviewer 5:

The reviewer commented that the proposed future research applies to larger test cases in worst case scenario, drivability, and extreme charging conditions.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that the project does not support all VTO objectives.

Reviewer 2:

The reviewer commented that the project is clearly relevant as increased mass transit usage would reduce energy and emissions per person mile traveled.

Reviewer 3:

Bus electrification is an important strategy to reduce transportation system greenhouse gases. The study improves our understanding of the issues surrounding bus electrification and strategies to address those issues.

Reviewer 4:

The reviewer commented that given a core facet of EEMS is to conduct early-stage research and development to create knowledge, insights, tools, and solutions to increase mobility energy productivity, this project is well aligned with the objectives. The electric transit space is very young and many transit operators are only comfortable taking on new technologies once they are proven and if they can fully understand the total cost of ownership (TCO). This project seeks to demystify some of this for transit providers while also providing data to support the financial picture of making that transition.

Reviewer 5:

The reviewer stated that there were more and more large vehicle applications.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer said that the resources are adequate.

Reviewer 2:

The reviewer commented that the inclusion of Utah Transit Authority and TriMet transit agencies is a clear value in this project, providing buses, routes, and chargers in the project. The modeling and analysis are well-handled by the core project partners.

Reviewer 3:

The reviewer stated that the project appears to be moving forward adequately with the resources available.

Reviewer 4:

The reviewer commented that the resources seem sufficient to me given the focused scope of this project.

Reviewer 5:

The reviewer commented that it is on track.

Presentation Number: EEMS105
Presentation Title: Energy Optimization of Light and Heavy Duty Vehicle Cohorts of Mixed Connectivity, Automation and Propulsion System Capabilities via Meshed V2V-V2I and Expanded Data Sharing
Principal Investigator: Darrell Robinette (Michigan Technological University)

Presenter

Darrell Robinette, Michigan Technological University

Reviewer Sample Size

A total of five reviewers evaluated this project.

Project Relevance and Resources

80% of reviewers felt that the project was relevant to current DOE objectives, 20% 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.

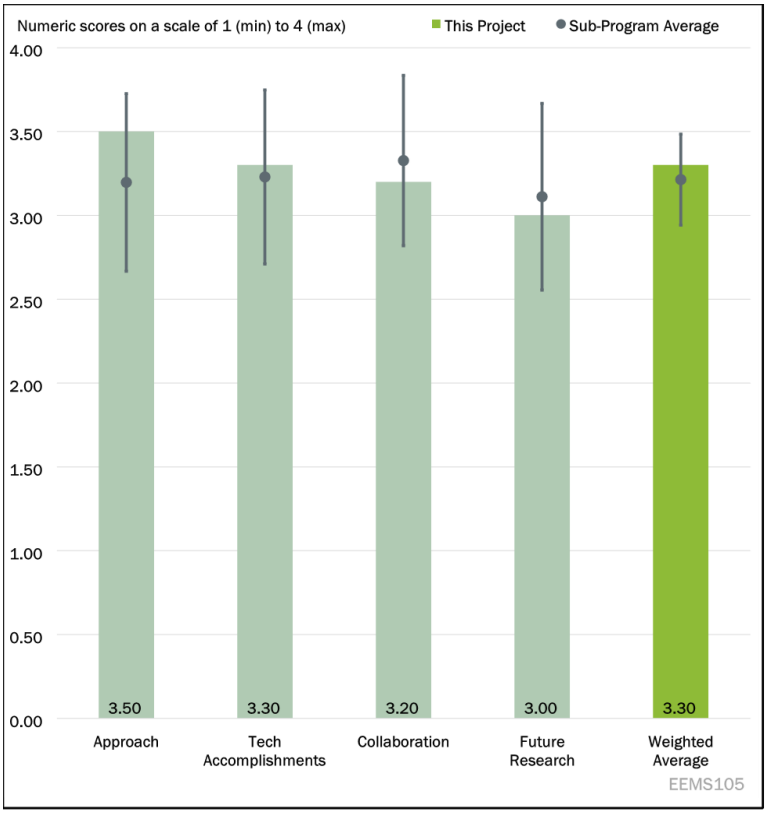

Figure 4-19 - Presentation Number: EEMS105 Presentation Title: Energy Optimization of Light and Heavy Duty Vehicle Cohorts of Mixed Connectivity, Automation and Propulsion System Capabilities via Meshed V2V-V2I and Expanded Data Sharing Principal Investigator: Darrell Robinette (Michigan Technological University)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the project does an excellent job of addressing the possible synergy between automation and connectivity.

Reviewer 2:

The reviewer noted that two of the items in Phase 3 are not complete.

Reviewer 3:

The reviewer noted that the project becomes a viable candidate to improve energy efficiency across the system in the near term if it is possible to create a variant of the design with nudged human-driven connected vehicles. The results and technical approach are excellent. It is interesting that the actual physical CAV cohort testing rendered energy savings greater than those predicted in simulation; curious on what might be responsible for the under-prediction of energy savings—a rare and excellent problem to have. Once simulation results are validated by the test track results, many more studies can be conducted with less live testing required. Use of the design of experiment (DoX) to analyze the trade space and optimize the cohort and timing was an excellent approach and yielded valuable insights. The "counterintuitive vehicle ordering" that DoX identified as most efficient may be similar to dimples on golf balls in that the dimples (or initial vehicle) create a turbulent

boundary layer that results in aero flows closer to the ball and less drag. The results run counter to the early project results: since cohort energy use is dominated by the HD vehicle, the HD vehicle was initially positioned first to make sure it always went through on a green. Awesome insight based on simulation results—counterintuitive ones are the most useful to find because they would not have been found otherwise. Also, BEVs being out front may be appealing to those drivers (better visibility). It is unclear if this logic holds for HD trucks—should they positioned at front, end, or middle of queue?

Reviewer 4:

The reviewer commented that technical barriers described in the project overview provide a clear problem statement for the project and that these technical barriers are addressed well within the project. The project has already demonstrated that connectivity along with automation can reduce energy consumption as well as reduce travel time which are both goals for the EEMS program.

Reviewer 5:

The reviewer commented that the presentation implies that all barriers have been successfully addressed as Slide 2 says that work is 100% by June 30, 2023, but by the time of the presentation there was work yet to be accomplished.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that technical progress has been quite good. In fact, the detailed modeling work is excellent, and the "Assumptions" slide was very good. However, several factors have been ignored: (1) Most vehicles were hybrids, but this is not the real-world case, most vehicles are not hybrid. Regeneration probably contributed a significant amount of the energy savings; (2) The 50% savings statement is misleading. It appeared that the 50% only applied to specific maneuvers, not the entire test cycle; and 3) Cyber security was not considered. This would most certainly slow down the connectivity response time.

Reviewer 2:

The reviewer stated that the presentation is very overwhelming with data and information and not clear on outcomes. It is also unclear as to whether the energy savings were for running this simulation on one approach or multiple approaches. The challenge with signal timing is not one direction but balancing the needs across multiple directions.

Reviewer 3:

The reviewer noted that the project has accomplished a significant amount of work in only 2 years. Milestones and products appear to have good relevance to prospective tech transfer candidates. Project completion is especially notable given the design of the control architecture was novel and different than conventional approaches. This team took some technical risks, and they appeared to have paid off.

Reviewer 4:

The reviewer commented that the project team is meeting its milestones as well as delivering the targeted performance. The project approach and technology content were effectively communicated during the project review. The extensive presentation material provided an outstanding level of supporting information. There was sufficient descriptive material to provide the reviewer with a suitable understanding of the technology pathway and the progress to date. It was useful to have this level of project material available ahead of the review. The presentation material clearly shows the program milestones and their status. There is sufficient supporting material to confirm the level of completion.

Reviewer 5:

The reviewer identified very good progress and results in a complicated and multifaceted project.

Question 3: Please comment on the collaboration within the 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 that it appears that each partner had a well-defined role.

Reviewer 2:

The reviewer noted that there are many organizations involved in this project. While the team explains each team's competency, it does not clearly describe their actual scope of work and how they interact with each other.

Reviewer 3:

The reviewer commented on great partnerships with industry, government, and academia, with each providing substantive contributions. All the industry partners are excellent potential tech transfer candidates, though it would be very helpful to have an OEM onboard as well.

Reviewer 4:

The reviewer stated that the collaboration is well architected. The balance of university, research institution, automotive suppliers and OEM provides an effective overall project team. Each of the team members are providing significant and useful contribution to the project's progress. The project is well coordinated by the prime. Each organization within the team brings a unique resource and capability to the project. The marriage of these is contributing to the strong progress achieved over the course of the project. An example is the inclusion of drive quality assessment within the project. This is a unique and important addition relative to other system level research activities. It recognizes the importance of system behaviors that will strongly influence technology adoption.

Reviewer 5:

The reviewer noted that many collaborators are from academia and industry. Although it was not very clear what was the actual effort contribution for some of the industry partners, the successful completion of the project goals implies good coordination and collaboration.

Question 4: Please comment on the 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 that the future work is in line with the original proposal.

Reviewer 2:

The reviewer commented that it is good that future work will be on actuated traffic signals. Since actuated signals make up the vast majority of modern signals, it is unclear why this was not part of the first element of work.

Reviewer 3:

The reviewer stated that previous year reviewers identified surrounding traffic as likely reducing these benefits. It would be very useful to study that in simulation as part of future work. Is the FY 2024 additional system-of-systems analysis with background unconnected traffic actually part of this funded project, or is it proposed as a follow-on?

Reviewer 4:

The reviewer noted that future work is well defined. The list seems very ambitious for the time remaining. It is difficult to judge the likeliness of completing the tasks described in the future work but, based on the strong progress achieved to this point, the project team is likely to complete the stated tasks.

Reviewer 5:

The reviewer commented that the evolution of the concept to include background unconnected traffic is critical to evaluating real-life implementation.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that automation and connectivity are certainly relevant to the VTO objectives. However, a cohort of vehicles is not only unrealistic, but it has also never been heard by the reviewer discussed as a technology to pursue. To the reviewer's knowledge, no technical roadmaps contain this concept as an avenue to pursue.

Reviewer 2:

The reviewer noted that while the project is relevant to the VTO mission, it is not clear how this would be commercialized or implemented in the real world. It is very highly unlikely that signal systems will be able to receive the level of detailed information on the vehicle that is being proposed here. Perhaps something a bit more practical that incorporates many of the design philosophies here would be more fitting.

Reviewer 3:

The reviewer stated that the project is relevant to VTO EEMS; it has created a new CAV and infrastructure controls architecture, optimized in simulation using statistical and AI techniques, and validated results by track testing. Now what comes next?

Reviewer 4:

The reviewer noted that the project supports the VTO/EEMS goals. The technology is demonstrating both reductions in energy consumption and travel time consistent with an overall improvement in mobility energy productivity. The project deliverables include the development of new tools and provides early-stage technology. It appears the team is effectively sharing its resulting insights. The project's inclusion of vehicles from multiple OEMs and both light and heavy-duty vehicles provides significant enhancement relative to single OEM or sector specific research. Ultimately, on-road mobility technology will be most effective if it is OEM and sector agnostic.

Reviewer 5:

The reviewer commented that the project has relevance in a world where vehicles will cooperate to form optimized platoons of vehicles. Although, the research findings are very interesting and advance the knowledge and tools, the reviewer is not sure about the real-world implementation potential of the concept as-is.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated a belief that there is a better way to spend $2 million dollars for research in areas that might yield some benefit to the specific objectives within VTO.

Reviewer 2:

The reviewer noted that the project team is very well resourced with many talented team members.

Reviewer 3:

The reviewer commented that resources appear sufficient. The project could have been extended a little longer, with a bit of follow-on funding given the very promising results. The reviewer hopes DOE follows up on this project and discusses what its next steps might be. Are these results generalizable to other locations or after varying the vehicle assumptions? Have there been any tech transfer inquiries from the private sector?

Reviewer 4:

The reviewer noted that, based on the comments from the project lead during the project review, the project could benefit from additional test time on the track to further refine and validate the technology within the project. It seems track availability and cost may limit the outcome that can be achieved from the project.

Reviewer 5:

The reviewer stated that the extensive partnership structure suggests a very good assembly of resources for such a complicated project.

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 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.

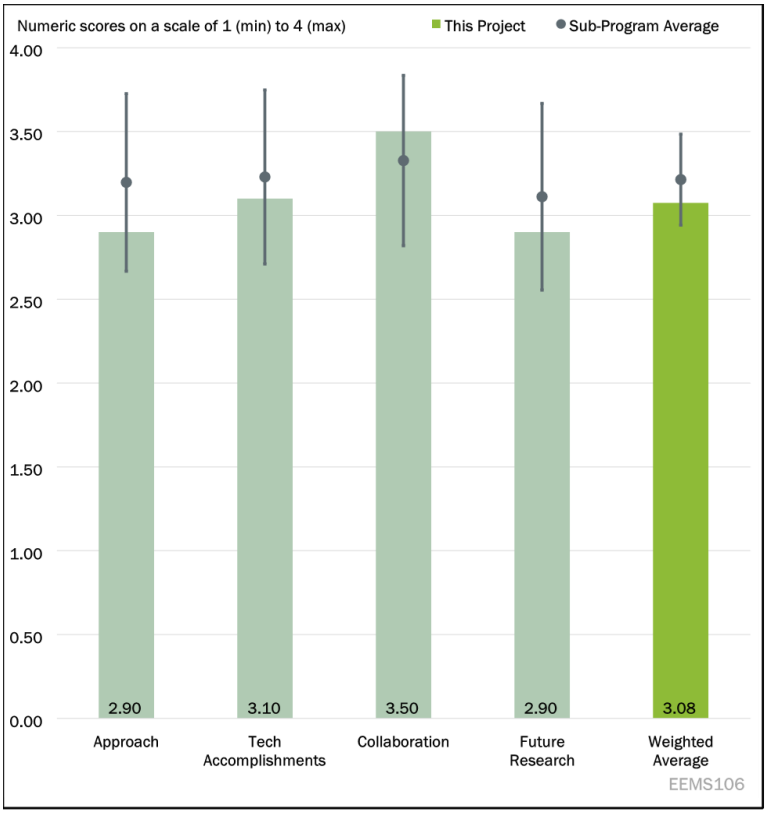

Figure 4-20 - Presentation Number: EEMS106 Presentation Title: Developing an Energy-Conscious Traffic Signal Control System for Optimized Fuel Consumption in Connected Vehicle Environments Principal Investigator: Mina Sartipi (University of Tennessee)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the project appears to have tight timing to meet project completion of December 2023. It appears some work, like traffic controller experimentation/integration could have been done in parallel instead of waiting for optimized routines to be developed.

Reviewer 2:

The reviewer stated that the overall approach, tools, simulation and use of data are excellent. Approach to Performance index is complex and link to physics and scenario applicability is not clear. Multi-termed equations applicability is uncertain. Two vehicle types are modelled but variants in powertrain (ICE, HEV, Plugin hybrid electric vehicle (PHEV), BEV) on light-duty (LD) vehicles is not clear. Fuel consumption plot is in units of mass; the reviewer would have expected it to be in units of mass/time.

Reviewer 3:

The reviewer noted that in Slide 16, the estimated energy savings in pure simulation is low (less than 3%). With the transition to the real-world testbed and its inevitable additional noise and variability, these savings may likely not be retained. The control architecture of this project is very complicated. It is possible that splitting the four stages (corridor partition, signal coordination, local signal control, multimodal priority) has over-constrained the controller and resulted in local optima for each stage and has hampered overall system

improvement. It may be worth sharing the approach and results from each stage to show how they improved upon their respective baselines to see if any of them individually are promising, even if their aggregate effect does not result in significant energy savings. For instance, the global optimization using reinforcement learning showed statistically significant improvements in EcoPI, stop delay, and number of stops. Perhaps it may be better to lean into real world pilot implementations of just these components of the controller rather than the full complicated controller. Is CAVE laboratory really a good place to do integration before field testing? CAVE laboratory's strengths are at a vehicle-level performance (nano-scale), but almost all of the controller development is at the micro/corridor (micro-meso?) traffic level. How would CAVE laboratory help verify micro/corridor level performance? The effort may be better spent elsewhere.

Reviewer 4:

The reviewer stated that based on the material presented at AMR, the project approach seems solid for this stage of the project and the reviewer does not have any concerns about the project team's approach to addressing the identified technical barriers.

Reviewer 5:

The reviewer commented that the use of software-in-the-loop (SIL) studies for planning the field test is an ok practice. It would have been better if the hardware-in-the-loop (HIL) that was performed with only one controller would have used more so networking and communication issues can be tested. The timeline for the field tests is extremely tight; the reviewer does not see much room for second tries if the initial field test encounters difficulties.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that Eco-PI is an interesting metric for global minimization of energy usage. It would be interesting to see a corresponding or modified metric for electrified vehicles due to the differences in idle energy rate and energy recapture. Further comments on the correlation between GHG/energy reduction and Eco-PI would be appreciated. Is it expected that the Eco-PI reduction is much greater? Are the results always directly proportional? It is not clear how the HIL testing/correlation work adds benefit to this project.

Reviewer 2:

The reviewer noted that there are excellent accomplishments in multiple areas. Data collection is especially impressive; real-time digital twin is also a powerful tool. It would be good to see the reporting of results. Only a single data set is given, and this appears to be the best achieved. What is the range of benefits over different scenarios, different traffic densities and flows?

Reviewer 3:

The reviewer identified that attempting a completely new controls approach is always a technical challenge and risk that should be considered as part of a basic research program. This project is also mostly executed per its original proposal. That said, this project could have benefited from more flexibility to deviate from the original FOA proposal. It would have helped if there had been early low-fidelity studies conducted to determine if the total integrated approach (with low fidelity representations of all four stages, not just each individually) looked promising and that would have allowed more agile development to streamline across the four stages. Instead, this project followed a waterfall development schedule in which there was little room to deviate from the original plan. This is as much a reflection of the rigidity of the FOA project management process as about this specific project. For such a complicated control design, the project made significant headway developing all the constituent components of the design.

Reviewer 4:

The reviewer stated that based on the material presented at AMR, they do not have any concerns with the technical progress that has been made against the project plan. The project appears to be on track for timely completion in accordance with the schedule.

Reviewer 5:

The reviewer commented that the presentation did not include a complete project plan. It provided only future milestones, so it is not possible to judge if the project is on time or not.

Question 3: Please comment on the collaboration within the 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 university, government, and laboratory collaboration is well done.

Reviewer 2:

The reviewer stated that numerous multiple universities, ORNL and City of Chattanooga all are contributing. The real-world demonstration and determination of impacts will be a significant outcome even if the energy benefits are difficult to determine.

Reviewer 3:

The reviewer commented that it is great that the City of Chattanooga is a research partner and willing to test out these ideas in a real-world testbed. The digital twin may also be invaluable for many other research efforts and is a worthwhile investment. The team appeared to work well together. However, it seems that the laudable desire to collaborate and appeal to each partner's research strengths may also have been what drove this project to create its overly complicated controller. Each partner made substantive contributions toward the project. However, ultimately, the project appeared to need a stronger systems integrator to ensure that all the pieces effectively worked together.

Reviewer 4:

The reviewer stated that based on the material presented at AMR, there appears to be great coordination amongst the project team. Kudos for getting the City of Chattanooga involved as a stakeholder—the reviewer applauds projects that bring local stakeholders with the jurisdiction to implement this type of project in the real world to the table to get feedback about barriers to implementation so that the team can work to address them as the research is being conducted.

Reviewer 5:

The reviewer noted that so far, the collaboration has been very effective and well-coordinated. A lot are depending on the collaboration with the City of Chattanooga but the evidence from the presentation suggests a well-coordinated partnership.

Question 4: Please comment on the 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 it may be difficult to complete all of the required work in the remaining time left for the project. Establishing baseline scenarios that allow for representative results, for this type of project, is not trivial. Understanding the error between on-road data and the simulation, even in the baseline scenario can be a challenge, and will need to be adequately understood.

Reviewer 2:

The reviewer noted that the outcome of real-world implementation will be a real success for the project.

Reviewer 3:

The reviewer commented that future research may follow the proposed plan, but given the marginal energy savings of the complete controller demonstrated in pure simulation, this project may want the contract officer to revise scope in order to focus on validating the most promising pieces of EcoPI and/or the four stage process (partitioning, signal coordination, local signal control, multimodal priority) instead of a live testbed running all the pieces together. This could be done on the stage which demonstrated the largest benefit in simulation. That piece of this project might be valuable for other research studies.

Reviewer 4:

The reviewer stated that based on the material presented at AMR, the team has a reasonable approach for future work. It is always challenging to move from simulation to real-world deployment. But the team is doing significant work using hybrid environments (like Digital Twins and SIL/HIL) to help mitigate those risks.

Reviewer 5:

The reviewer noted that the presentation did not elaborate on future research plans beyond the current project scope. Defining as future research the successful completion of the remaining proposed tasks, the schedule is very aggressive and having a lot of risk.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer affirmed that the project meets the objectives of the EEMS subprogram.

Reviewer 2:

The reviewer noted that the project is well-aligned with EEMS including demonstration.

Reviewer 3:

The reviewer stated that the project is relevant to VTO EEMS in its use of AI/ML, game theory, and optimal control theory to improve traffic flow in order to save system-level energy.

Reviewer 4:

The reviewer commented that this project supports VTO/EEMS Strategic Goal 2: Identify and support early-stage R&D to develop innovative technologies that enable energy efficient future mobility systems.

Reviewer 5:

The reviewer noted that optimizing traffic signal control has the potential of great gains in fuel economy and reduction in pollution. The project has a realistic and feasible approach to the problem.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources are sufficient to achieve the milestones.

Reviewer 2:

The reviewer commented that resources are sufficient, and project is meeting milestones and timeline.

Reviewer 3:

The reviewer stated that resources appear sufficient.

Reviewer 4:

The reviewer commented that resources appear sufficient for the project to achieve the stated milestones.

Reviewer 5:

The reviewer noted that all necessary resources seem to be available. Even so the inclusion of an actual vehicle HIL could be considered a bit excessive.

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 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.

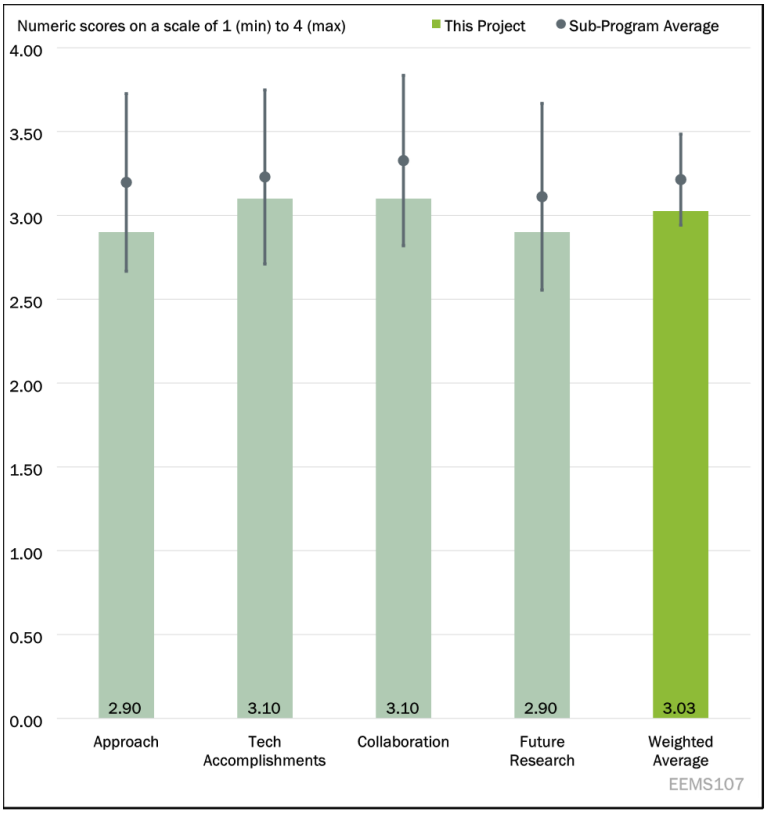

Figure 4-21 - Presentation Number: EEMS107 Presentation Title: Improving network-wide fuel economy and enabling traffic signal optimization using infrastructure and vehicle-based sensing and connectivity Principal Investigator: Joshua Bittle (University of Alabama)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the project scope and complexity are both very wide. While there appears to be progress in addressing the technical barriers, it would be easier to understand the contribution of each technological area to the overall efficiency improvement, rather than a final result. For example, are both camera and radar needed? How does the V2X data compare? Are there issues when fusing all data sources together? What is the impact of optimized vehicle control?

Reviewer 2:

The reviewer noted that with respect to estimating energy and emissions saving in future mobility scenarios, this is difficult in mixed traffic scenarios and with only two LD vehicles modelled this would seem to be a difficulty.

Reviewer 3:

The reviewer commented that in Slide 11 the presenter elaborated on the content of the C-V2X/dedicated short range communications (DSRC) submitted publications. One topic described how potentially a single roadside unit (RSU) might be able to broadcast information for multiple intersections. This research would be of great relevance and importance, with FHWA's recent push for state/local departments of transportation to deploy RSUs at scale in the next few years. According to a DOT spectrum expert, it does not appear that C-V2X

(PC5, or point-to-point) can cover multiple intersections unless it is connected to the broader cellular network communications (Uu), or up/downlink to cell tower. DOT is interested in learning more about the findings from these papers. Simulated results show 10%–15% fuel savings, which is decent though likely to decrease once implemented in the real world (project aimed to reduce fuel use by more than 20% in real world). Three intersections are a rather limited scope to test within. The reviewer suggests considering simulating across a longer corridor, then validating just the three intersections. Of the CDA FOA projects, this team has the most traditional approach and can help establish solid baseline expectations for what current technologies and approaches might achieve when integrated together.

Reviewer 4:

The reviewer stated that based on the material presented at AMR, the project approach seems solid for this stage of the project. However, the reviewer expressed some concerns with the base estimates of fuel consumption. It is documented in the literature that if one wants to use trajectory outputs from microsimulation (i.e., trajectories from microsimulation to estimate fuel consumption), one must calibrate the microsimulation model with trajectory level data—models calibrated with traditional, infrastructure-based data sources (like total volume flow, indicated on Slide 15) are insufficient to have confidence in the trajectories produced by the model. The reviewer cited this report. Getting a proper estimate of current fuel consumption is paramount for assessing if the project successfully reduces fuel consumption by more than 20%.

Reviewer 5:

The reviewer commented that it is difficult to see how the whole framework will work. So far, the presented information has a gap regarding the way the traffic control will be optimized based on vehicle trajectories. Simulation will never produce trajectories that are realistic and based on kinematics that match reality. Car following models do not adhere to physics. For this reason, the reviewer does not see from the presented information how the goal of the feedback loop between optimized traffic control and optimized vehicle trajectories will be bridged.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that project completion given the current timeline may be difficult. There has been a lot of technical progress on individual milestones with regard to data collection and simulation. The synthesis of this data and application to the next milestones involving vehicle integration will be a challenge.

Reviewer 2:

The reviewer identified excellent work on data collection and analysis of vehicles on infrastructure data collection. Sharing data in LiveWire would be an important contribution. It is uncertain about the usability of the distributions as there are numerous factors in the data for car following models.

Reviewer 3:

The reviewer noted that the project is mostly on-schedule, accounting for a six month slip due to lightning strike-damaged hardware. Accomplishments to date are solid and per project management professional (PMP) practices.

Reviewer 4:

The reviewer stated that based on the material presented at AMR, the reviewer does not have any concerns with the technical process that has been made against the project plan. The project appears to be on track for timely completion in accordance with the schedule.

Reviewer 5:

The reviewer commented that, looking at the comments from last year as well as the information presented now, the reviewer doesn't see clear answers have been achieved. Instrumentation and data collection effort accomplished is old news since even in this AMR several projects that have done much more were presented. Regardless, there has been minimal information regarding the field implementation which is a critical part of the go/no-go decision in the project.

Question 3: Please comment on the collaboration within the 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 automotive collaboration could be helpful for this project to help develop/enable optimized vehicle controls.

Reviewer 2:

The reviewer stated that collaborations with Alabama Department of Transportation (ADOT) and ORNL are in progress and infrastructure measurements are playing a key role.

Reviewer 3:

The reviewer noted that the University of Alabama (UA) and ORNL teams appear well coordinated, but it is unclear what the role of German Aerospace Center is. Likewise, is the City of Tuscaloosa considered a partner? It is also unclear how long the pilot deployment is supposed to last.

Reviewer 4:

The reviewer stated that based on the material presented at AMR, there appears to be great coordination amongst the project team. What is ADOT's role on the project (they're mentioned on the first slide, but not on Slide 22)? Are they just a data supplier, or an active collaborator? The reviewer suggested getting an infrastructure owner operator involved to help the project team understand and mitigate the challenges associated with deploying this solution in the real world.

Reviewer 5:

The reviewer commented that most of the work is accomplished by UA and specifically the mechanical engineering department. The role of the ORNL effort with the HIL testing is not clear as to why it is necessary for the project. Other collaborations are incidental.

Question 4: Please comment on the 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 that the proposed future work is valuable, yet still broad. It is recommended to focus on a subset of deliverables for a greater chance of success and completion on time. Actuated and coordinated control vs. fixed-phase coordinated control as a baseline should be re-examined. The research has shown that ACE control provides considerable benefit, at a much lower level of investment and integration effort.

Reviewer 2:

The reviewer commented that important and future research with implementation and demonstration in the corridor will be a significant achievement. The reviewer is not sure how the assessment of, "Ability to impact traffic flow at low connected vehicle penetrations levels will be assessed with two vehicles. It is not clear how the project is targeting, "Powertrain Optimization" per Slide 6 and "engine control module." What engine optimization is being done over the baseline calibration and how is this alternative optimum determined?

Reviewer 3:

The reviewer stated that future work is a reasonable progression from simulation results.

Reviewer 4:

The reviewer commented that based on the material presented at AMR, the team has a reasonable approach for future work. It is always challenging to move from simulation to real world deployment, but it sounds like the project is doing what they can to mitigate the risk through their engagement with the DOT and an OEM.

Reviewer 5:

The reviewer is not fully convinced that what is proposed in terms of future tasks will be feasible given the presented project path. Specifically, it is very unclear how vehicle trajectory optimization will happen in reality. Optimizing a single intersection for a short duration field test is not an exciting accomplishment.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted that this program supports the EEMS subprogram objectives.

Reviewer 2:

The reviewer stated that the project meets overall EEMS program objectives with real-world demonstration and impact of traffic optimization and impact on energy (here denoted as fuel economy).

Reviewer 3:

The reviewer commented that the project is relevant to VTO EEMS. With its traditional controls engineering approach, it may usefully serve to set baseline expectations for what integrated connected and automated technologies might accomplish with respect to vehicle- and system-level energy efficiency.

Reviewer 4:

The reviewer commented that this project supports the following VTO EEMS Strategic Goals: Identify and support early-stage R&D to develop innovative technologies that enable energy efficient future mobility systems.

Reviewer 5:

The reviewer noted that the project scope and intentions are very relevant to the VTO subprogram objectives. Novelty of advancements is promising but not great.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the resources for this project are sufficient.

Reviewer 2:

The reviewer commented that resources seem appropriate but there is a large amount of valuable data that hopefully is used both in this project and can be used by others.

Reviewer 3:

The reviewer noted that resources appear adequate.

Reviewer 4:

The reviewer stated that the resources available for this project appear sufficient to meet the stated milestones.

Reviewer 5:

The reviewer commented that for the budget level the resources are adequate, but others have done more with less. The reviewer hopes the field instrumentation will stay in place to support long term data collection and further research.

Presentation Number: EEMS108
Presentation Title: Co-Optimization of Vehicles and Routes
Principal Investigator: Nick Hertlein (PACCAR)

Presenter

Nick Hertlein, PACCAR

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, 20% 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.

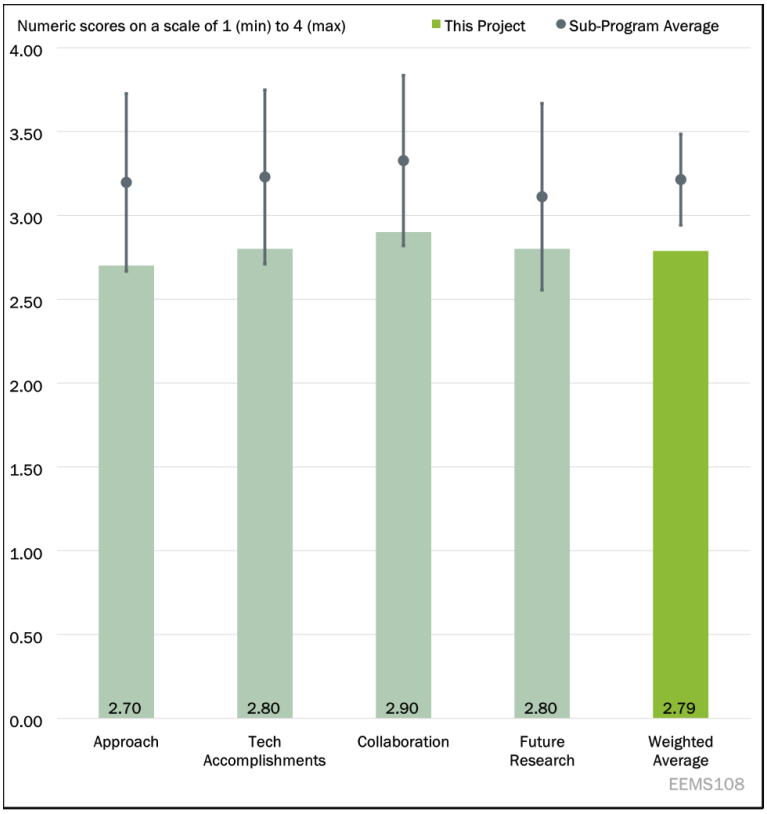

Figure 4-22 - Presentation Number: EEMS108 Presentation Title: Co-Optimization of Vehicles and Routes Principal Investigator: Nick Hertlein (PACCAR)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer noted good use of the eco-routing software. However, the business incentives were not addressed in sufficient detail.

Reviewer 2:

The reviewer stated that the entire project description lacks scope. The program outline Gantt chart lacks a key for color coding. Some of the most important elements of quantifying success is pushed to the last quarter of the project. There appears to be no mechanism for stakeholder feedback, which is essential for buy-in to ensure implementation, adoption and commercialization and sustainment. There are very capable partners with well-defined roles.

Reviewer 3:

The reviewer noted limited impact.

Reviewer 4:

The reviewer was confused by the stated barriers communicated within the project review on Slide 2: Business Incentives for Cloud Providers, OEMs and Fleets; Vehicle to Cloud Architecture Technologies; and Network Bandwidth. Referencing Slide 19, the reviewer reported that the presentation refers the main barrier as, "completing the final analysis and determination of freight efficiency improvement compared to baseline data." Slide 19 also mentions several technical challenges. The reviewer observed some confusion between technology barriers and project execution barriers and indicated that while there is useful work going on within

the project, its alignment with technical barriers seems muddled. The reviewer asserted that the barrier described as, "Business Incentives for Cloud-Providers, OEMs and Fleets," seems particularly troublesome. If the project is intended to address this barrier, it needs to communicate the project's approach more effectively. A clearer statement of technical barriers addressed within the project and the alignment with the project deliverables would be helpful from this reviewer's perspective.

Reviewer 5:

The reviewer commented that the project is aimed at improving fleet energy efficiency by 25% through a multi-pronged approach consisting of four technologies—powertrain optimization, fleet management, eco-routing, and eco-driving. The four technologies are well established and, aside from the use of telematics and cloud platform, it is unclear how connectivity is used to enhance these technologies.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that eco-routing software seemed to perform well, however, assumptions were not made clear—what changes in the powertrain resulted in a 7% improvement? What characteristics did the driver training result in a 5% improvement. Both of these figures are very high. The accomplishments should provide more detail. An assumptions slide would also be helpful.

Reviewer 2:

The reviewer stated that the accomplishments are well described and appear to be on track in comparison to the Gantt chart. The ability to weigh time, cost and a combination is a nice feature.

Reviewer 3:

The reviewer commented that real life traffic data rather than historical data could offer better accuracy in predicting an optimized route.

Reviewer 4:

The reviewer noted that it difficult to judge the progress relative to the project's scheduled deliverables. There is not an effective overview of the actual milestones and their intended timing. The milestones listed on Slide 5 don't line up with the tasks on the Program Outline on Slide 4. Project "EEMS105" provided a slide showing the project phases, milestones and their status. It would be best if this project team provided a similar chart.

Reviewer 5:

The reviewer commented that development work seems to have gone through a few iterations and looks to be commensurate with the project timeline. Given that the project is 84% complete, the reviewer would have liked to see more results in the presentation.

Question 3: Please comment on the collaboration within the 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 good collaboration within the project. However, more information regarding the fleets should have been shared.

Reviewer 2:

The reviewer commented that other than the internal working partners, there is no description of outside stakeholder involvement, from the American Trucking Associations, DOT, AASHTO, National Academies of Science, etc.… There is also no mention of overlap, or coordination with other VTO projects that could be mutually beneficial to the success of meeting project objectives. Driver feedback is also very important.

Reviewer 3:

The reviewer stated that balanced collaboration is evident.

Reviewer 4:

The reviewer noted that the project team includes a useful range of participants. The inclusion of a national laboratory, university, fleet services, and an OEM provides a comprehensive project team. Each of the participating organizations bring a unique resource and capability to the project. Given the description of the project, it appears the level of collaboration is sufficient.

Reviewer 5:

The reviewer commented that the project team consists of team members with necessary and complementary skills. However, the team seems to lack a member with expertise in eco-driving.

Question 4: Please comment on the 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 future research is in line with the original project plan and suggested emphasizing model data validation with actual fleet results.

Reviewer 2:

The reviewer commented that stakeholder engagement is instrumental from the onset of the project, with periodic briefings on progress to gage interest and gather information on what potential customers may want so that adjustments can be made where viable. There are good example demonstrations of the integration of systems and example data. This would be of interest to not only the participating fleet, but others as well. Since BEVs are not yet included, it would be appropriate to mention how the location of charging facilities would be incorporated into the route/time calculations for future research. FHWA could be a good source for their plans under the Bipartisan Infrastructure Law (BIL) and/or the Inflation Reduction Act (IRA).

Reviewer 3:

The reviewer noted limited impact.

Reviewer 4:

The reviewer commented that the project team has communicated its purpose for future work. It seems likely the future work will allow the project to achieve its targets.

Reviewer 5:

The reviewer stated that the proposed future work seems logical but lacks specifics on the testing and evaluation plan. It is unclear how the energy efficiency improvements will be attributed to each of the four technologies. Does the project team plan to conduct customer discovery to inform the commercialization of these technologies?

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted that this project is very relevant—because most of these tools can be used today—no need to wait for new technology.

Reviewer 2:

The reviewer stated that the project supports VTO subprogram objectives and is relevant in the sense of improving efficiency of fleet management, however some discussion of charging station locations, type and frequency should be included.

Reviewer 3:

The reviewer commented that the project has relevance to an extent.

Reviewer 4:

The reviewer stated that the project supports the VTO/EEMS goals. The project intends to demonstrate reductions in energy consumption related to freight operations and freight travel time which is consistent with the EEMS goal for mobility energy productivity. It is unclear to what extent project data and insights will be shared. It would be useful to communicate the project's approach to sharing consistent with the EEMS goal in this respect.

Reviewer 5:

The reviewer commented that given that freight transportation consumes a large amount of energy, reducing energy consumption and emissions from this sector is important.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that resources utilized on this project seemed in line with the project scope.

Reviewer 2:

The reviewer noted that considering the amount of work yet to be completed and the efforts of incorporating BEVs, additional stakeholder outreach and commercialization, there appears to be a need for additional funding.

Reviewer 3:

The reviewer noted sufficient and multi-skilled resources to meet objectives.

Reviewer 4:

The reviewer stated that resources appear to be consistent with the goals and timing of the project. The project is likely to meet its stated milestones within the project timeline. The reviewer did not note any resource concerns mentioned during the project review.

Reviewer 5:

The reviewer commented that resources should be sufficient.

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 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.

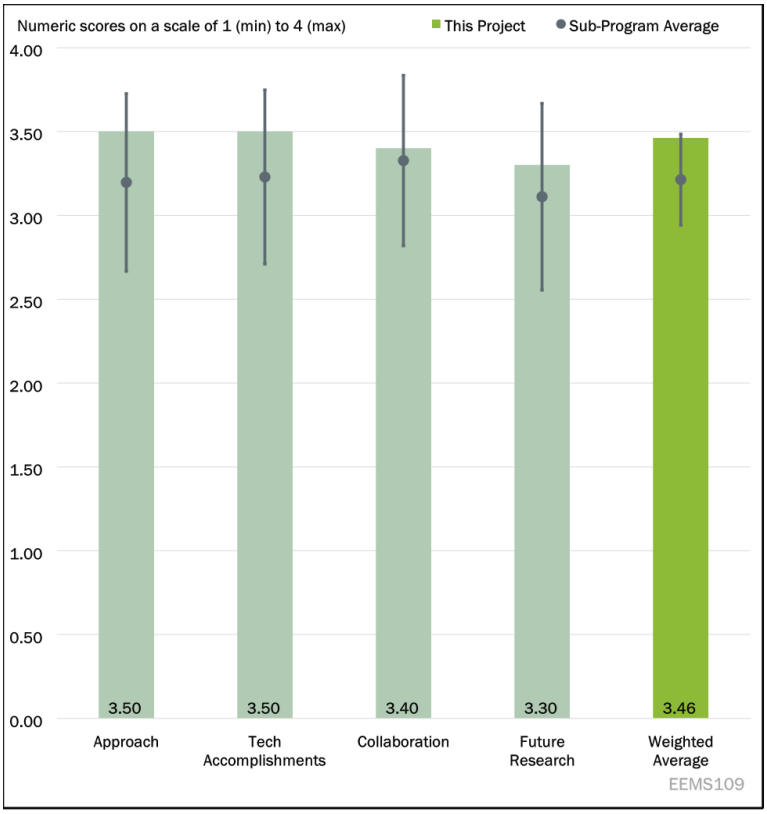

Figure 4-23 - Presentation Number: EEMS109 Presentation Title: Connected and Learning Based Optimal Freight Management for Efficiency Principal Investigator: Ali Borhan (Cummins)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented on nicely documented goals and achievements.

Reviewer 2:

The reviewer noted that the project was designed and executed well and had excellent use of real fleet data. More detail could have been shared regarding assumptions like charging station availability, cost of electricity, and cost of hydrogen, among others.

Reviewer 3:

The reviewer noted that the project is ending.

Reviewer 4:

The reviewer stated that the project team clearly identified the barriers it intended to address in the course of the project (optimal decision making for fleet vehicle purchasing and fleet operations for decarbonization). The project content seems well focused to address the barriers described in the project overview. The timeline appears to be aggressive but feasible.

Reviewer 5:

The reviewer commented that the project approach addresses both the investment and operation phases of fleet management, allowing for the optimization of long-term capital planning of emerging technology adoption and short-term day-to-day fleet operation. It is commendable that the project considers well-to-wheel emissions.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that it was an excellent presentation, a lot to learn from.

Reviewer 2:

The reviewer noted that technical accomplishments were demonstrated very well. The graphs on the top right side of Slide 12 are not labeled.

Reviewer 3:

The reviewer commented that the simulation was completed.

Reviewer 4:

The reviewer stated that the project approach and technology content was described very well within the presentation material and was nicely communicated during the project review. There was sufficient descriptive material to provide the reviewer with an effective understanding of the technology plan and the progress relative to the plan. It was useful to have this level project material available ahead of the presentation. There was a lot to cover in a short amount of time. The presentation material clearly shows the program milestones and their status. How these completion dates compare to the project plan is difficult to assess without more detail on the intended project cadence, but the milestones and their timing seem consistent with the high-level timeline.

Reviewer 5:

The reviewer commented that the use of large-scale real-world data provides credibility to the results obtained. The ability to account for real-world payload is unique. While the project team observes similarity between 3-months and 12-months, miles per gallon (MPG) distributions, for the baseline diesel vehicles, indicating stable MPG throughout the year, this may not be true for battery electric vehicles where ambient temperature can have significant effect on range.

Question 3: Please comment on the collaboration within the 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 it looks like a lot of people did contribute to the work as planned and appears to be well managed.

Reviewer 2:

The reviewer noted excellent collaboration across the entire project.

Reviewer 3:

The reviewer commented that it is interesting to see the influence from tire rolling resistance but no evaluation of more impactful variables such as drag coefficient or other criteria.

Reviewer 4:

The reviewer stated that the project team includes a useful range of participants. The inclusion of a national laboratory, university, automotive supplier, and an OEM provides a comprehensive project team. Each of the team members is providing significant and useful contribution to the project's progress. For example, the project makes good use of the Argonne POLARIS tool. Also, the inclusion of a dynamic tire model appears to be a useful enhancement relative to other vehicle cycle simulations the reviewer has seen in the past. There are a range of systems in a Class 8 tractor and trailer. The engine and tires are represented within this project team.

Participants from other vehicle system suppliers could certainly bring additional benefits. On the other hand, the team has chosen a manageable range of participants relative to the scope of the project.

Reviewer 5:

The reviewer commented that the project team consists of team members with necessary and complementary skills.

Question 4: Please comment on the 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 it seems to be on track.

Reviewer 2:

The reviewer commented that future research is in line with the original project planning.

Reviewer 3:

The reviewer noted validation of simulation results.

Reviewer 4:

The reviewer stated that the slide regarding future work could benefit from some description beyond the milestone headings. It is difficult to interpret the intention and scope behind the headings on the "Proposed Future Research" slide. That said, the project review material was very extensive and it is understandable that some sections may have been light to allow time for other portions of the review material. In any case it seems likely the project team will meet the research targets.

Reviewer 5:

The reviewer commented that proposed future work is thorough and logical.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted Electrification and EEMS relevance.

Reviewer 2:

The reviewer stated that a tool like this is important because it can be utilized today—without waiting for the next technology to be developed.

Reviewer 3:

The reviewer commented yes to the defined extent.

Reviewer 4:

The reviewer stated that yes, the project supports the VTO/EEMS goals. The project intends to demonstrate reductions in energy consumption related to freight operations and freight travel time which is consistent with the EEMS goal for mobility energy productivity. The project also supports efficient deployment of freight capital expenditure (CAPEX). The project has provided an effective description of the technical approach and technologies features developed within the activity. It would be good to know the level of data and methodology sharing that the project will provide to the 21CTP community going forward. It appears this project will produce some very useful insight for freight efficiency.

Reviewer 5:

The reviewer noted that given that freight transportation consumes a large amount of energy, reducing energy consumption and emissions from this sector is important.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that it seems like sufficient fundings were allocated.

Reviewer 2:

The reviewer stated that resources allocated to this project appear to be in line with the scope.

Reviewer 3:

The reviewer commented on the need for stronger coordination and better consideration of other relevant parameters.

Reviewer 4:

The reviewer stated that based on the accomplishments to date, the project appears to be well resourced and effective. The reviewer feels confident the team will achieve the stated milestones within the timeline established for the project.

Reviewer 5:

The reviewer noted that the budget seems high for a mostly modeling project.

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 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.

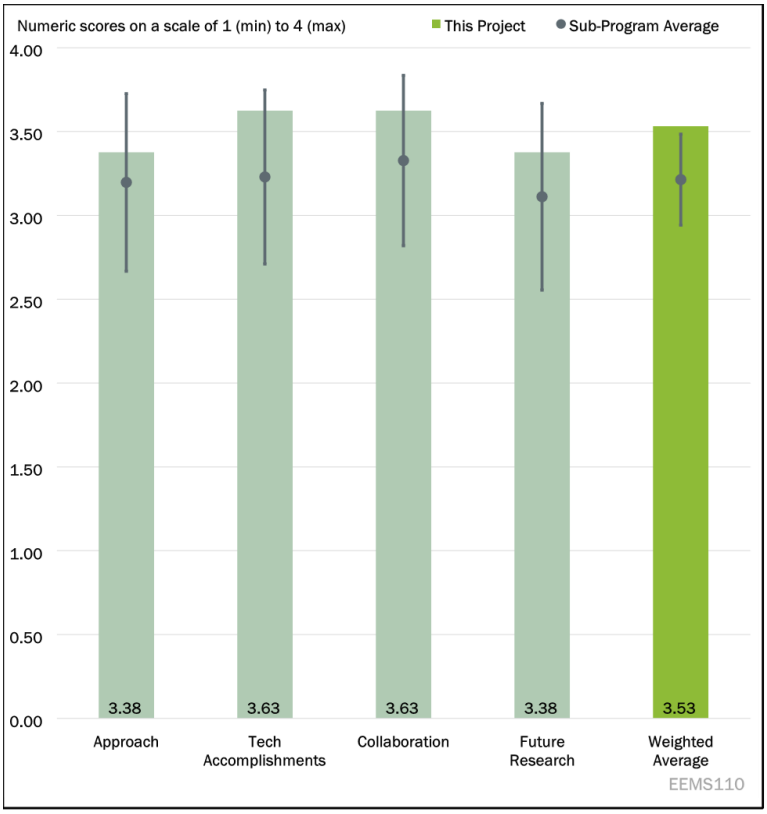

Figure 4-24 - Presentation Number: EEMS110 Presentation Title: Human Factors and Technologies Design to Improve User Acceptance of Pooled Rideshare (PR) for Increasing Transportation System Energy Efficiency Principal Investigator: Yunyi Jia (Clemson University)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the technical approach for the project involves collecting human factors data to analyze pooled rideshare barriers, develop pooled rideshare acceptance and choice models, and use pooled rideshare acceptance and choice models to assess and validate new human factors guided technology designs. The project is well-designed with successive steps for addressing prescribed barriers involving human factors for accepting pooled rideshare, lack of modeling tools, and validation of new technologies and their impacts on energy use. The researcher provided in-depth coverage of each step in the approach and the respective research objectives.

Reviewer 2:

The reviewer noted that the project addresses a key barrier in the lack of understanding of user-acceptance for pooled rideshare, and more importantly endeavors to design solutions that overcome these barriers and increase pooled rideshare adoption. Pooling rides is a powerful lever for improving the efficiency of the transportation system.

Reviewer 3:

The reviewer commented that the project approach is well designed, spanning original data collection through surveys, factor and choice analyses of the survey data, development of PR choice model from the survey data, and simulation of PR service with and without the PR choice model. The project timeline is reasonable.

Reviewer 4:

The reviewer stated that the research is timely considering that human factors are a driver of modal choices especially carpooling. The reviewer appreciates the approach of integrating human factors into their modeling and approach; this is a critical nexus for understanding the ridesharing landscape. The project is well designed but could have more integration from rideshare providers. The landscape with rideshare like Lyft, Uber, etc. is changing and this project would be strengthened with their engagement especially as the research points to safety and service experience have high impact on decisions around PR. In addition, understanding or gaining insights into future pooled options from companies may help with the projects next steps as well as helping the companies understand influences for pooling in their business models.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that technical progress appears on plan, albeit only at 50% due to nine-month delay. The team has completed two pooled rideshare datasets (factors and choices) as planned; completed analysis and identified human factor barriers; produced the pooled rideshare acceptance model (PRAM) and pooled rideshare choice model (PRCM); initiated the model guided user experience design and optimization; and produced a POLARIS-based simulation for optimizing pooled rideshare optimization strategies and heuristic assignment validation for multiple cities.

Reviewer 2:

The reviewer stated that the project is very logically designed, and the team has made outstanding progress relevant to the project plan. Important information has been gleaned from human factor surveys and studies and choice analysis, and the pooled rideshare choice model has been integrated into POLARIS to evaluate impacts in a medium-sized city. Human factors-based design is underway.

Reviewer 3:

The reviewer noted that the surveys are well designed and produce very useful data, which are then used to develop the PR acceptance and choice models. These models will help PR providers better design PR services that appeal to riders. The project seems to be on track and has produced interesting datasets and results.

Reviewer 4:

The reviewer commented that the project is on track and making progress on the established timeline and milestones.

Question 3: Please comment on the collaboration within the 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 project exhibits excellent internal and external collaborative efforts. Internal collaboration involves diverse partners from academia (Clemson University), a national laboratory (Argonne National Laboratory), industry (J.D. Power, Ford Motor Company, and International Transportation Innovation Center (ITIC)). The research provided a thorough explanation of each team members role and why they were selected for the project. External collaboration involves a variety of other VTO-funded project teams,

including EEMS093 POLARIS: Multimodal; EEMS093 POLARIS: Behavior models; EEMS093 POLARIS: Workflow; O'Hare Optimization FOA; and TI104 Rideshare Pilot. The symbiotic relationship has afforded the research with results contributing to the human factor studies of the project, while this project afforded the other projects the human factor results (including the PR models).

Reviewer 2:

The reviewer noted that the collaborative team is impressive, led by a major academic institution partnered with a leading national laboratory, and leading market research firm, a leading automotive company, and an important test facility.

Reviewer 3:

The reviewer stated that the project team consists of team members with necessary and complementary skills. The results from this project are being leveraged in other EEMS projects.

Reviewer 4:

The reviewer commented that, as mentioned above, expanding the partnerships to companies that provide the options for pooling would increase the contributions to the project. More collaboration is needed with these companies especially as this landscape continues to change, especially in light of COVID and changes in transportation patterns. Outreach to PR providers will strengthen the overall outcome and allow the team to be more responsive to the market.

Question 4: Please comment on the 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 that the researcher did clearly define the future anticipated work for the project. The researcher will be completing the PRAM guided PR vehicle and service designs and validating those designs based on focus group studies and a national survey. The team will also be refining the PR choice model and completing the PR assignment and routing optimization and PR repositioning strategy based on the previous model. Finally, the team will validate PR technologies for improving PR energy savings. These future activities seem reasonable and achievable given they generally work off of previous work and can be accomplished in the remaining time left on the project (1 year+).

Reviewer 2:

The reviewer commented that future work consists of continuing to execute on the existing project plan. The results of the pooled rideshare user experience design will be an important outcome of the project, as will continued model refinement and validation.

Reviewer 3:

The reviewer stated that the proposed future work is logical.

Reviewer 4:

The reviewer commented that the project team has laid out the challenges and framed the next steps and future work. The team should include other partnerships, as mentioned above, the rideshare companies should be considered in future work and evaluations.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that this project focuses on pooled rideshare research for increasing understanding and developing effective modeling tools. The project supports VTO EEMS research initiatives.

Reviewer 2:

The reviewer commented that the project focuses on removing barriers to ride pooling, which is highly relevant to the goals of the EEMS subprogram.

Reviewer 3:

The reviewer noted that increasing usage of pooled rideshare will contribute to reduced vehicle miles traveled and energy consumption from passenger transportation.

Reviewer 4:

The reviewer commented that understanding the intersections of human factors with multimodal transportation options is important especially as the federal government evaluates how mode shift and community design can reduce emissions and save energy and fuel costs.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the resources appear sufficient for completing the research and meeting project milestones, although the researcher indicated 50% progress to date with about a year and a half left on the project. The project did receive a no cost extension that was approved due to the delays impacting project data collection.

Reviewer 2:

The reviewer noted that funding resources are sufficient for this project to meet its goals. In context with the overall scope and scale of the project, the outcomes of this project may represent a higher-than-normal return on investment. In other words, while sufficient, the funding resources are modest compared to the potential project results.

Reviewer 3:

The reviewer commented that the resources should be sufficient.

Reviewer 4:

The reviewer stated that the project has the resources to sufficiently meet the milestones and timeline that’s established.

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 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.

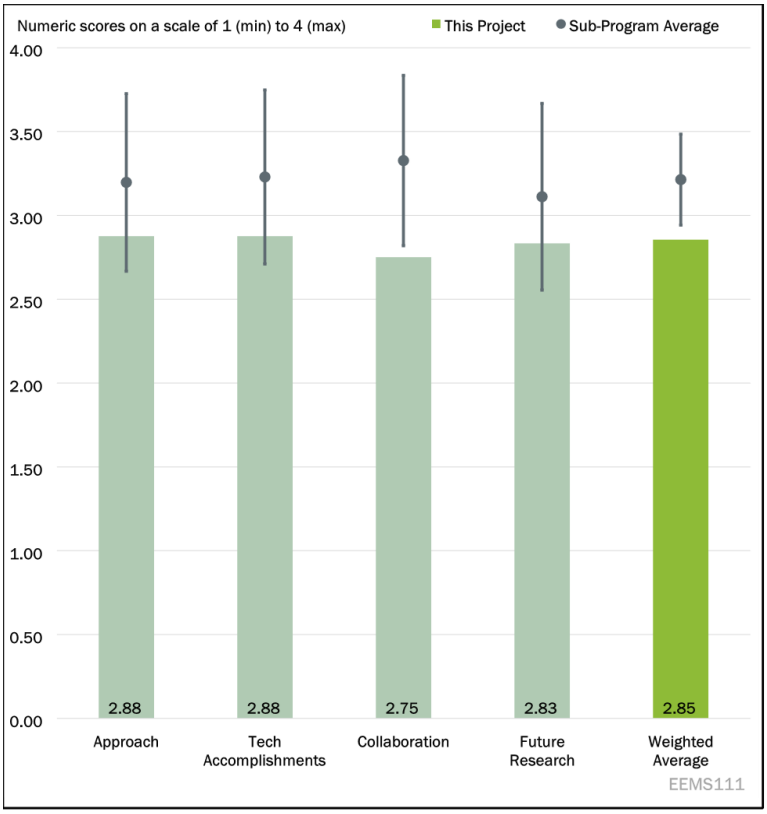

Figure 4-25 - Presentation Number: EEMS111 Presentation Title: Contextual Predictions and Eco Services for Electrified Vehicles Principal Investigator: Jacopo Guanetti (AV-Connect, Inc.)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that it seems that the PI did not present sufficient data convincing the reviewer that the team has made progress planned in this project. It lacks detail of methodology, vehicle information, data sampled, accuracy of model.

Reviewer 2:

The reviewer noted the approach of automated and continuous learning of vehicle, components and driver behaviors. They also combine physics-based and data-driven models to preserve high accuracy in a variety of contexts, capture human and context-dependent factors. Context based segmentation and clustering of data and models. They make predictions of charge usage and charging time, learned from and validated on driving data. This is a good approach to increasing the use of EVs.

Reviewer 3:

The reviewer stated that it is an interesting project, and while the discussion is that this gives more detailed and specific info it still seems very similar to available applications for eco-routing.

Reviewer 4:

The reviewer commented that the overall project provides a solid listing of objectives to increase energy performance and adoption of EVs within commercial fleets and passenger vehicles. Specific objectives for Phase II include the validation of prediction robustness to changes in parameters, and real-world testing of routing and charging planning. The basic approach seems sound. It is to: (1) suggest charging stops to the EV

driver for preferred location commerce while minimizing driving time and maintaining minimum journey state of charge (SOC), and (2) assignment of EVs in fleets to specific driving tasks and charging sessions, while maximizing EV utilization, minimizing charging fees, and maintaining minimum SOC. The project presents specific responses to and ways to address identified barriers including inertia, access to data, and computational costs. Furthermore, inherent lower-level challenges are discussed within the approach strategy. The overall project approach offers some unique/novel aspects to help overcome the vexing challenges of barriers to higher EV utilization in commercial fleets and passenger vehicles. Drawbacks of current approaches are discussed.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that as indicated in item 2, it lacks information for reviewer to justify the progress of this project in this year. There is no back-up slide providing further information.

Reviewer 2:

The reviewer commented that the Technical Accomplishments and Progress include streamlined onboarding of transit fleets. Automated daily creation of per-vehicle/per-route predictions, daily creation of driving and charging plans, periodic update of key performance indicators dashboard and daily/weekly creation of prediction accuracy reports. They have also successfully deployed to three fleets.

Reviewer 3:

The reviewer noted that it will help move the EV fleeting into the realm of "Regular Vehicle."

Reviewer 4:

The reviewer commented that Phase II has focused on robust predictions and EV routing which combines route choice and charge planning. Overall, Phase II has demonstrated solid technical accomplishments and progress. This includes demonstration that high prediction accuracy is robust to the following factors: (1) load variations due to changing occupancy, (2) temperature variations affecting battery charging and auxiliary usage, and (3) driving style variations. Technical accomplishments also include streamlining onboarding of transit fleets and automation of a number of process elements. More importantly, the value of tailored predictions and planning have ostensibly been demonstrated and prospective customers can now envision the entire system. This includes how it may address their challenges of low utilization, high CAPEX and operational expense (OPEX), and difficult operations.

Question 3: Please comment on the collaboration within the 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 this team presents the partners of this project in Slide 2 and Slide 14 but did not present any data collected from these partners, which should have been reported. The data collected in this year was not presented in this presentation.

Reviewer 2:

The reviewer commented that Collaboration and Coordination across the project team include, Hyundai America Technical Center, Capital District Transit Authority, Albany, New York, Delaware Transit Corporation, Wilmington, Delaware, Quad Cities Metro LINK, Moline, Illinois, and University of California Berkeley. This group provides vast knowledge in the transit industry. A commercial fleet partner should be included as that industry is much different than mass transit.

Reviewer 3:

The reviewer noted that Industry and Transportation Industry participation is good.

Reviewer 4:

The reviewer commented that the project team appears relatively sound and well rounded. It includes incorporation of validation data from a relatively diverse set of partners. Although, the reviewer would hope there would be available somewhat more commercial fleet data.

Question 4: Please comment on the 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 team proposed to continue its phase II data collection but did not explain the new results to expect. The work proposed for more funding seems will address some of the concerns which should have been done in this project.

Reviewer 2:

The reviewer stated that "Future Research" includes continued data collection for on-road validation of predictions and plans and the final report needs to be produced. Proposed Phase IIB includes cloud infrastructure scaling and scaling of learning and recommendations including support of delivery fleets as well as scaling of deployments and validation (target 100 fleets, 30,000 vehicles).

Reviewer 3:

The reviewer noted that the project is listed as 95% Complete.

Reviewer 4:

The reviewer commented that the primary commercialization to market strategy is to focus on prediction and planning services to commercial fleets. The reviewer agrees with this strategy of targeting the most fertile opportunities, as opposed to a broader strokes approach. Proposed future work under Phase IIB appears to largely focus upon scaling issues which seems to make sense. It focuses upon scaling for cloud infrastructure; learning and recommendations including support for delivery fleets; and deployments and validation (target 100 fleets, 30,000 vehicles). Ultimately, the reviewer guesses the proof will be in the pudding, specifically whether commercial fleets adopt and implement this technology for EV prediction and planning services, and it leads to accelerated EV adoption and utilization.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that this project is relevant to energy efficient mobility system. However, the project did not show any data convincing the reviewer that they have completed the work supporting what this team has claimed.

Reviewer 2:

The reviewer noted that this project has relevance to the VTO by Increase energy performance and adoption of electric vehicles. It also reduces range anxiety.

Reviewer 3:

The reviewer stated that it aligns with reducing Energy use.

Reviewer 4:

The reviewer commented that as indicated, there are a number of barriers to advancing the acceptance of EVs into transportation fleets, especially commercial fleets. Development of accurate and reliable predictions, as

well as recommendations for EV routing and charge planning, can significantly help to overcome many of the barriers to EV acceptance. If successful, the project predicts impressive (if somewhat optimistic) energy efficiency reductions of up to 15–20% with EV routing, reduction of charging times and/or charging fees with highly accurate charging time prediction, and an estimate of a 30% increase in fleet utilization leading to lower CAPEX and OPEX for commercial fleets.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer noted that resources may be sufficient, but the reviewer cannot justify it with the information in this presentation.

Reviewer 2:

The reviewer noted that the project is almost complete and should require no additional funding.

Reviewer 3:

The reviewer commented that the project is wrapping up with the $1.3 million listed on page 2.

Reviewer 4:

The reviewer stated that the funding resources are adequate to achieve project objectives and deliverables. The project does not have any cost share.

Presentation Number: EEMS112
Presentation Title: NREL Core Modeling & Decision Support Capabilities (RouteE, FASTSim, OpenPATH, T3CO)
Principal Investigator: Jeff Gonder (National Renewable Energy Laboratory)

Presenter

Jeff Gonder, National Renewable Energy Laboratory

Reviewer Sample Size

A total of five reviewers evaluated this project.

Project Relevance and Resources

80% of reviewers felt that the project was relevant to current DOE objectives, 20% 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, 20% 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.

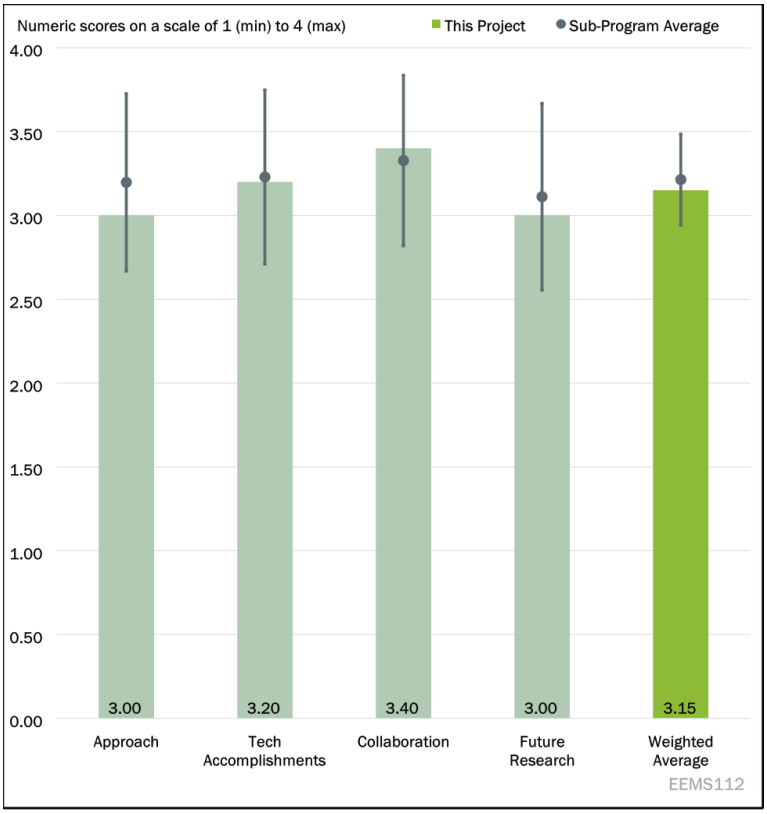

Figure 4-26 - Presentation Number: EEMS112 Presentation Title: NREL Core Modeling & Decision Support Capabilities (RouteE, FASTSim, OpenPATH, T3CO) Principal Investigator: Jeff Gonder (National Renewable Energy Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that this project approach is sound and is comprised of the following elements: (1) Maintain, update/enhance core capabilities (FastSim, RouteE, T3CO) for streamlined vehicle energy + cost modeling and mobility data collection (OpenPATH); (2) Expand representation of emerging technologies (CAVs, etc.); and (3) Create a modeling foundation for laboratory research and for industry collaborations.

Reviewer 2:

The reviewer commented that the top-level concept of the work approach makes sense. The presentation was light on content and details to effectively assess. Fast Sim's focus on most influential factors is good. Work like OpenPATH addresses understood gaps.

Reviewer 3:

The reviewer noted that two of four items are significantly delayed. The overall design of this project is incredibly scattered. There seems to be one nexus point of these applications, but the specific use cases are so incredibly scattered that makes it very difficult to evaluate and complete.

Reviewer 4:

The reviewer stated that the PI and the team are very effective, impressive at dealing with barriers.

Reviewer 5:

The reviewer commented that the approach recognized the shortfalls of democratic process of achieving equity policies and practice and provided alternatives to mitigate the obstruction.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the project technical accomplishments include the following: (1) FASTSim—validation report, tracking supported publications, thermally sensitive component models, etc.; (2) RouteE—co-optimizing time and energy in Compass, heavy duty truck and transit bus models, validation report, etc.; (3) T3CO—sweep functionality to analyze numerous vehicle/vocation scenarios, payload capacity cost approach.; and (4) Tool Applications—EEMS projects, decarbonization analysis for VTO/DOE, e-bikes, etc.

Reviewer 2:

The reviewer noted that the project appears to have accomplished a significant amount. However, the remaining challenges provide a contradictory picture with a need to improve confidence and ease of use of the work.

Reviewer 3:

The reviewer noted that it seems that the RouteE application has had significant success in being used in other applications that have scale. Little to no information is provided on the outcomes of any of this work, just that its being distributed to others. How many users do each of these partners have? How does one quantify the outcomes?

Reviewer 4:

The reviewer stated that the activities are on track or accomplished as planned, technical progress is as proposed. The reviewer sees improvements from the last year's review.

Reviewer 5:

The reviewer commented that the OpenPATH app is a useful product supported by ENERGY I-CORPS from DOE. Global positioning system data captured by the app is available from DOE via application, otherwise it is secured for privacy. The other advantage is inviting app users to contribute their data to the study for future enhancement. Color-only differentiation on data plots is problematic for the color-blind.

Question 3: Please comment on the collaboration within the 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 team has demonstrated good collaboration with a variety of stakeholders/partners: Google Maps, PACCAR's CoVaR project (EEMS108), EPA, Colorado Energy Office, etc.

Reviewer 2:

The reviewer stated that there are clear, numerous end-users. What is not clear is how the end-users contribute to the development or provide feedback.

Reviewer 3:

The reviewer noted that NREL has been successful in distributing this product to many potential users.

Reviewer 4:

The reviewer commented that last year's comments regarding insufficient details of the collaboration and coordination activities have been addressed. This will help increase the overall impact of the project.

Reviewer 5:

The reviewer noted that a wide variety of partners and collaborators, such as cities and states are referenced. Also cited are related EEMS VTO projects. Other countries and US Territories are referenced. FHWA should be considered for data relative to plans under the BIL for charging corridors.

Question 4: Please comment on the 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 future work plans include the following: (1) Vehicle model updates for FASTSim; (2) External accessibility of RouteE and T3CO modeling; and (3) Automated, anonymized spatial visualization of OpenPATH data. These are all well-motivated and the work plan is sound.

Reviewer 2:

The reviewer noted that proposed future work is aligned to addressing some user feedback.

Reviewer 3:

The reviewer stated that future work is not well articulated. Many of the items listed are maintenance and operations for the applications. Use of "easy button" multiple times in this presentation is not helpful.

Reviewer 4:

The reviewer commented that the proposed future research is very consistent with the plan, supporting stronger and broader impact of the project.

Reviewer 5:

The reviewer suggested considering reaching out to U.S. Postal Service or United Parcel Service, as this may be useful as a product for them and others.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that the project is aimed at providing modeling tools for optimizing the efficiency of multi-mode transportation, thereby reducing CO_2. This is well-aligned with the VTO subprogram objectives.

Reviewer 2:

The reviewer commented that the different sub projects are aligned with vehicle and overall efficient movement of people and goods.

Reviewer 3:

The reviewer commented that there is no information on quantification of the desired outcomes for the VTO. Items like OpenPath while on the face of it sound great really need a deep dive on how many users it has. It claims to be a solution for a problem around community participation but doesn't show that it actually improves that at all.

Reviewer 4:

The reviewer noted that the relevance of this project to the overall VTO subprogram objectives is very clear; no further comments.

Reviewer 5:

The reviewer stated that relying on in-house data repositories provides long-term control and security. Adding two-wheeled vehicles to the database and functionality—informed policy decisions on expanded bike infrastructure.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that the allocated budget of $1.2 million per year for 3 years is just right for the stated objectives.

Reviewer 2:

The reviewer commented that the budget seems appropriate for the scale of the work. To remain confident that the resources are sufficient vs. excessive, more specific of the scope of future work is necessary for next year's evaluation.

Reviewer 3:

The reviewer noted that many of the items listed as future work are maintenance and operations that are necessary for any commercialized application. The VTO will not be supporting this project in perpetuity and no info is provided on how NREL proposes to sustainably fund this application.

Reviewer 4:

The reviewer commented that the project has sufficient resources to achieve and even exceed its goals.

Reviewer 5:

The reviewer stated that making use of user/partner feedback for future product enhancements contributes to resources, along with an optional open and closed sourced version for different levels of users and licensing opportunities. Relying on in-house data repositories provides long-term control and security.

Presentation Number: EEMS113 Presentation Title: Testing and Evaluation of Curb Management and Integrated Strategies to Catalyze Market Adoption of Electric Vehicles Principal Investigator: Lauren Harper (Los Angeles Cleantech Incubator)

Presenter

Lauren Harper, Los Angeles Cleantech Incubator

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.

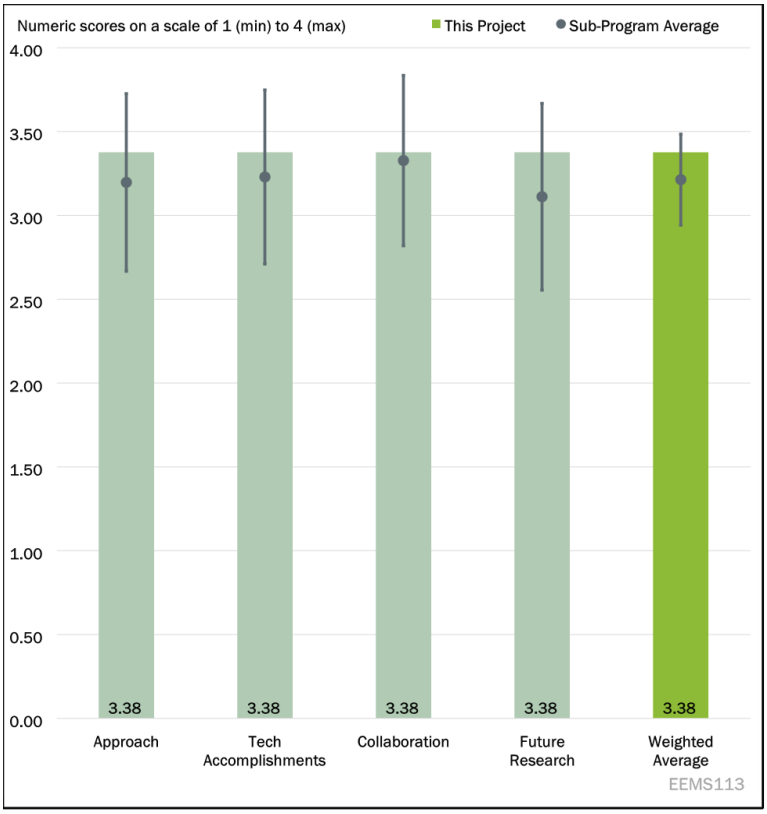

Figure 4-27 - Presentation Number: EEMS113 Presentation Title: Testing and Evaluation of Curb Management and Integrated Strategies to Catalyze Market Adoption of Electric Vehicles Principal Investigator: Lauren Harper (Los Angeles Cleantech Incubator)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the project is biting off an awful lot but seems well designed to evaluate various approaches to the problems identified. The reviewer thinks the equity issues will need more focused attention, particularly as they will likely surface conflicts among goals. For example, pushing for zero emission gig driving and delivery vehicles in some markets will disadvantage historically underserved populations unless there are additional interventions; effective enforcement may also be more punitive for lower-income drivers of color.

Reviewer 2:

The reviewer noted the approach of disseminating modeling and benchmarking tools to address difficulty managing traffic congestion and enforcement in last mile and rideshare operations. The team will develop and test, simulated and real-world intervention models, to support EV adoption, and create and demonstrate how to use a framework for estimating the energy consumption reduction, cost, and emissions reduction benefits. To compare and evaluate strategies, the team will analyze intervention implications and outcomes, incorporate feedback, adjust modeling, and provide recommendations to cities.

Reviewer 3:

The reviewer stated that the project seems to be well designed. The barriers are significant, such as determining who is involved in a community level oversight committee, how to address any ideology of the committee, and where to install a system like this, for example in urban areas or in suburbia.

Reviewer 4:

The reviewer commented that the project directly addresses barriers related to management and enforcement of policies for curb infrastructure utilization, and specifically targets transportation network company drivers and e-commerce delivery drivers. Additionally, the project considers equity impacts as part of the solution space.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the project seems to be proceeding well, in general. The metrics feel somewhat arbitrary. The reviewer inquired why target a 5% increase in EV adoption, vs. 7% or 10%, or 100% in California? Is the project pursuing the same increase across all vehicle classes? Is electrifying heavy duty vehicles a higher priority because they otherwise pollute more, or is electrifying gig driving a priority because it does more to support equity? The project would be strengthened by clarifying these points and connecting the dots from metrics to policy interventions.

Reviewer 2:

The reviewer noted progress: Completed Metrics Methodology—NREL, in collaboration with CityFi, finalized the metrics methodology to ensure that the project can support its priority objectives, the curb management goals of local governments and communities and is actively developing a supportive data framework. Verified Dynamic Network Model—Carnagie Melon University verified their dynamic multi-modal curb management simulation package for their MAC-POST, a sophisticated multi modal simulation model. The reviewer noted upgraded hardware and purchase orders submitted by Automotus for better camera vision capabilities.

Reviewer 3:

The reviewer stated that accomplishments seem to be up to date and well done. A good plan going forward.

Reviewer 4:

The reviewer commented that although the project was reported to be only 30% complete, it has made significant progress in its technical milestones. The automated license plate reader technology is a key enabler for the success of the project.

Question 3: Please comment on the collaboration within the 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 it seems that the project partners are working together well and are reasonably well balanced. The reviewer would like to see more partners for outreach and dissemination (e.g., local government and planning associations) and more industry partners (e.g., gig driving platforms, delivery services, etc.)

Reviewer 2:

The reviewer commented that the team is strong and has most of the technical avenues covered. However, they do not have any end users involved from the last mile delivery companies or the ride share community. These are important stakeholders as they will have to comply with the regulations. None of the current team has the industrial engineering acumen required that major transportation companies have.

Reviewer 3:

The reviewer stated that the team has all factors engaged with different partners.

Reviewer 4:

The reviewer commented that this is a highly collaborative project, with multiple points of engagement across the national laboratories, technology providers, and local governmental organizations. This level of collaboration is exemplary and will maximize the impact that successful completion of the project will have.

Question 4: Please comment on the 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 this project is trying to do a lot of things at once and the reviewer doesn't expect they will all work. But seems some of them likely will. The work on automated license plate reader enforcement and related issues seems particularly helpful.

Reviewer 2:

The reviewer stated that they plan to finalize analysis of the initial project perception survey for pilot participants as well as further refine the metric definitions and identify additional data needs. They will also select locations for loading zones based on siting criteria and scaling up cameras in the cities.

Reviewer 3:

The reviewer noted that the list of future research seems to be complete and noted the following: (1) The privacy versus cameras is a big issue; (2) Equitable is good but reverse equitable also needs to be addressed; and (3) Technically, how is a plate read if next to another parked vehicle?

Reviewer 4:

The reviewer commented that research planned for FY 2023 and FY 2024 is consistent with the original project plan. Scaling up sensing infrastructure, down selecting locations, developing models, and refining metrics are all important parts of the overall effort.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that zero emission delivery zones are a hot topic with local governments, as is curb management, and both deserve EEMS attention.

Reviewer 2:

The reviewer commented that this project supports the priorities of the VTO and clean energy technology to move people and goods by utilizing curb management strategies and interventions to cultivate a roadmap for accelerating electrification, and improved efficiency and accessibility in the transportation sector. The structured, step-by-step roadmap will help other cities achieve their curb management goals, leveraging recommendations, model analysis, stakeholder feedback and city policy from this project.

Reviewer 3:

The reviewer noted that congestion in large cities is an issue, and this research certainly addresses a solution.

Reviewer 4:

The reviewer stated that the project is highly relevant to EEMS subprogram goals. In addition to developing an understanding of curb management issues and solutions to address them, the project is highly focused on on-the-ground deployment and demonstration within the context of environmental justice—priorities for VTO/EEMS.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that there was nothing particular to add here.

Reviewer 2:

The reviewer commented that resources are sufficient; however, they need to add the proper team members for success.

Reviewer 3:

The reviewer believes the funding is sufficient. However, the reviewer does not understand how much data will be collected to be of significance. The project has been expanded to three cities, but how many corridors within the cities are being explored has not been provided. Will seasonal data be extracted? Snow in Pittsburg? Corridors in unequitable areas?

Reviewer 4:

The reviewer stated that given the real-world demonstration component of this project, the funding resources are appropriate. Federal resources are leveraged with significant cost-share as well, demonstrating effective resource management that will support completion of project milestones.

Presentation Number: EEMS114
Presentation Title: Real Twin
Principal Investigator: Yunli Shao (Oak Ridge National Laboratory)

Presenter

Yunli Shao, Oak Ridge National Laboratory

Reviewer Sample Size

A total of three reviewers evaluated this project.

Project Relevance and Resources

67% of reviewers felt that the project was relevant to current DOE objectives, 33% 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.

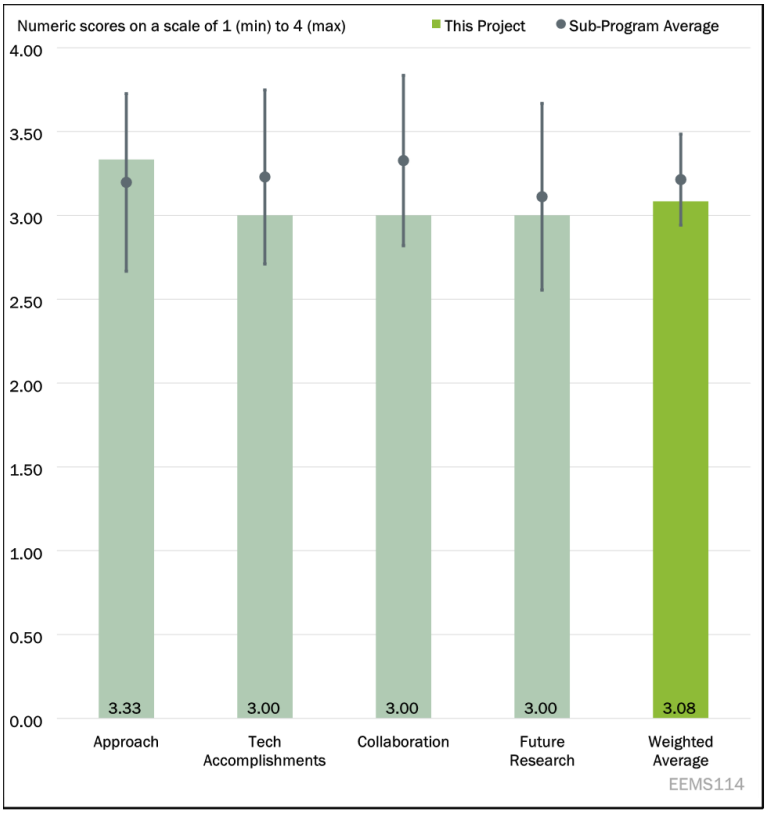

Figure 4-28 - Presentation Number: EEMS114 Presentation Title: Real Twin Principal Investigator: Yunli Shao (Oak Ridge National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that interoperability of microsimulation platforms allows future efforts to proceed in an efficient manner.

Reviewer 2:

The reviewer noted that there was not enough information mentioned during the presentation to justify higher scoring.

Reviewer 3:

The reviewer commented that based on the material presented at AMR, the project approach seems solid for this stage of the project, and the reviewer did not have any concerns about the project team's approach to addressing the identified technical barriers. The reviewer expressed appreciation for the commitment to developing a model agnostic solution.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that the technical progress outlined in Slides 5 and 7 demonstrated outstanding progress.

Reviewer 2:

The reviewer noted that the project appears to be making adequate process toward the project plan presented on Slide 5 and 7.

Reviewer 3:

The reviewer commented that the rhetoric does not support the objectives of the VTO. There may be someone inside the laboratory that understands what the objectives and impact are, otherwise if you are from a different agency or industry, it is indecipherable. For example, when they use words such as, "A unified, model agnostic scenario generation capability unified, model agnostic scenario generation capability that is equipped with well-defined workflows, integrated tools, and comprehensive metrics that streamline the scenario generation workflows, integrated tools, one might ask themselves, "with what?", "how?" and "why?".

Question 3: Please comment on the collaboration within the 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 presentation does not appear to reference FHWA traffic research data models and sources at all. There does appear, however, to be some correspondence with other DOT and DOE agencies, as well as industry, academia, and State Highway Agencies. The outcome of these collaborations is not made clear.

Reviewer 2:

The reviewer noted close, appropriate collaboration with other institutions; partners are full participants and well-coordinated.

Reviewer 3:

The reviewer commented that there appears to be sufficient coordination across the project team, as well as with other institutions. The reviewer was pleased with the stakeholder engagement conducted to understand scenario development needs and considerations.

Question 4: Please comment on the 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 future research does not appear to build upon or have any anticipation of trends in travel or behavior data. It is a good sign that they cite related EEMS095 and EEMS120 projects.

Reviewer 2:

The reviewer noted that all future work is integral for the success of the project and completed work.

Reviewer 3:

The reviewer stated that on Slide 19, the project team defines their future research for the Real Twin project. On Slide 18, the project team highlights their remaining challenges and barriers. The reviewer has two suggestions for the project team to consider: (1) Re: Network data—As the data "wish list" for scenarios is developed, it would be great to connect observations with the work currently underway to develop the General Network Modeling Specification (https://github.com/zephyr-data-specs/GMNS); (2) Re: Uncertainties w/ CAV and other emerging technology market penetration rates—Many State department of transportations (Texas, Oregon, Maryland, etc.) are starting to use scenario planning for their long range forecasts. It is still not "ground truth" data, but at least we're getting the assumptions from infrastructure owners and operators (which feels more "valid" than us as researchers making these assumptions). How will autocalibration work planned for FY 2024 and FY 2025 be calibrated?

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that the project does not show any tangible evidence that the objectives will be met currently, nor with the plans for the future.

Reviewer 2:

The reviewer noted analysis.

Reviewer 3:

The reviewer stated that this project contributes to the VTO EEMS strategic goals of: (1) Develop new tools, techniques, and core capabilities to understand and identify the most important levers to improve the energy productivity of future integrated mobility systems; (2) Share research insights, and coordinate and collaborate with stakeholders to support energy efficient local and regional transportation systems.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the resources are sufficient to carry out the current and future objectives. The reviewer would consider this to be a play on simulation and nothing more.

Reviewer 2:

The reviewer stated that the resources appear sufficient for the project to achieve the stated milestones.

Presentation Number: EEMS115
Presentation Title: Modeling Connected and Automated (CAV) Compute Power
Principal Investigator: Ben Feinberg (Sandia National Laboratories)

Presenter

Ben Feinberg, Sandia National Laboratories

Reviewer Sample Size

A total of four reviewers evaluated this project.

Project Relevance and Resources

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

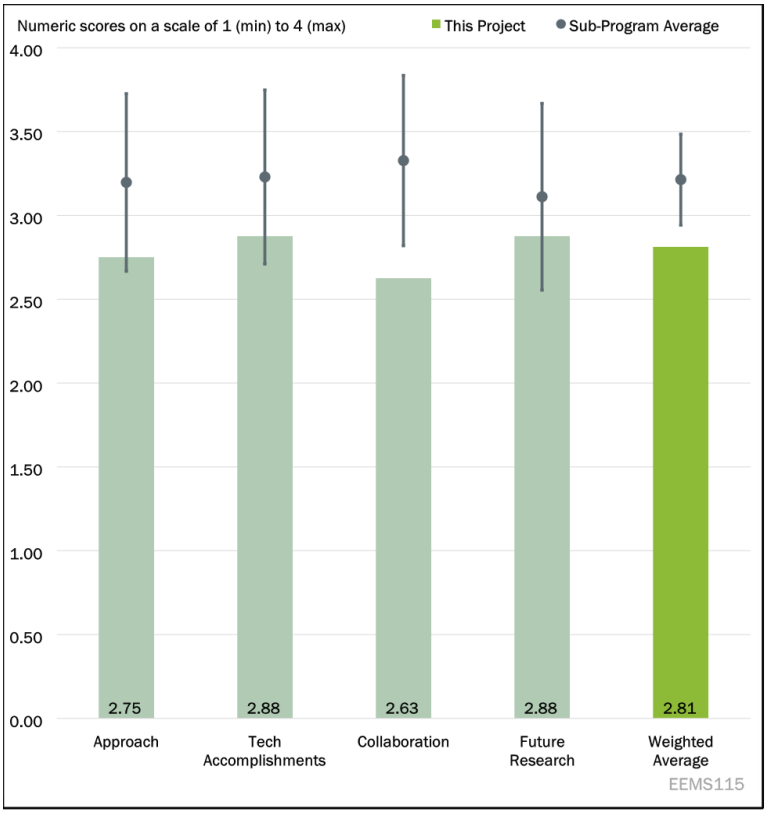

Figure 4-29 - Presentation Number: EEMS115 Presentation Title: Modeling Connected and Automated (CAV) Compute Power Principal Investigator: Ben Feinberg (Sandia National Laboratories)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer noted that with respect to barriers the connection should be clarified. Two are given on Slide 2—inventor current cost/performance and revisit/expand the traditional V-Diagram. It is not clear how these specific barriers are being addressed within this project.

Reviewer 2:

The reviewer commented that the approach in this project is general and fundamental so there are not too many barriers to be addressed. The project, for its stated scope, is well designed and with a reasonable timeline.

Reviewer 3:

The reviewer stated that the program is early in its inception, so the approach seems reasonable.

Reviewer 4:

The reviewer commented that, to be honest, the reviewer doesn't think the presenter clearly defines the problem and at least the reviewer did not quite understand the whole project clearly.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that this is difficult to assess based upon the information provided.

Reviewer 2:

The reviewer commented that the progress as presented in the AMR meeting does not completely justify a project 83% complete. Still the reviewer believes this to be an issue with the presentation rather than the actual project progress.

Reviewer 3:

The reviewer noted it is early into the program.

Reviewer 4:

The reviewer stated that it is hard to tell if a significant amount of technical progress has been made, based on the presentation. To the reviewer, the slides do not provide enough details to make any judgement.

Question 3: Please comment on the collaboration within the 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 it is good to see collaboration with US DRIVE Energy Efficient Advanced Compute (EEAC) working group but unclear what the outcomes of this are. There are very good models developed by other teams on vehicle energy usage that should be referenced and utilized as the baseline per figure on Slide 3. The project team should also consider different class vehicles as it is expected the compute load will not change significantly with the vehicle, but vehicle specific energy consumption varies (W-h/mile) significantly.

Reviewer 2:

The reviewer stated that it is unclear as to the level of effort or active contribution the US DRIVE EEAC Working Group has, other than keeping the PI updated on the subject.

Reviewer 3:

The reviewer commented that it seems as though the project team is only collaborating with US DRIVE EEAC on a monthly basis.

Reviewer 4:

The reviewer noted that maybe this is a relatively small project. There is not much collaborative effort.

Question 4: Please comment on the 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 project is 83% complete and at this point there is only a couple months left. The reviewer is not sure of the output and their impacts. How will the extended modeling framework impact design etc.? Benchmarking is in this year's work and should include not only consumption but also cooling requirements.

Reviewer 2:

The reviewer commented that the most significant work and proof that the proposed modeling framework is realistic seems to be planned for the future. It is not clear from the presentation how likely it is to achieve its targets.

Reviewer 3:

The reviewer stated that the research depends on the data gathered and the computational experience with the machine. At the lower speeds much more attention is required, but at the higher speeds, response is much more difficult.

Reviewer 4:

The reviewer noted that the future work presented is very limited and rough. More details should be disclosed as this topic is an emerging one and deserves further research.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that Aux electrical, compute, sensing, and cooling loads continue to grow and as vehicles continue to become more efficient reducing these are critically important.

Reviewer 2:

The reviewer commented that relevance is marginal, since the nature of the software and hardware supporting vehicle control is a fast-moving target. It is unclear how the modeling framework will be future proofed.

Reviewer 3:

The reviewer stated that yes, it seems to be relevant for the VTO.

Reviewer 4:

The reviewer noted that it is related to the energy use for CAV due to the increasing computational power.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that it isn't clear what the resources being used are so difficult to evaluate.

Reviewer 2:

The reviewer stated that for the scope and budget, resources are sufficient.

Reviewer 3:

The reviewer commented that the work will get done with the resources offered.

Reviewer 4:

The reviewer noted that it is not very sure if the time and partnership resources are enough. It would be great if any OEMs can get involved.

Presentation Number: EEMS116
Presentation Title: High-Quality Perception Data
Principal Investigator: Zach Asher (Western Michigan University)

Presenter

Zach Asher, Western Michigan University

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.

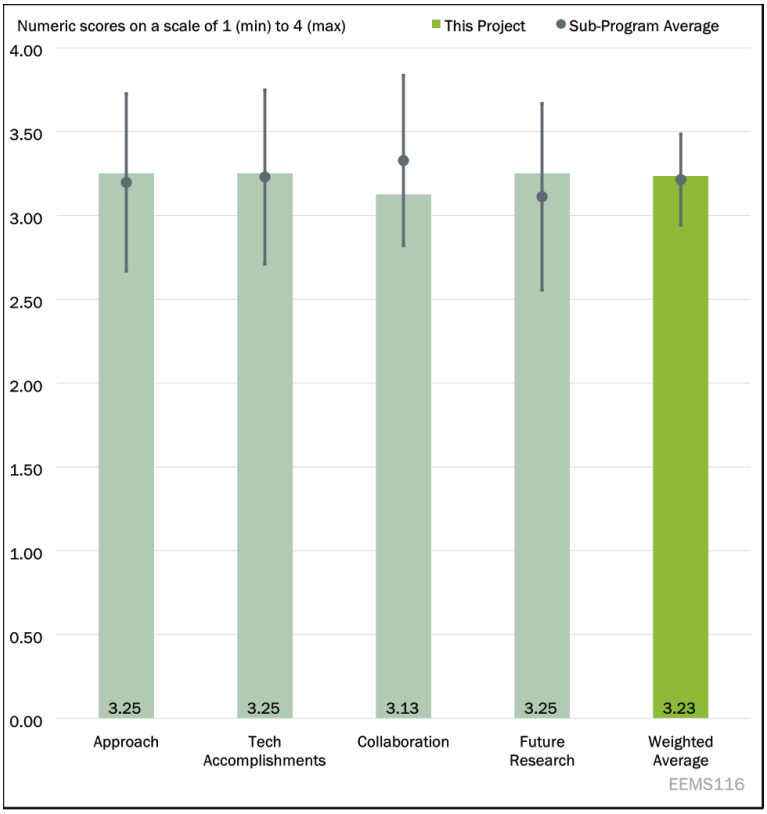

Figure 4-30 - Presentation Number: EEMS116 Presentation Title: High-Quality Perception Data Principal Investigator: Zach Asher (Western Michigan University)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the project addresses the technical barriers well. Using infrastructure for energy savings (and safety improvements) in the ADAS space is relatively unexplored and presents a very large opportunity for development. The baseline scenario for the "traditional sensor fusion approach" should be further refined moving forward. In this space, automotive OEMs are taking different approaches in sensor usage/fusion and baseline components are continually improving with respect to power consumption.

Reviewer 2:

The reviewer stated that the work appears to be well tracked and performed to address the barriers.

Reviewer 3:

The reviewer noted that the project seems to be progressing well to overcome eventually all planned technical barriers. Even though the PI is confident the project will achieve all its goals, the reviewer has this concern: combining on-board and off-board sensors to improve quality of perception data so that the computing power consumption is significantly reduced might not be achievable in practice, e.g., when not all sensors are providing info, etc. That's why the reviewer rated the project lower than some others. The reviewer will add related comments below.

Reviewer 4:

The reviewer commented that the concept being explored in this project is very interesting. It is high risk but with potential for high return. The sensor fusion work also adds value to the overall project. The reviewer would encourage the team to quantify the energy usage of the infrastructure-based sensors themselves, and account for it in the estimation and optimization of the overall energy savings for the entire perception system (on-board vehicles and infrastructure).

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that significant progress has been made in the short time since the project started. The project appears to be on track to meet milestones per the plan. Further research/commentary on the disabling of sensors needs to be completed to understand the impact on safety-critical systems and features. Some sensors may not be able to be disabled, or have reduced usage, due to their use in redundant or required safety features. For example, a camera may be used for object detection in addition to lane detection.

Reviewer 2:

The reviewer stated that the technical work appears to be progressing well. Sensors are very important and often overlooked part of "autonomous" driving.

Reviewer 3:

The reviewer rated this higher than above, for the reviewer does appreciate and can relate to complexities of the tech challenges pertaining to real-life experiments. The reviewer encouraged the PI to consider practical challenges when deploying chip-enabled raised pavement markers (CERPMs), retroreflectors, etc. While such units will help greatly in snow and adverse weather conditions, the snowplows can easily damage them unless they are placed inside the road. What about much more complex maintenance, i.e., replacing batteries in such units? US roads are often poorly maintained today, not to mention significantly increased maintenance costs.

Reviewer 4:

The reviewer commented that the sensors have been developed and perception data from these sensors collected. The project seems to be on track and has produced interesting datasets and results.

Question 3: Please comment on the collaboration within the 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 collaboration with partners is well done. Working with an automotive OEM or supplier in the future could be beneficial to gain insights on real-world constraints and limitations.

Reviewer 2:

The reviewer commented that they are not sure how much collaboration is being done beyond providing data and/or sensors itself.

Reviewer 3:

The reviewer rated this as "Good", however the reviewer recommended including (in a no-cost advisory role) somebody from transportation authority/road maintenance company, to guide the project through practical challenges.

Reviewer 4:

The reviewer noted that the project team consists of team members with necessary and complementary skills. It is commendable the team is already working on a spinoff company to commercialize the technology from this project.

Question 4: Please comment on the 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 future research plan appears to be solid. In addition to the energy tradeoff between the new sensors and fusion, it would be good to report out on accuracy and reliability vs. incumbent sensors.

Reviewer 2:

The reviewer stated that future work seems to be progressing well.

Reviewer 3:

The reviewer noted that the project has strong partners that seem to coordinate well. The reviewer doesn't have concerns about the PI and the team completing the remaining research and achieving the targets.

Reviewer 4:

The reviewer commented that it is unclear how the chassis dynamometer environment would provide realistic computational load requirements for perception. Perhaps, this aspect of the project could be deemphasized while placing more focus on the on-road testing.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that this project supports the EEMS subprogram objectives. In addition, the unique focus on infrastructure integration and development is appreciated. This is an overlooked area for ADAS/ autonomous vehicle (AV) development.

Reviewer 2:

The reviewer noted relevance to Analysis/EEMS.

Reviewer 3:

The reviewer commented that yes, the project is highly relevant to the goals of EEMS, and the reviewer expressed practical concerns above.

Reviewer 4:

The reviewer stated that the outcome of this project could shift the paradigm of how automated vehicles and transportation systems are designed to be more energy efficient.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the resources allocated for this project are sufficient.

Reviewer 2:

The reviewer stated that the budget seems to be appropriate to the work which is being performed.

Reviewer 3:

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

Reviewer 4:

The reviewer noted that resources should be sufficient.

Presentation Number: EEMS117
Presentation Title: Visual-Enhanced Cooperative Traffic Operations (VECTOR) System
Principal Investigator: Cami Qianwen (University of South Florida)

Presenter

Cami Qianwen, University of South Florida

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. 33% of reviewers felt that the resources were sufficient, 67% 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.

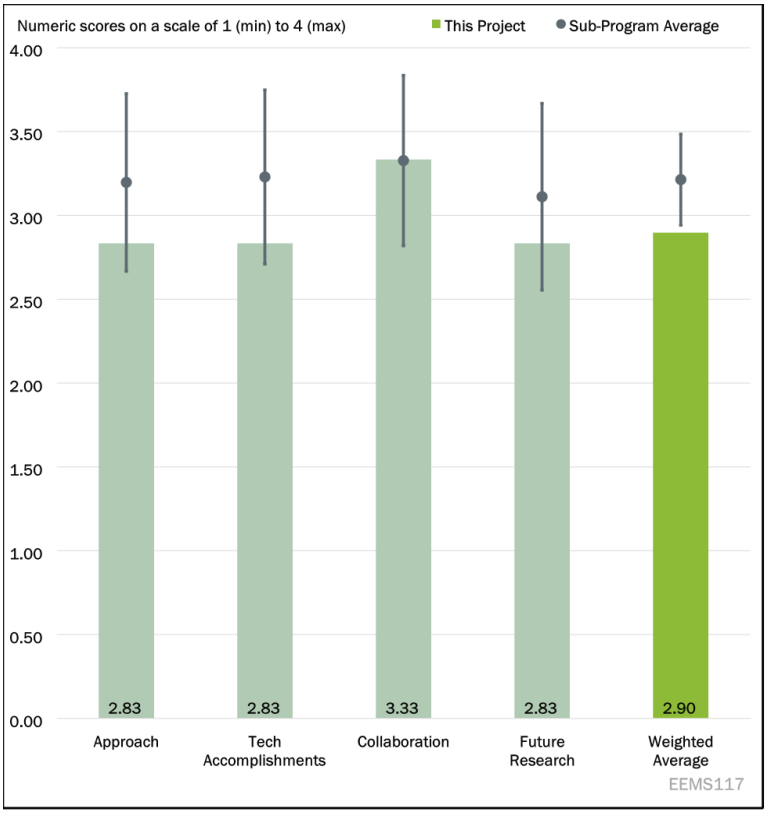

Figure 4-31 - Presentation Number: EEMS117 Presentation Title: Visual-Enhanced Cooperative Traffic Operations (VECTOR) System Principal Investigator: Cami Qianwen (University of South Florida)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer stated that the proposed approach of AI sensing, low-cost communication, cybersecurity, simulation and field testing for this new low-cost architecture for cooperative traffic operations is very well scoped.

Reviewer 2:

The reviewer commented that the project objectives claim large reductions in cost, energy consumption, congestion and crashes. The project plan does not sufficiently outline a roadmap of how these objectives will be met or even measured. The building blocks/enablers being developed may be useful as part of a large CDA system, but the project does not adequately plan their integration in an actionable way.

Reviewer 3:

The reviewer noted that the project approach is logical, combining sensing, communication, computing, and control. The consideration of cybersecurity issues is commendable. Given that the project will take advantage of existing infrastructure and utilize some of the existing sensing and communication technologies, it is unclear how this project would contribute to lower costs and energy consumption for CDA systems. What is the baseline CDA system that the project will compare itself against?

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that technical accomplishments include development of vision-based AI sensing algorithms, light-code communications, and cooperative communications. This is a very good start to an ambitious set of goals.

Reviewer 2:

The reviewer stated that development progress on the individual models appears to be on track. The low-cost signage and communication module appear to be a promising technological area. Further work on the integration and testing plan is required to prove out the benefits of these modules on a system basis.

Reviewer 3:

The reviewer commented that the project is still in an early stage with 25% completion. However, the reviewer would have liked to see more quantitative results in the presentation. For example, what is the performance of the modules shown on Slides 5 and 6?

Question 3: Please comment on the collaboration within the 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 the collaboration and coordination chart show a diverse list of partners and stakeholders including MPO, Bosch, ANL, and University of South Florida, etc. This is an impressive and comprehensive list.

Reviewer 2:

The reviewer stated that there are "many" partners/stakeholders involved in this project. Their exact involvement and commitment to the project is unclear. Further comments on the roles for each contributor would be appreciated.

Reviewer 3:

The reviewer commented that the project team consists of a large number and a diverse group of team members and partners.

Question 4: Please comment on the 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 future research list includes key module development (sensor fusion based CDA data generation algorithm, prototype of AI sensing module, low-cost communication module, etc.) simulation tests, and field tests. This is a good research plan.

Reviewer 2:

The reviewer noted that future work for Phase 2 and Phase 3 needs to be defined. The performance evaluation of the developed modules at a component level is good, but there needs to be a plan to transform their impact on a system level.

Reviewer 3:

The reviewer commented that the proposed future work is logical although more specific details would have been useful. A successful integration of the different modules will be crucial to the success of this project.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that the project is aimed at creating a low-cost architecture for cooperative traffic management and this would lead to efficiencies in transportation and hence support VTO program objectives of CO_2 reduction.

Reviewer 2:

The reviewer noted that the project supports the EEMS subprogram objectives.

Reviewer 3:

The reviewer stated that enabling CDA systems with lower cost and energy consumption will improve mobility and energy efficiency of surface transportation systems.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented yes, the resources are adequate for execution of the stated objectives.

Reviewer 2:

The reviewer stated that to achieve the lofty goals of the project, more resources are likely needed. If the focus was only the development of the four modules, resources would be sufficient. To test at scale and determine system benefits, resources on par with similar projects is required.

Reviewer 3:

The reviewer noted that the budget seems low for a project of this scope and scale.

Presentation Number: EEMS118
Presentation Title: AI-Based Mobility Monitoring System and Analytics Demonstration Pilot
Principal Investigator: Scott Samuelson (University of California, Irvine)

Presenter

Scott Samuelson, University of California, Irvine

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.

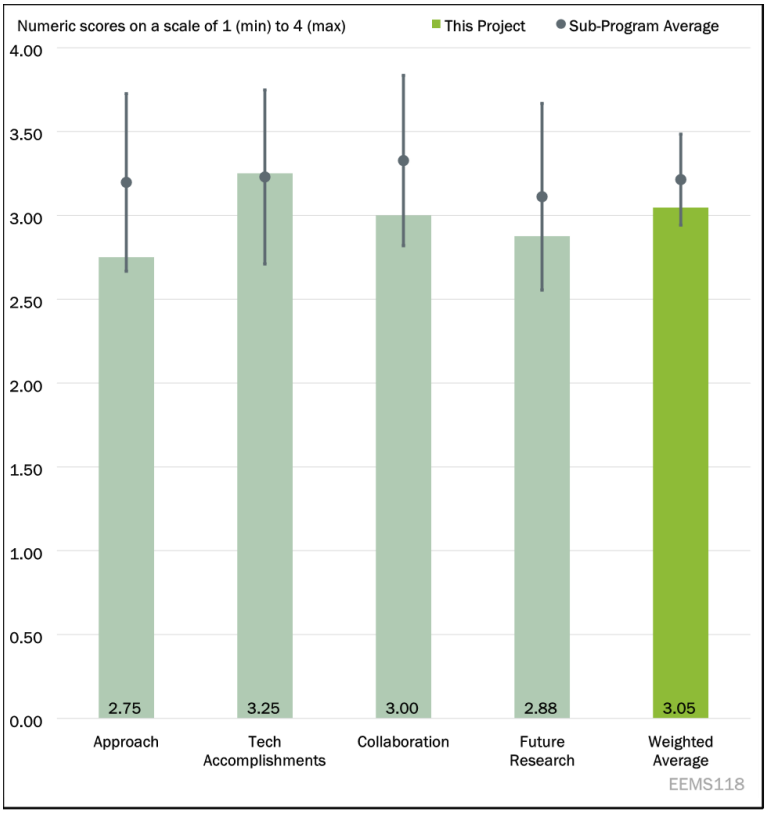

Figure 4-32 - Presentation Number: EEMS118 Presentation Title: AI-Based Mobility Monitoring System and Analytics Demonstration Pilot Principal Investigator: Scott Samuelson (University of California, Irvine)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that many of the milestones are not complete. No information given on why this is the case.

Reviewer 2:

The reviewer noted that the project will likely contribute meaningfully to our understanding of the interaction between and among vehicles and highway-traffic signals. The plan to specifically look at vehicle-to-vehicle communications will be very useful. However, it is not clear that the project is addressing real-world traffic operations issues like pedestrian crossing times at signalized intersections. As the reviewer pointed out during the presentation, it is not clear that benefits from project modeling will accrue when more realistic traffic-signal cycle lengths are implemented. How about responses to traffic incidents? It will be important to understand the components of changes in metrics. How much of any measured benefits from this study's strategies would have accrued from a simple updated timing plan using current technology? Are the new strategies, e.g., driver alerts, likely to be acted upon by diverse population groups?

Reviewer 3:

The reviewer stated that the proposed approach for deploying the sensors and AI-system and testing in XIL is well designed. The timeline may not be very realistic (refer to Question 8).

Reviewer 4:

The reviewer commented that the project is timely and seeks to further investigate as vehicles get smart how do humans interact with alerts that are connected to transportation infrastructure. In addition, the reviewer appreciated that the project team is looking for a solution that can be widely adopted and one that isn't dependent on a specific piece of equipment.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer stated that the simulation results are impressive. More discussion is needed on the existing signal system at the installed intersections (are they actuated? What type of actuation do they have? Do they have adaptive signal control? Etc.). More information is needed on the expected results of the sensors. Much of the simulation results are dependent on the detection distance. What is expected here?

Reviewer 2:

The reviewer noted that the project has progressed, but important questions lie ahead with implementation and additional technical work.

Reviewer 3:

The reviewer stated that the proposed four categories of Controlled Traffic Events is a novel approach.

Reviewer 4:

The reviewer commented that the project team is making progress in alignment with the schedule timeline. The team has demonstrated successful progress with installation of traffic control systems and engagement from city and the university. The team is still installing AI systems, but data has been collected since 2021.

Question 3: Please comment on the collaboration within the 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 based on the achievement of expected milestones it seems that project management and coordination has not been efficient.

Reviewer 2:

The reviewer noted that a mix of stakeholders is involved, but involvement of auto users, pedestrians and cyclists, including those of color, would be important in understanding future applicability of this to broader, more diverse communities.

Reviewer 3:

The reviewer stated that the team is qualified, and role of each member and their coordination is clear.

Reviewer 4:

The reviewer commented that the core partners represent the research and governmental agencies and appears to be a strong partnership. Increased engagement from other transportation modes may be helpful including how AI systems can interact with non-motorized forms of transportation.

Question 4: Please comment on the 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 future work described is very high level. Based on the team's lack of success in the first year, the reviewer would expect this section to be significantly more detailed as to how to make up for lost time.

Reviewer 2:

The reviewer noted that the project's planned vehicle-to-vehicle research is important. Research into user responsiveness to alerts will be important, as will an understanding of the system-acceptance of both vehicle drivers with communications and those without communications.

Reviewer 3:

The reviewer stated that the proposed work seems to be a heavy lift for the remaining time. Developing a live AI-system and adding V2V data to the AI system seems to be a large challenge for one year.

Reviewer 4:

The reviewer commented that targets are clear, and the future work is likely to achieve the targets. It will be helpful for future work to consider the dynamic nature of streets including pedestrian interactions, bikes, and micro mobility considerations.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that this project is very relevant to the VTO goals and is very practical. This type of project could be scaled by transportation agencies very quickly because it uses many commercially available components.

Reviewer 2:

The reviewer noted that improving vehicle efficiency approaching traffic signals is an important strategy to reduce energy consumption.

Reviewer 3:

The reviewer stated that the project is relevant to EEMS considering the focus on energy efficiency as well as emissions reduction.

Reviewer 4:

The reviewer commented that human factors are a critical component of integration of AI into mobility systems. This research is timely and supports the overall VTO mission.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that no information is given on budget losses given the lack of progress made thus far. If budget has been utilized in a linear fashion rather than based on work achieved this could be rated as insufficient.

Reviewer 2:

The reviewer commented that the project seems to have a generous budget, but the reviewer is concerned that important questions, like user acceptance and the impact of any buses and pedestrian traffic, do not seem to be addressed.

Reviewer 3:

The reviewer stated that the team has access to enough resources to an achieve the goals of the project.

Reviewer 4:

The reviewer noted that resources are sufficient to complete the project and the established milestones.

Presentation Number: EEMS119
Presentation Title: Improved Mobility and Energy Savings Through Optimization of Cooperative Driving Automation (CDA) Application for Signal Controls for Arterial Mixed Traffic Scenarios
Principal Investigator: Xiao-Yun Lu (Lawrence Berkeley National Laboratory)

Presenter

Xiao-Yun Lu, Lawrence Berkeley National Laboratory

Reviewer Sample Size

A total of three reviewers evaluated this project.

Project Relevance and Resources

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

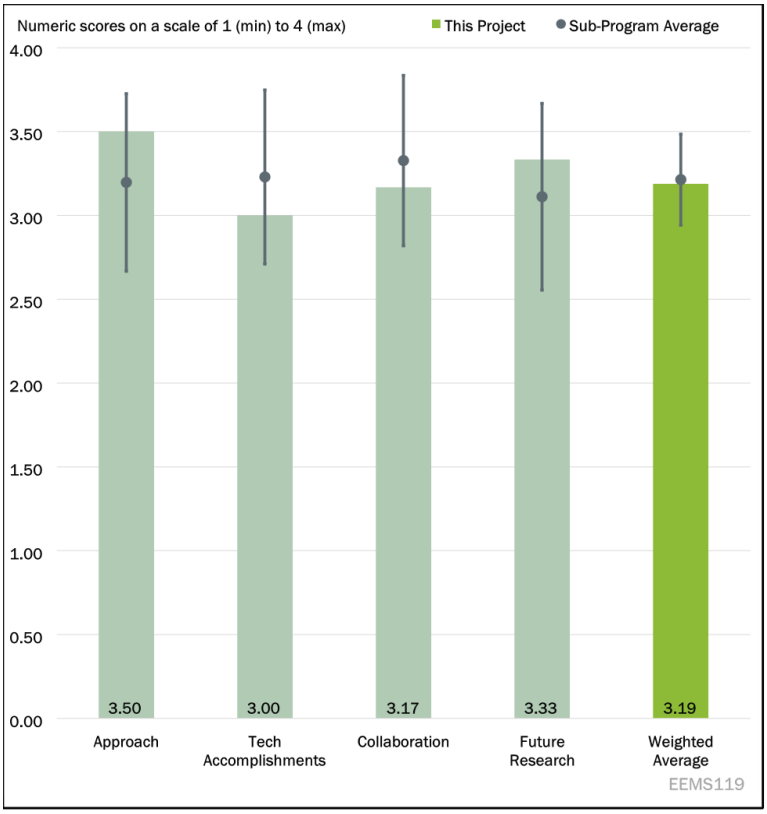

Figure 4-33 - Presentation Number: EEMS119 Presentation Title: Improved Mobility and Energy Savings Through Optimization of Cooperative Driving Automation (CDA) Application for Signal Controls for Arterial Mixed Traffic Scenarios Principal Investigator: Xiao-Yun Lu (Lawrence Berkeley National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that on Slides 6 and 7, the reviewer was glad to hear during the presentation that most of the work developing messages is flowing to the relevant SAE committees (though the content still needs refinement prior to real world deployment). With the Federal Communications Commission (FCC) decision, the landscape of V2X is evolving and hardening, so if the project's communications architectures and messages ignore these hardening constraints, resulting applications will never be viable for real-world deployment. The use of multiple, different vehicle platforms makes the development and testing more realistic and relevant. On Slide 13 regarding the statement, "Not taking into account other vehicles in the front and maneuvers," this mostly decentralized approach allows an easier pathway to adoption. Industry can implement this with little dependence on external inputs. Benefits may therefore be reaped independent of market penetration rate. On Slide 14 regarding natural CAV strings, it may be worth connecting this project and the Michigan Technological University (MTU) FOA project about cohort size, vehicle order, and timing optimization. The reviewer thinks there could be benefit from common lessons learned and to determine what next steps might be pursued to implement in real world pilot deployments. Summaries of technical takeaways at the bottom of each slide are good as they make the presentation clear.

Reviewer 2:

The reviewer stated that the project appears to be well scoped and provides three vehicles that will be tested as a coordinated group having different powertrains on different infrastructures. The proposed timeline and milestones appear adequate for the project scope and desired outcomes.

Reviewer 3:

The reviewer noted that this is a large scope project aligning needed communications for CAV platooning. It is a good start to getting the plan in place along with model development prior to vehicle testing to begin. The program should also look at making sure that any tool developed is capable of replacing the need for over the road testing.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the project appears to be on track. Milestone deliverables clearly inform technical requirements for the application under development. Please just make sure this information is published/shared outside DOE and academia.

Reviewer 2:

The reviewer stated that from the presentation it was hard to determine what was accomplished and what was projected to be accomplished in future tasks. Based upon Slides 5, 6 and 7, that clearly label accomplishments for the first year of a multi-year project, the tasks accomplished of C-V2X messaging and literature review are critical for setting the foundation of success for the prime technology development phases of the project.

Reviewer 3:

The reviewer commented that the initial math looks good, but most of the project plan is remaining and is future work.

Question 3: Please comment on the collaboration within the 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 partner list is solid but a bit sparse. ORNL, American Center for Mobility, and California for Advanced Transportation Technology (PATH) are all historical partners. Please consider the potential destination for this work (besides academic publications): USDRIVE, OEMs, SAE, state/local departments of transportation, etc. and identify pathways to engage or potentially tech transfer with them. Is it to inform an SAE standards effort? Is it to encourage licensing of this project's outcomes? What does success look like for this project in 5 years? 10 years? Consider working with MTU cloud-cohort optimizer team to identify the trends associated with this class of eco-driving application. Are there general high-level requirements regarding communications latency, frequency, bandwidth, mode (dedicated 5.9GHz spectrum versus cellular), types of messages sent (infrastructure to vehicle [I2V] or vehicle to infrastructure [V2I] or both), minimize number of data sets exchanged if possible, and consider centralized versus decentralized control, etc.

Reviewer 2:

The reviewer commented that the project appears to have all sufficient collaborations and partnerships in place to execute the tasks and field demonstration CAVs. Berkeley and ORNL have more than enough resources to support any shortcomings the prime might have (though there doesn't appear to be any).

Reviewer 3:

The reviewer noted that between all of the laboratories listed (LBNL, ANL, NREL, ORNL, INL) the correct resources are in place for Model Build, Model Use, and Vehicle Test to complete successfully.

Question 4: Please comment on the 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 proposed future work is solid—to mature these concepts, the work will need to integrate with mixed traffic and other traffic system management and operations (TSMO) strategies.

Reviewer 2:

The reviewer commented that the proposed future research and tasking is on track for successful integration of C-V2X on multiple platforms and to development and implement the real-time model predictive control (MPC) optimization for CDA.

Reviewer 3:

The reviewer would like see work to prove out that the models are as good as the test to a point where future tests are not needed.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer commented that the project is relevant to VTO EEMS and further matures both vehicle- and infrastructure-based eco-driving algorithms by expanding the number of intersections compared to SMART 1.0 project.

Reviewer 2:

The reviewer stated that this project is the next step of CAV in coordinating multiple vehicles for coherent dynamics to reduce energy and improve mobility, key pillars for DOE VTO.

Reviewer 3:

The reviewer commented that the project aligns with the goal of reducing energy use.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer stated that resources appear sufficient.

Reviewer 2:

The reviewer commented that the team has all the components necessary for successful execution including teaming with ORNL and Berkeley.

Reviewer 3:

The reviewer stated that the $5.6 million listed on Slide 2 should be sufficient to complete the project.

Presentation Number: EEMS120
Presentation Title: A Cooperative Driving Automation (CDA) Framework for Communications
Principal Investigator: Adian Cook (Oak Ridge National Laboratory)

Presenter

Adian Cook, Oak Ridge National Laboratory

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.

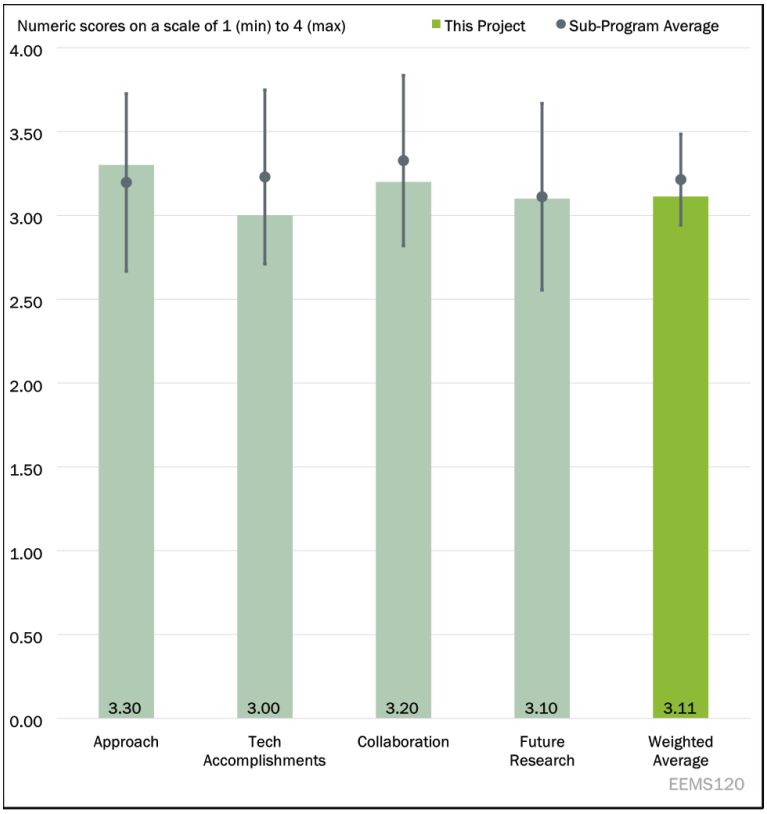

Figure 4-34 - Presentation Number: EEMS120 Presentation Title: A Cooperative Driving Automation (CDA) Framework for Communications Principal Investigator: Adian Cook (Oak Ridge National Laboratory)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the approach is good and recognizes the high complexity. There are some unanswered questions on how the work will scale up to full on-road universal application for all vehicles. Clarify what work is generating foundational knowledge and what work is aligned to the intended longer term use application where computational complexity and bandwidth are critical factors.

Reviewer 2:

The reviewer stated that work is progressing as planned however work is very front loaded with literature review and simulation.

Reviewer 3:

The reviewer noted that some of these research topics (energy prioritized scenarios, scenario definition) are foundational and therefore will be of broad applicability and interest. AMR slides focus on describing scope of work but neglect to highlight the accomplishments, which is a missed opportunity. The reviewer assumes this is because of AMR time constraints, but even a summary at the end of major takeaways (shown but not necessarily discussed) would be tremendously helpful. On Slide 8, what do ratings 1, 2, 3, and NA represent? What is the 100% scale in each direction supposed to represent? And what were the most energy significant scenarios? Is this summarized in a presentation or report that can be shared? (Task was completed in Oct 2022, so results should presumably be available.) Slide 9 mentions two formats for working group—what working

group is this? On Slide 10, are all three applications (platooning, merging, intersection navigation) enabled by this same set of messages and Class C framework? On Slide 12 the project team may want to also learn how others are using event configurable basic safety messages, which allow transmission as needed rather than constant 10Hz. This can reduce spectrum congestion, thereby opening up more potential applications. Also, for energy applications, the project team will probably want to consider non-5.9GHz since that portion of spectrum will likely be dedicated to safety-critical (low latency) applications. Energy applications can often tolerate more latency. On Slide 13, what are "severe road conditions, severe congestion, or severe weather?" On Slide 14, what is total energy savings if Class C adds 6–7% on top of Class A/B?

Reviewer 4:

The reviewer really loves this project from a design and execution perspective. The multiple classes of CDA, the partnering, the leveraging of previous EEMS projects and collaborations is strong and the focus is to show how multiple vehicles of mixed powertrain and OEM origin can work together. The use of XIL on the dynamometer will be a real time and money saver. The reviewer is overall excited for the progression and outcomes of this project and in particular to see it be used to push legislative rules regarding labeling credits/benefits to OEMs for engineering and undertaking connectivity technology.

Reviewer 5:

The reviewer commented that bandwidth to include a large amount of detailed vehicle data has historically not been overcome in similar proposals.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer commented that the project appears to need more time to generate technical accomplishments. It is too early to fully evaluate but appears on track. The thorough review of existing literature is noted and noteworthy. Other areas convey a more work in progress as a new start.

Reviewer 2:

The reviewer stated that it is unclear how work to date is an improvement over state of the art of previous V2X design. There is a statistic on simulated results but little to no info is provided on the key differences that account for this.

Reviewer 3:

The reviewer commented that the project is well-planned and appears to be on schedule. Milestones are very applicable and of interest to many stakeholders; please make them publicly available, so those outside the DOE ecosystem may benefit and learn from work. Please also consider identifying external stakeholders whom the project team may want to brief on this foundational work. It is fantastic to see that the collaborative literature review conducted by the four laboratories has been submitted to Springer for publication—a real team effort.

Reviewer 4:

The reviewer noted that this project is in year one but has made excellent progress on the software and CDA logic side as well as scenario and application.

Reviewer 5:

The reviewer stated that progress appears to be on track with commitments listed on Slide 4. The reviewer appreciates that the review of previous and similar work was thoroughly performed. The signal list looks complete, but the reviewer is concerned about adding additional tracking/communication signals to broadcast. The data shown on Slide 13 is compelling to make the transition to cooperative driving more comfortable to the user/driver.

Question 3: Please comment on the collaboration within the 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 collaborators are listed, but need more clarity and details on what the collaboration is, why important, and who is doing what. The slide material suggests much of it is pushing out information (knowledge transfer) vs. deep coordination and collaboration.

Reviewer 2:

The reviewer noted that partner roles are clearly articulated.

Reviewer 3:

The reviewer commented that partnerships with several national laboratories and DOT are excellent. Please also consider if there are any industry, academic, government, or SDO stakeholders the project team may want to engage.

Reviewer 4:

The reviewer noted strong teaming partnership with Berkeley, NREL DOT, Argonne and ORNL. Good to see that there is an effort to seek out overlap and common tool chain.

Reviewer 5:

The reviewer stated that participation and alignment between ANL and ORNL is shown in the presentation and oral review.

Question 4: Please comment on the 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 task steps appear appropriate to work towards the objective, especially the on-road test refinement. More specificity in the plan is warranted.

Reviewer 2:

The reviewer stated that the majority of the work for this project is still in the future especially as it relates to the significant challenges.

Reviewer 3:

The reviewer commented that proposed future work is intriguing. Fault insertion to ensure algorithm robustness is definitely useful. The project team may also want to consider testing with more traffic in either sim or live, as that challenges the tidy assumptions that are often used by algorithms to minimize energy use.

Reviewer 4:

The reviewer noted that what is specific for future research falls within expected approach for such a project. It would be good to see more than just merging scenario, but the reviewer is sure the team will expand to additional scenarios and infrastructures.

Reviewer 5:

The reviewer stated that in laboratory and on road testing is likely needed here and is targeted for future research. The project team should continue work to validate that computer models can replace over the road testing.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer noted that CDA holds the potential to improve overall fleet efficiency.

Reviewer 2:

The reviewer stated that, while it achieves the goals, the improvements from the simulation are relatively marginal. Typically, real work improvements are significantly less than idealized simulations which is a bit troubling here.

Reviewer 3:

The reviewer commented on relevance of driving automation applications to save vehicle- and transportation system-level energy use.

Reviewer 4:

The reviewer stated that this project definitely supports EEMS program goals and objectives and leverages past project outcomes, tools, etc. In the reviewer's opinion, this project has the potential to bring DOT-EPA into working towards inclusion of connectivity credits on certification if approached aggressively and the project demonstrates energy savings accumulated by single vehicles operating with CDA over a meaningful driving cycle.

Reviewer 5:

The reviewer noted that the project fits within the goals to reduce overall energy consumption.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that a clear breakdown on budget is not available. However, in the absence of expensive resources like physical testing or supercomputing the budget relative to the labor seems high given the information presented.

Reviewer 2:

The reviewer stated that there is still a significant amount of work in the future. The role of FHWA is critical here for knowledge transfer. Understanding how this will work will be very important to make sure this research is of any use.

Reviewer 3:

The reviewer noted that resources appear sufficient.

Reviewer 4:

The reviewer commented that the team has everything they need with super support from other laboratories, partners, etc. It should be a success.

Reviewer 5:

The reviewer stated that the $9 million listed for the program on Slide 2 should be sufficient, even with significant hardware and testing expenditures needed later in the project.

Presentation Number: EEMS121
Presentation Title: Decentralized and Cooperative Traffic Signal Network for Freight Energy Efficiency, Safety, Sustainability, and Public Health
Principal Investigator: Michael Lim (Xtelligent)

Presenter

Michael Lim, Xtelligent

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.

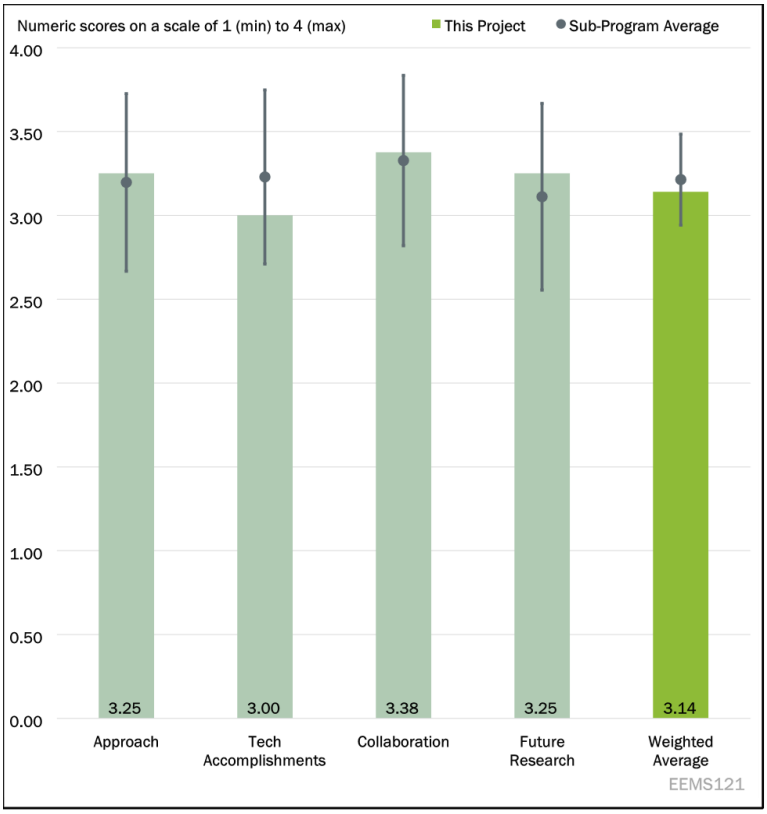

Figure 4-35 - Presentation Number: EEMS121 Presentation Title: Decentralized and Cooperative Traffic Signal Network for Freight Energy Efficiency, Safety, Sustainability, and Public Health Principal Investigator: Michael Lim (Xtelligent)

Question 1: Please comment on the degree to which technical barriers are addressed. Is the project well designed, and is the timeline reasonably planned?

Reviewer 1:

The reviewer commented that the approach proposed for the project is good. It will be good to see how the team will address the challenge with limited amount of CAV data.

Reviewer 2:

The reviewer noted that the objectives for the project are very clearly defined, which is excellent. This includes specific, quantified mobility, energy efficiency, and air quality goals. The approach incorporates three broad elements: (1) Development, system integration, and deployment emphasizing cooperative intelligent transportation systems (C-ITS) operating with high-definition connected vehicles (CVs); (2) Data collection and processing with CV technologies in "living labs"; and (3) Model implementation and energy impact evaluation looking at freight CV technologies and C-ITS technologies under various scenarios. This approach appears reasonable and sound. While the approach is focusing on freight corridors, it is also applicable to the broader light/medium-duty transportation system. Additional strong attributes are that the project takes a software-centric approach which exhibits lower capital expense and will utilize legacy infrastructure hardware systems. Additionally, it is looking not just at corridors, but also at the network level. With regards to defining "success" of the project, the PI indicated the following: (1) technology validation and supply chain throughput gains; and (2) determination that the system can scale. These seem like reasonable broad measures of success.

Reviewer 3:

The reviewer commented that the team has made progress and has completed many of the established milestones. The reviewer also appreciates that the team is looking to wider scale deployment so they are adopting a software approach which can be scaled nationwide. The next steps will be more complicated as the team integrates into real world situations with varying aspects in city environments and varying fleets. The reviewer applauds the team for seeking to address energy efficiency, pollution, and mobility with their project.

Reviewer 4:

The reviewer stated that, frankly, the provided information (presentation) provided no factual evidence that the stated goals or barriers have or can be addressed. If taken on a face value basis, the deployment of instrumentation has happened, and data collection has started. Where, what, and how much are not described.

Question 2: Please comment on the technical progress that has been made compared to the project plan.

Reviewer 1:

The reviewer noted that the team has reached the milestone of infrastructure being able to receive CV data and vehicles being able to receive signal phasing and timing (SPaT). Details on how this data will be used in the adaptive system nor how the system can work with limited data wasn't discussed.

Reviewer 2:

The reviewer commented that so far progress was only on practical tasks of hardware deployment and data collection. So far, no innovative progress has been made.

Reviewer 3:

The reviewer stated that the team has made progress, however it does seem that some challenges are being realized in working with varying cities and their rules and protocols as well as the competitive nature of these technologies. The competitive nature of information and data sharing and data security may continue to be a challenge for the project team.

Reviewer 4:

The reviewer commented that the project has demonstrated strong technical accomplishments in its first year and a half. This includes: (1) C-ITS technology deployed in "living labs"; (2) CV data provision pipeline built and tested; (3) backend infrastructure completed; and (4) prototype CV/C-ITS integration with platform has been completed. Critical milestones have been completed including passing the first go/no-go milestone (M1.4) to validate system soundness. The project appears on its way to accomplishing Budget Plan 2 tasks and is roughly on schedule (or maybe slightly lagging).

Question 3: Please comment on the collaboration within the 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 team has the expertise needed to achieve the goal. The team has shown a collaborative environment.

Reviewer 2:

The reviewer stated that information provided is unclear. Most of the work is accomplished by the PI with support from other partners not justified in the information provided.

Reviewer 3:

The reviewer applauded the partners and corridor that the team chose for this project. Incorporation of the Cities of Long Beach, Fremont and Ontario is remarkable, especially because of the intersections of pollution and impacted communities. In addition, working with OEMs on the solution is key for understanding the dynamics between the vehicle and the roadway networks.

Reviewer 4:

The reviewer commented that the project team is relatively lean but appears effective. The team includes industry, a university, California freight corridor cities, and vehicle manufacturers. In short, a well-rounded team with extensive experience in seemingly all relevant elements including intelligent infrastructure, connected vehicle technologies, R&D, tool development, testing, integration, and demonstration. The team coordinates frequently on a weekly or bi-weekly basis.

Question 4: Please comment on the 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 coming year progress is key to this project, considering the barriers.

Reviewer 2:

The reviewer noted that remaining work seems well planned assuming the unknown C-ITS system promised actually exists. No information is provided. Also, no information is provided on how the system will influence the CAVs.

Reviewer 3:

The reviewer commented that the team is in the early stages of this project, so future work was not discussed in great detail. Also, when asked what success looked like at the end of the presentation the team responded with technical verification and supply chain efficiencies, which is valid, but would that be a direct result of this project? At the next review, the team should think through tangible next steps in research and future work. The integration into MEP could be beneficial to multiple users throughout the nation. The reviewer is looking forward to the next phases of the project and the integration into the MEP tool.

Reviewer 4:

The reviewer noted that the presentation provides a clear, frank discussion of remaining challenges and barriers—which actually is quite refreshing. Briefly, this includes: (1) algorithm development; (2) system testing/integration with legacy systems and competitive concerns; and, (3) data sharing. Reasoned responses and progress are being made to address these issues. This includes new business models/partnerships and recruitment of industry experts to overcome integration challenges and legal approaches to address IP and cybersecurity concerns. Overall, a strong, proactive strategy to tackle these issues.

Question 5: Please comment on the relevance of the project. Does the project support the overall VTO subprogram objectives?

Reviewer 1:

The reviewer stated that this project is relevant to EEMS.

Reviewer 2:

The reviewer noted that conceptually the project is very relevant, but the budget as compared to other much cheaper projects is not justified in the presented information.

Reviewer 3:

The reviewer commented that the project is relevant to VTO's and EEMS's work. The reviewer especially appreciates the attention and detail given to impacted communities in their research. Integration of energy efficiency, mobility and environmental justice is critical, and the reviewer appreciates the team's efforts and attention given to the nexus of these topics.

Reviewer 4:

The reviewer stated that vehicles account for a large percentage of criteria pollutants and GHG emissions, with freight corridors (often in disadvantaged communities) being especially heavy contributors. Successful development, communication, and coordination amongst C-ITS infrastructure and CVs can help significantly in addressing these challenges through improved system efficiency, mobility, and reduction of emissions.

Question 6: Please provide comments on the resources of the project. Are the resources sufficient for the project to achieve the stated milestones in a timely fashion?

Reviewer 1:

The reviewer commented that the team has sufficient resources to accomplish the goals.

Reviewer 2:

The reviewer noted that for the awarded budget they would expect having some more factual information provided.

Reviewer 3:

The reviewer stated that the project funds appear to be sufficient for the completion of the project.

Reviewer 4:

The reviewer commented that the project appears adequately funded to meet defined objectives and milestones. The project is 50/50 cost shared which is excellent.

Acronyms and Abbreviations – EEMS

Abbreviation	Definition
21CTP	21st Century Truck Partnership
AASHTO	American Association of State Highway and Transportation Officials
ADAS	Advanced driver assistance system
ADOT	Alabama Department of Transportation
AI	Artificial intelligence
AMBER	Advanced Model Based Engineering Resource
AMR	Annual Merit Review
ANL	Argonne National Laboratory
AV	Autonomous vehicle
BEAM CORE	Behavior, Energy, Autonomy, and Mobility Comprehensive Regional Evaluator
BEV	Battery electric vehicle
C-V2X	Cellular-vehicle-to-everything
CAPEX	Capital expenditure
CAV	Connected and automated vehicle
CAVE	Connected and Automated Vehicle Environment
CDA	Cooperative driving automation
CMAP	Chicago Metropolitan Agency for Planning
CO_2	Carbon dioxide
COVID	Coronavirus disease (COVID-19), infectious disease caused by the SARS-CoV-2 virus
CRADA	Cooperative research and development agreement
CTA	Chicago Transit Authority
CV	Connected vehicle
DOE	U.S. Department of Energy
DoX	Design of experiment
DSRC	Dedicated short range communications
DWG	Livewire Data Working Group

Abbreviation	Definition
EEAC	Energy Efficient Advance Compute
EEMS	VTO Energy Efficient Mobility Systems subprogram
EPA	U.S. Environmental Protection Agency
EV	Electric vehicle
eVTOL	Electric vertical takeoff and landing
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FCEB	Fuel cell electric bus
FHWA	Federal Highway Administration
FOA	Funding opportunity announcement
FRA	Federal Railroad Administration
FSD	Tesla Full Self Driving
GHG	Greenhouse gas
GLOSA	Green light speed advisory
GM	General Motors
GNSS	Global navigation satellite system
HD	Heavy-duty
HEV	Hybrid electric vehicle
HIL	Hardware-in-the-loop
I2V	Infrastructure to vehicle
ICE	Internal combustion engine
INL	Idaho National Laboratory
IP	Internet protocol
IRA	Inflation Reduction Act
ITIC	International Transportation Innovation Center
ITS	Intelligent transportation systems
LBNL	Lawrence Berkeley National Laboratory
LD	Light-duty

Abbreviation	Definition
LDP	Liveware Data Platform
LTE	A wireless data transmission standard
MAC-POST	Mobility Data Analytics Center-Prediction, Optimization, and Simulation toolkit for Transportation Systems
MD	Medium-duty
MDS	Mobility Data Specification
MEP	Mobility energy productivity
MITIE	Micromobility-Integrated Transit and Infrastructure for Efficiency
ML	Machine learning
MPC	Model predictive control
MPG	Miles per gallon
MPO	Metropolitan planning organization
MTU	Michigan Technological University
NCTCOG	North Central Texas Council of Governments
NHTSA	National Highway Traffic Safety Administration
NN	Neural network
NREL	National Renewable Energy Laboratory
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
OD	Origin-destination
OEM	Original equipment manufacturer
OPEX	Operational expense
ORNL	Oak Ridge National Laboratory
PC5	No base stationary intermediary in V2X LTE-Cellular protocol
PHEV	Plugin hybrid electric vehicle
PI	Principal investigator
PMP	Project management professional
PNNL	Pacific Northwest National Laboratory
PR	Pooled rideshare

Abbreviation	Definition
PRAM	Pooled rideshare acceptance model
PRCM	Pooled rideshare choice model
RDD&D	Research, development, deployment, and demonstration
ROS	Robot operating system
RSU	Single roadside unit
SAE	SAE International, formerly Society of Automotive Engineers
SDO	Standards development organization
SIL	Software-in-the-loop
SMART	Systems and Modeling for Accelerated Research in Transportation
SOC	State of charge
SUMO	Simulation of Urban Mobility
TCO	Total cost of ownership
TI	VTO Technology Integration subprogram
TSDC	Transportation Secure Data Center
TSMO	Traffic system management and operations
TSMS	Transit-Centric Smart Mobility System
UA	University of Alabama
Uu	Cellular network communications
U.S. DRIVE	United States Driving Research and Innovation for Vehicle efficiency and Energy sustainability
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
V2X	Vehicle-to-everything
VECTOR	Visual-Enhanced Cooperative Traffic Operations
VPPG	Virtual and Physical Proving Ground
VTO	Vehicle Technologies Office
XIL	Everything-in-the-loop

(This Page Intentionally Left Blank)