8. Vehicle Analysis

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

The VTO Analysis subprogram provides critical information and analyses to prioritize and inform Vehicle Technologies research portfolio planning through technology-, economic-, and interdisciplinary-based analysis, including target-setting and program benefits estimation. Projects continue to support analytical capabilities and tools unique to DOE's national laboratories. For data activities, trusted and public data are critical to Vehicle Technologies efforts and are an integral part of transportation and vehicle modeling and simulation. For modeling activities, the subprogram supports the creation, maintenance, and utilization of vehicle and system models to explore energy impacts of new technologies relevant to the Vehicle Technologies Office portfolio. Finally, for analysis activities, integrated and applied analyses will bring together useful findings and analysis of the energy impacts of transportation systems through the integration of multiple models including vehicle simulation and energy accounting of the entire transportation system. The result creates holistic views of the transportation system, including the opportunities and benefits that advanced vehicle technologies create by strengthening national security, increasing reliability, and reducing costs for consumers and businesses. Overall, Analysis activities explore energy-specific advancements in vehicles and transportation systems to inform Vehicle Technologies' early-stage research and offer analytical direction for potential and future research investments.

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 8-1 – Project Feedback

Presentation ID	Presentation Title	Principal Investigator (Organization)	Page Number	Approach	Technical Accomplishments	Collaborations	Future Research	Weighted Average
van021	Transportation Energy Evolution Modeling (TEEM) Program	Zhenhong Lin (ORNL)	8-3	3.56	3.67	3.78	3.39	**3.62**
van028	Electric Vehicle (EV)-Grid Analysis Modeling	Srinath Ravulaparthy (LBNL)	8-10	3.67	3.58	3.33	3.42	**3.55**
van034	Medium- and Heavy-Duty Vehicle Choice Modeling and Applied Analysis	Alicia Birky (NREL)	8-15	3.57	3.57	3.64	3.43	**3.56**
van035	Assessing Vehicle Technologies Benefits in a Transportation Energy Ecosystem	Vincent Freyermuth (ANL)	8-21	3.00	3.21	3.43	3.21	**3.19**
van036	Distributions of Real-World Vehicle Travel	Dave Gohlke (ANL)	8-28	3.50	3.57	3.50	3.36	**3.52**
van038	The Department of Energy's (DOE) More Comprehensive Total Cost of Ownership (TCO) Franework	Dave Gohlke (ANL)	8-34	3.72	3.83	3.61	3.67	**3.76**
van039	Electric Vehicles at Scale	Michael Kintner-Meyer (PNNL)	8-41	3.44	3.13	3.56	3.38	**3.29**
van040	Energy Impacts of Electrified Passenger Air Transport	Dominik Karbowski (ANL)	8-48	3.29	3.29	3.29	3.33	**3.29**
van041	Location History	Venu Garikapati (NREL)	8-54	3.21	2.79	3.00	2.86	**2.93**
Overall Average				**3.45**	**3.42**	**3.48**	**3.32**	**3.42**

Presentation Number: van021
Presentation Title: Transportation Energy Evolution Modeling (TEEM) Program
Principal Investigator: Zhenhong Lin (Oak Ridge National Laboratory)

Presenter

Zhenhong Lin, Oak Ridge National Laboratory

Reviewer Sample Size

A total of nine 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. 89% of reviewers felt that the resources were sufficient, 11% 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.

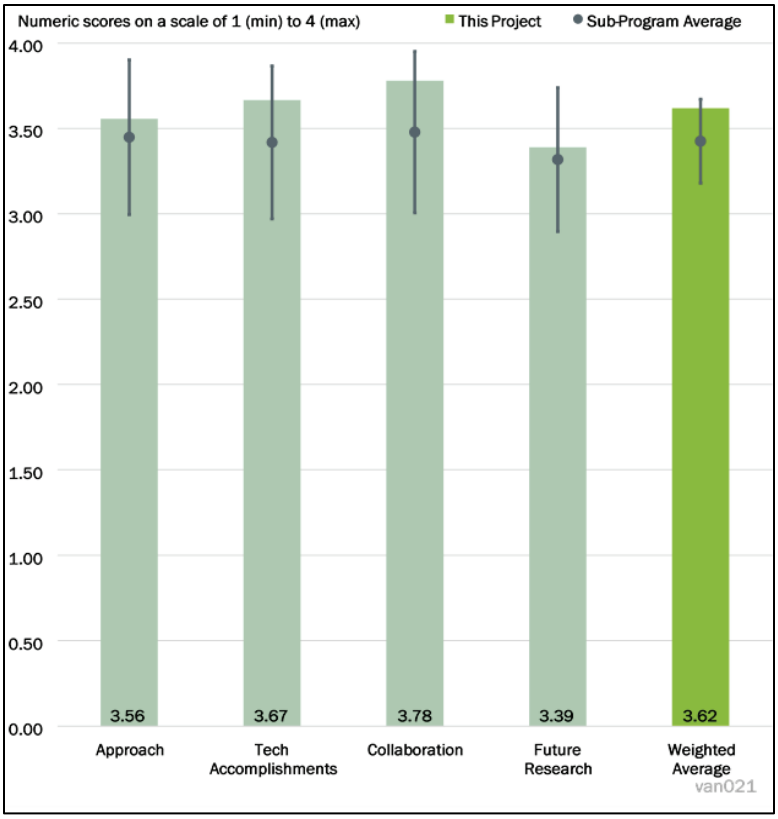

Figure 8-1 - Presentation Number: van021 Presentation Title: Transportation Energy Evolution Modeling (TEEM) Program Principal Investigator: Zhenhong Lin (Oak Ridge National Laboratory)

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

Reviewer 1:

The reviewer applauded the research team for helping advance transportation decarbonization across the United States. The reviewer noted that the tools have been used in multiple decarbonization and policy studies and provide the rigor and ease-of-use that a lot of decision-makers seek. The reviewer stated that there simply are not enough similar tools that are publicly available.

Reviewer 2:

The reviewer said that the project team's approach to exploring these issues is sound, and that it utilizes existing VTO modeling resources and expands/improves where necessary. The reviewer added that integrating a few of the models (Market Acceptance of Advanced Automotive Technologies [MA3T]; Greenhouse gases, Regulated Emissions, and Energy use in Transportation [GREET]; and VISION) is an excellent way to assess carbon neutrality scenarios without having to develop a new modeling framework.

Reviewer 3:

Although the stated TEEM goal includes addressing issues related to equity as well as employment, it was unclear to the reviewer how these are addressed in research.

Reviewer 4:

The reviewer mentioned that in general the project team has done a good job applying best practices in its modeling. The reviewer expressed two concerns. The reviewer explained that the first is the extent to which modeling uncertainty is passed through each of the sub-models. The reviewer asked how the uncertainty in the mode choice model is passed through to other models, and how sensitive, for example, the results on Slide 8 are to uncertainty in underlying models. The reviewer's second concern is that it might be worth attempting to validate the upper bound of the projection scenarios based on upper limits of expected production capacities, as the scenarios seem very ambitious.

Reviewer 5:

The reviewer stated that the objectives were clearly explained, and that the use of tools including MA3T, GREET, and VISION was explained and appropriate for the task. The reviewer added that carbon neutrality analysis was clear, and that meaningful scenarios were presented. The reviewer suggested more clarity in the description for internal combustion engine vehicles (ICEVs) and "other" categories to articulate where gasoline and diesel fall. The reviewer clarified that ICEV was described as gasoline and "other" as diesel and natural gas (NG) ICE and said that this is not intuitive and should be clearly defined.

Reviewer 6:

The reviewer noted that the approach is sound, but that it could have more emphasis on sensitivity analysis and uncertainty in some of the factors driving adoption. The reviewer remarked that the data driving the model are based on empirical data that may be less relevant going forward in a rapidly changing system. The reviewer indicated that the regional considerations and Truck choice model are valuable additions.

Reviewer 7:

Overall, the reviewer observed a well-reasoned approach that addresses barriers. The reviewer expressed slight confusion over the 2050 carbon neutrality analysis regarding the conclusions drawn—"Policy forcing and PHEV force out may be necessary." The reviewer stated that, while the results are an accomplishment, the approach incorporated scenarios that did not seem tied to potential and/or likely future policy scenarios. The reviewer indicated that any policy work that includes assumptions about future policy scenarios should be explicit about the basis.

Reviewer 8:

The reviewer noted that the project approach could be refined/improved to better align with project goals in assessing barriers to adoption or identifying mechanisms for reducing these barriers. Carbon neutrality policy results are interesting but rely on existing model outputs, and do not address underlying data issues or seem to endogenize any feedback effects of these pricing strategies on travel demand. The reviewer remarked that choice modeling for trucks should consider vocational differences to better reflect operational demands on purchase decision-making. The reviewer commented that the approach could also be improved by considering the impacts of reductions in criteria pollutant emissions near roadways with respect to regional air quality attainment targets. The reviewer remarked that the charging infrastructure model should include regional arterial and local traffic and should address additional/restorative investments required in historically disadvantaged communities. The reviewer indicated that it is unclear how the proposed Transportation Energy Evolution Modeling (TEEM) approach assesses equity in the context of adoption.

Reviewer 9:

The reviewer stated that the research builds on eight previous models that explore things like vehicle and transportation mode choice, battery electric vehicle (BEV) performance, charging infrastructure, and industry actions. The reviewer commented that recent studies have focused on the impacts of fast charging on BEVs, from both a performance side (in terms of capacity fade from fast charging) and impacts on adoption. The

reviewer indicated that it is not clear whether the range considered is the vehicle highway range, or a general range with more city driving (where efficiency improvements and regenerative braking have a substantial role in increasing the vehicle range). The reviewer remarked that more detail could be given about how the models were updated in the most recent years.

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

Reviewer 1:

Numerous accomplishments are recorded by the presenter and it appeared to this reviewer that good progress has been made.

Reviewer 2:

The reviewer stated that the project team outlines several research products and model improvements.

Reviewer 3:

The reviewer remarked that the project team has numerous publications (including many collaborative efforts) and updates to models to include truck choice models and overall GHG impact analyses.

Reviewer 4:

The reviewer indicated that the team has accomplished quite a lot in just 1 year.

Reviewer 5:

The reviewer noted that progress is on schedule and deliverables are being met.

Reviewer 6:

The reviewer remarked that the performers have made progress and are on track to meet goals.

Reviewer 7:

The reviewer said that the scope is large, but the milestones are on track. The reviewer remarked that the project team has a very productive record of publications, and that the inclusion of emerging mobility, charging infrastructure, mobility choice, and multimodal travel models is important. The reviewer commented that equity was listed, but could be expanded beyond employment considerations.

Reviewer 8:

The reviewer commented that the project is on schedule according to the milestone table, and that it has several excellent accomplishments, including linking up multiple modeling frameworks across different labs to complete a carbon neutrality analysis, publishing a paper on workplace charging, assessing the value of extreme fast charging, and further developing the TruckChoice model. The reviewer added that integrating MA3T, GREET, and VISION is a technical accomplishment on its own, but that it would have been interesting to hear more specifics about the carbon neutrality assumptions and results. The reviewer found that it is difficult to gauge the rigor of the carbon neutrality scenario assumptions and methodology and suggested that additional explanation/proof would be helpful in assessing the completeness of the related tasks. The reviewer remarked that there are some similar gaps in the explanation for the other projects, and that it seems like the project may be a bit spread thin working on multiple, not clearly linked, fronts.

Reviewer 9:

The reviewer asserted that that the TruckChoice model is desperately needed in the public space.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer stated that the project team has collaborated with many companies and other researchers on studies of different aspects of transportation.

Reviewer 2:

The reviewer indicated that the Principal Investigator (PI) is actively collaborating with a wide range of stakeholders, including other national laboratories, academia, and industry.

Reviewer 3:

The reviewer remarked that there appears to be excellent collaboration across multiple entities on this project.

Reviewer 4:

This reviewer reported that the presenter indicates a significant amount of collaboration between industry, academia, government, and lab organizations in support of a variety of topics within the TEEM models.

Reviewer 5:

The reviewer reported that the collaborations are meaningful and reasonable, and suggested including some fleets to provide industry relevance and feedback.

Reviewer 6:

The reviewer observed that the presentation nicely mapped out the many connections and collaborations and how they are related. Slide 14 was helpful.

Reviewer 7:

The reviewer remarked that the PI and the project team do an excellent job collaborating across the government, industry, and academia.

Reviewer 8:

The reviewer stated that Oak Ridge National Laboratory (ORNL) projects are tied well to multiple collaborators. It was difficult for this reviewer to assess the efficacy/role of collaborators; based on outcomes, they seem to play an equal and appropriate level of involvement. The reviewer added that one of the noted barriers is data availability for heavy-duty (HD) electrification, which seems like it may be a problem for a number of researchers within the VTO portfolio, and suggested that perhaps coordinating or leveraging existing partnerships could help solve that. The reviewer said that it is great to see the emphasis on publications and software being made publicly accessible.

Reviewer 9:

The reviewer observed a large project team. Given the range of international participation, the reviewer suggested that it would be good to see how this work is being translated or applied in other contexts.

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

Reviewer 1:

The reviewer remarked that future research is planned well.

Reviewer 2:

The reviewer looked forward to the public release of as many of the models in TEEM as possible.

Reviewer 3:

The reviewer reported that future research plans appear sound.

Reviewer 4:

The planned next steps seemed logical to the reviewer, but more detail would have been helpful. The reviewer suggested expanding on the impact of different policy avenues.

Reviewer 5:

The reviewer noted that the future research plan is good. The reviewer was interested to see further work with the MA3T TruckChoice model applied to medium-duty (MD) and HD commercial vehicles. The reviewer encouraged consideration of selected off-highway equipment after commercial vehicles (CV) are modeled. The reviewer stated that a question was raised about making a version of the model available to the public for use, but that there are no plans to do so formally, but the team can make it available on a special request basis. The reviewer encouraged making a public version available.

Reviewer 6:

The reviewer suggested that the project team should consider placing additional focus on infrastructure costs and planning in low income and historically disadvantaged communities. The reviewer noted that the scope of impacts should be refined/expanded with respect to air pollution impacts, potentially linking cost-effectiveness with pollution-related health cost impacts. The reviewer suggested further work on the implications of coronavirus disease 2019 (COVID-19) and growth in last-mile goods movement as well as its implications on cost effectiveness and adoption.

Reviewer 7:

The reviewer found the study objectives for the plug-in hybrid vehicle (PHEV) and BEV study to be somewhat ambiguous. The reviewer asked if the project team will focus on cost, environmental impacts, and/or emissions. The reviewer remarked that the presentation also touched on the ability to examine jobs as one area of study, although how this is incorporated into the existing models is somewhat unclear. The reviewer suggested that the equity models seem to need additional modeling capabilities.

Reviewer 8:

The reviewer stated that the future research that is part of the current project (Quarter [Q] 3 and Q4 milestones) was not clearly explained. The reviewer added that other future research items appear to be reasonable modeling pursuits, but that it is not clear whether these were specifically requested by VTO or if they are ideas from the PI.

Reviewer 9:

Proposed work, as described, was somewhat vague to this reviewer, who noted difficulty in determining if future work is planned effectively.

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

Reviewer 1:

This reviewer indicated that yes, this work supports DOE energy-specific advancement objectives in vehicles and transportation systems and informs VTO's direction for potential and future research investments.

Reviewer 2:

The reviewer noted that this study does address policy-relevant planning questions with respect to climate and emissions reduction targets as well as technology development.

Reviewer 3:

The reviewer remarked that simple models examining different adoption patterns and their estimated environmental impacts are an important toolset to have.

Reviewer 4:

The reviewer asserted that the project clearly works toward developing data-driven, advanced transportation analysis tools (e.g., TEEM, MA3T, TruckChoice, and REVISE) to answer critical questions and create insights about energy use and other metrics.

Reviewer 5:

The reviewer indicated that there are multiple contributions through a variety of models that can be used by different organizations to model a wide variety of impacts of future vehicle technologies.

Reviewer 6:

The reviewer said that, yes, the work provides a better understanding of the scenarios for deployment of alternative propulsion systems in achieving GHG objectives.

Reviewer 7:

The reviewer commented that the work is very relevant to the VTO mission and beyond. Further, the presentation laid out the relevance very nicely and tied together various pieces with the broader goals.

Reviewer 8:

The reviewer observed that the work by TEEM is directly relevant to the work of the U.S. Department of Energy (DOE), offering insights into the energy transition and market adoption.

Reviewer 9:

No comment was indicated by this reviewer.

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

Reviewer 1:

The reviewer stated that significant project funding has been provided, but that it supports a large team with several collaborative initiatives.

Reviewer 2:

The reviewer indicated that the project supports multiple models that need continuous improvement, along with new collaborative analyses using those tools.

Reviewer 3:

Sufficient project resources were observed by this reviewer to achieve the stated milestones. Progress has been made in a timely manner to date and should be expected to continue with given resources.

Reviewer 4:

The reviewer observed that, given the accomplishments of just 1 year, the proposed future work appears feasible to be completed in the following year under the current budget plan.

Reviewer 5:

The reviewer remarked that no barriers were identified.

Reviewer 6:

The reviewer said that the level of funding seems about right for the project scope and significance.

Reviewer 7:

The reviewer indicated that the resources are adequate and appropriate.

Reviewer 8:

The reviewer noted that there is an increasing need for publicly available tools to help policy makers and decision-makers at the local, state, and federal levels. The reviewer would have liked to see an expansion and acceleration of the modeling tools in TEEM, if possible.

Reviewer 9:

The reviewer reported that resources appear sufficient to meet the stated milestones, but that it seems like there are also several other tasks going on in parallel (not in the milestones). The reviewer added that this could be a misunderstanding based on the presentation being slightly disjointed; if not, then there is a risk that the team could become overwhelmed with tasks adjacent to the milestones.

Presentation Number: van028
Presentation Title: Electric Vehicle (EV)-Grid Analysis Modeling
Principal Investigator: Srinath Ravulaparthy (Lawrence Berkeley National Laboratory)

Presenter

Srinath Ravulaparthy, Lawrence Berkeley National Laboratory

Reviewer Sample Size

A total of six reviewers evaluated this project.

Project Relevance and Resources

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

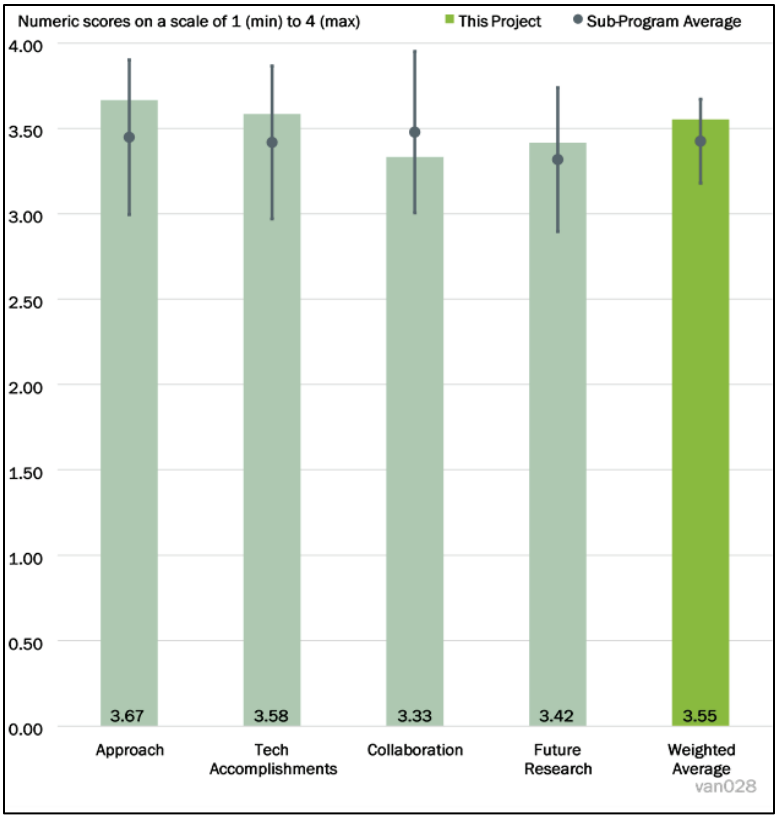

Figure 8-2 - Presentation Number: van028 Presentation Title: Electric Vehicle (EV)-Grid Analysis Modeling Principal Investigator: Srinath Ravulaparthy (Lawrence Berkeley National Laboratory)

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

Reviewer 1:

This reviewer observed a well-designed and well-planned project. Inclusion of micromobility in the GEM model is novel and has value for communities considering modal shift opportunities.

Reviewer 2:

The reviewer stated that the project has two parallel components—freight truck electrification and micromobility—each with a grid impact analysis. The reviewer added that the team's approach—using the Greenhouse gas Emissions Model's (GEM) Truck Electrification component to scale up truck advanced technology impacts and GEM's micromobility component to assess potential modal shifts—sufficiently bridges the gap between the data (truck advanced technology assumptions and National Highway Travel Survey [NHTS] travel data) and national-level environmental and cost impacts. The reviewer said that the inclusion of GEM's grid modeling capabilities further addresses the technical barriers to accurately model such a complex system by ensuring that transportation impacts are not estimated in isolation.

Reviewer 3:

The reviewer noted that the project is ambitious, but that the methodology is straightforward, and the team has thus far done a good job executing the project.

Reviewer 4:

The reviewer observed that this is a good approach to include micromobility vehicles in addition to shared and freight trucks.

Reviewer 5:

The reviewer reported that the project has a straightforward approach to answering important questions about both emerging mobility and understudied modes, and their potential interactions with the grid. The reviewer added that the GEM model is uniquely positioned to tackle these questions, and that there is high value in building out the relevant components.

Reviewer 6:

The reviewer stated that the bottom-up modeling work is deeply granular, and that it offers a robust approach that clearly provides nuanced results.

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

Reviewer 1:

The reviewer asserted that Q1 and Q2 milestones are marked complete, and that the remaining milestones are marked as on schedule. The reviewer noted that the heavy-duty vehicle (HDV) accomplishment slides show results from the battery technology/capacity scenarios, but that it would have been helpful to see the actual battery assumptions and range results that were developed to meet the Q1 milestone. The reviewer stated that these are of particular interest in studies of freight truck electrification, as the freight truck market is fragmented, and it is difficult to develop simple "average battery specs" that apply across the board. The reviewer added that the accomplishment clearly suggests the project is on track to meet the future milestones, as the milestones do not require the battery technology/capacity/range scenarios to be vetted. The reviewer observed that the micromobility accomplishments clearly show completion of the Q2 milestone and progress toward the final (Q4) milestone, although, again, it would be helpful to see the reasoning behind some of the scenario assumptions. The reviewer reported that it is great that the team has published results and is working to make GEM more available to the public to encourage transparency and reproducibility of the results.

Reviewer 2:

The reviewer said that, to date, the progress is very good, and applauded making the model openly available on GitHub.

Reviewer 3:

The reviewer reported that the research team has made progress and the plan is on schedule. Additionally, accomplishments related to computational efficiency improvements are noteworthy.

Reviewer 4:

The reviewer stated that the progress is on schedule.

Reviewer 5:

The reviewer said that the project is on track and has produced interesting results to date. The reviewer highlighted that most of the work to date has been on building out the new model components, and looked forward to the published results for HDV and micromobility.

Reviewer 6:

The reviewer asserted that the performers are hitting project milestones on time, and that results for both HDV and micromobility are provided. The reviewer recommended that takeaways be included on the accomplishments slides in the future. The reviewer noted that it is great to see micromobility modeled in

GEM, and that it is particularly interesting, given modal shift opportunities. The reviewer stated that the HDV charging load is equally important; however, the implications of the results are unclear.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted good collaboration across the team.

Reviewer 2:

This reviewer remarked that collaboration between LBNL and UC Davis appears to be sufficient for project success.

Reviewer 3:

The reviewer reported that the team is collaborating with other national laboratories as well as academia. The reviewer stated that the approach has been developed with an eye to others who may use the work. The reviewer said that the GEM model has been made open source to allow for users to customize scenarios.

Reviewer 4:

The reviewer expressed that the collaboration between Lawrence Berkeley National Laboratory (LBNL), University of California at Davis (UC Davis), and Marain Inc. is clearly effective, as it leverages the expertise of all participants and is well coordinated. The reviewer was glad to also see that an open-access version of GEM has been published and includes a user tutorial.

Reviewer 5:

The reviewer stated that the collaboration with universities and national laboratories is mentioned. This reviewer would have liked to see more collaboration with fleets or industry to gather relevant feedback and perspective on the issues related to deployment in the micromobility space and other applications.

Reviewer 6:

The reviewer observed that the collaboration with the University of California, Davis (UC Davis) and Marain was not discussed beyond the quad chart slide. The reviewer suggested that it would be beneficial to summarize the different collaborators' roles and responsibilities.

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

Reviewer 1:

The reviewer observed that future work—beyond meeting the remaining milestones—was not very clearly explained. However, what was stated appears to imply that ride-hail electrification could be added; and that modeling results will be validated and vetted to ensure the results are "finalized." The reviewer said that these are logical next steps.

Reviewer 2:

The reviewer remarked that the proposed future research continues to focus on emerging mobility and would be a worthwhile effort. The reviewer added that the multimodal integration is an especially interesting avenue to explore.

Reviewer 3:

The reviewer noted that the current research is well planned, and that the proposed future research is in keeping with that.

Reviewer 4:

Proposed work is appropriate and effectively planned in a logical manner from this reviewer's perspective. Researchers should consider targeting distribution of information related to micromobility research to the urban transportation planner sector.

Reviewer 5:

The reviewer indicated that, overall, the future work plan seems solid. The reviewer expressed concern about the specific choices for scenario analyses, as there are quite a lot of variables that will be incorporated into this framework, and it is unclear whether any generalizable findings will result, given the potentially large amount of scenario analyses that might be needed.

Reviewer 6:

The reviewer said that freight movement is focused on long haul. The reviewer suggested that consideration be given to MD package delivery and autonomous package delivery (drones) for last-mile delivery, as these are expected to be entry points for semi-autonomous and autonomous vehicles, as well as electrified powertrain systems. The reviewer encouraged that, for completeness, some study of the adoption rates of e-bikes, forecasts and scenarios for deployment, and the role that they could play in the micromobility sector.

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

Reviewer 1:

The reviewer asserted that the project supports overall DOE objectives in that it aims to extend DOE vehicle technologies benefit analysis to include the upstream costs and benefits of EVs to the grid.

Reviewer 2:

The reviewer noted that this project is primarily focused on using data to build, maintain, and expand DOE VTO modeling capabilities to generate impactful analysis, particularly analysis of transportation electrification impacts on the grid.

Reviewer 3:

The reviewer said that, yes, this project has a lot of relevance for real-world decisions made by state and local governments, e.g., how to plan for the needed future charging infrastructure.

Reviewer 4:

The reviewer observed that this program is relevant to the overall objectives.

Reviewer 5:

The reviewer noted that this project is very relevant to DOE objectives, with good focus on high-priority areas that will be broadly useful for decision-makers as well as other modeling efforts.

Reviewer 6:

The reviewer stated that, yes, this work is deeply relevant to the overall objectives of DOE. The reviewer added that, as electric vehicles (EVs) become more prevalent, they will inherently play a role in the grid. Quantifying the costs and benefits allows VTO to better articulate the value of its technical work or make different decisions based on the outcomes of modeling.

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

Reviewer 1:

Resources appeared sufficient to this reviewer for the project to achieve stated milestones in a timely fashion.

Reviewer 2:

The reviewer reported that the resources are sufficient considering the scale of the project.

Reviewer 3:

The reviewer said that the resources are adequate.

Reviewer 4:

The reviewer indicated that the resources appear to be sufficient, although the presenter mentioned that the original PI has moved on.

Reviewer 5:

The reviewer had no additional comments on resources as the budget seems sufficient.

Reviewer 6:

The reviewer noted that no resource constraints were identified.

Presentation Number: van034
Presentation Title: Medium- and Heavy-Duty Vehicle Choice Modeling and Applied Analysis
Principal Investigator: Alicia Birky (National Renewable Energy Laboratory)

Presenter

Alicia Birky, National Renewable Energy Laboratory

Reviewer Sample Size

A total of seven 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.

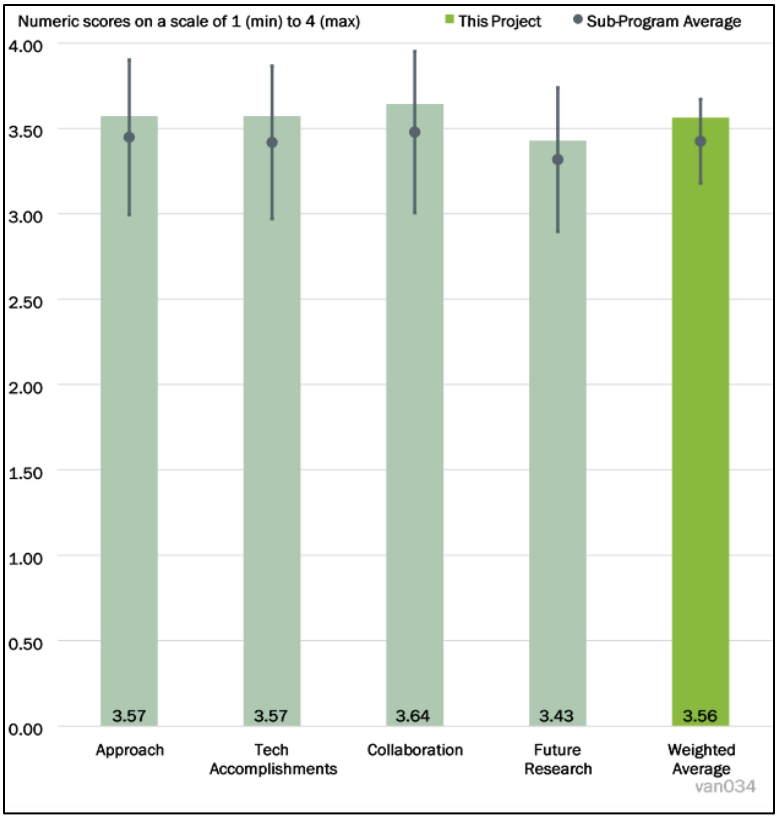

Figure 8-3 - Presentation Number: van034 Presentation Title: Medium- and Heavy-Duty Vehicle Choice Modeling and Applied Analysis Principal Investigator: Alicia Birky (National Renewable Energy Laboratory)

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

Reviewer 1:

The reviewer stated that the project incorporates multiple modeling approaches to estimate the adoption of alternative powertrains in the MD and HD sectors. The reviewer added that the pilot models have focused on Class 8 vehicles because of their share in overall energy use. The reviewer mentioned that the use of multiple modeling strategies is one way to hedge against the uncertainties associated with how vehicles are adopted in the MD and HD segments, which are under-studied relative to light-duty vehicles (LDVs). The reviewer noted that there is some mention of perhaps combining the approaches from both TRUCK and Automotive Deployment Options Projection Tool (ADOPT), although the exact method for doing so is uncertain. The reviewer indicated that the performance parameters for the new technologies (BEV and fuel-cell electric vehicle [FCEV]) have generally improved in recent years, and it seems like there is more collaboration between the offices, which helps to improve the input assumptions. The reviewer observed that, for the BEV segment, it seems like the useable state of charge (SOC) window is a bigger factor in changing the overall cost of BEVs in the long term (approximately 2040–2050) than the cost of the batteries, which may be something to explore. The reviewer said that the process for developing scenarios is generally a bit limited given a significant reliance on Annual Energy Outlook (AEO) assumptions.

Reviewer 2:

The reviewer indicated that the approach to handling the MD and HD VTO benefits analysis—using the legacy modeling framework while developing a new and potentially more capable framework that is consistent with that used in the LDV analysis—is reasonable and appropriately navigates the opposing risks of redundant work (parallel models) and using a model that is not ready (ADOPT). The reviewer added that the team clearly understands how complex the freight truck market is, and is implementing an approach and methodology (i.e., a focus on adding Class 8 tractors to ADOPT first, rather than all trucks) that can be thoroughly executed in the project timeframe without unworkable data availability issues. The reviewer mentioned that it was also scoped to ensure that the model adds the largest energy consumer first, and that the approach includes Future Automotive Systems Technology Simulator (FASTSim) to help relate specific component-level technologies to the national-level benefits in TRUCK/ADOPT.

Reviewer 3:

The reviewer reported that the benefits estimation tool (ADOPT) is well suited to the MD and HD truck applications. The reviewer noted that the approach is sound in assessing total cost of ownership (TCO) and other benefits to decarbonization technology, and in enhancing modeling capabilities within the TRUCK choice model.

Reviewer 4:

The reviewer indicated that the approach and ADOPT framework were clearly laid out, and care was taken in the development of a new approach alongside the existing model. The reviewer expressed some concerns regarding the ability of this approach to adequately inform decarbonization pathways in the long term due to the lack of data and reliance on older data that does not seem representative of new technologies and emerging trends in the sector. The reviewer remarked that the program scenario has low BEV penetration compared to other modeling efforts.

Reviewer 5:

Project is well-designed and well planned, representing strong analytical work in the MD and HD sectors.

Reviewer 6:

The reviewer noted that the approach to performing the various objectives is well reasoned and addresses barriers.

Reviewer 7:

The reviewer remarked great use of multiple models to incorporate HD trucks into the ADOPT framework. The reviewer expressed concern (as with many of these projects) about passing uncertainty through to model outputs. The reviewer added that there can be large uncertainty from choice models, and it is important to enable the modeler to pass that uncertainty through to further downstream outputs of the analyses, like emissions impacts. The reviewer encouraged scenario analyses where it is asked what needs to happen to achieve a climate goal, like fully zero-emission vehicles (ZEV) in HD applications by 2050. The reviewer asked if there is any scenario where this might be even remotely feasible, and stated that this could be assessed using these tools.

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

Reviewer 1:

The reviewer indicated that the project appears to be on track to meet all milestones. The reviewer mentioned that the modifications to ADOPT have enabled Class 8 tractor vehicle choice modeling in a similar fashion to the LDV methodology (as targeted in the approach), and that further research has identified a potential "next

group" to add to the model (Class 4-6). The reviewer added that TRUCK modifications have expanded its flexibility to continue as a comprehensive MD and HD benefits analysis tool until ADOPT is fully set up. The reviewer noted that the team has completed the 2020 benefits analysis, including all of the inter-office coordination on input assumptions (VTO and Hydrogen and Fuel Cell Technologies Office [HFTO]) as well as the modeling and validation of results. The reviewer remarked that this is a substantial accomplishment, given the amount of model improvement and modification that is going on in parallel.

Reviewer 2:

The reviewer noted the project has made good progress toward overall project goals, with numerous accomplishments presented within the project's Fiscal Year (FY) 2020 analysis results.

Reviewer 3:

The reviewer observed that the project team made very reasonable assumptions given limited data.

Reviewer 4:

The reviewer stated that progress appears to be on track, and that interesting scenario results were presented.

Reviewer 5:

The reviewer indicated that the project is on track to update the MD/HD capabilities of ADOPT. The reviewer added that the ability to run LD and HD scenarios in the same interface, generate consistent LD and HD benefits analysis, and improve the quality of the MD/HD results by adding additional market segments is a significant accomplishment. The reviewer reported that other project goals, including maintaining and enhancing legacy models and generating benefits analysis results, are on track and are generating significant improvements.

Reviewer 6:

The reviewer noted that the project team has made good progress to expand the MD and HD segments of the TRUCK and ADOPT models, and that the focus on specific market segments as a pilot study is a good choice. The reviewer noted that there is documentation of model updates, but that analysis from the models is ongoing and the scope has shifted given the administration's priorities.

Reviewer 7:

The reviewer remarked that progress is on track and looked forward to the draft technical paper describing MD/HD ADOPT updates and enhancements. The reviewer noted the following and asked the questions below:

- Slide 10 refers to the validation of results. Please expand on the extent of the validation and the process for validating. Is there a comparison to real-world data for validation purposes?
- Slide 11 shows sources of data for Class 4–8 adoption rates, but these sources are old. Are there more recent data on which to assess adoption rate in the MD and HD segments?
- Slide 14 shows an inflection near 2040, later described as related to the hydrogen (H_2) fuel price. Please add this explanation to the report.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer indicated that the modeling team has experience from other vehicle choice models and has partnered with the Bioenergy Technologies Office (BETO) and HFTO to incorporate technology parameters. The project is also part of other, broader HDV efforts.

Reviewer 2:

The reviewer observed great collaboration.

Reviewer 3:

The reviewer remarked that there are good collaboration partners, including 21st Century Truck Partnership stakeholders.

Reviewer 4:

The reviewer observed that the project is inherently deeply collaborative, requiring the input of DOE's technology program managers, as well as of DOE partnerships. The reviewer added that the performers are clearly coordinating effectively considering progress to date.

Reviewer 5:

This reviewer reported that the project represents collaboration within DOE Sustainable Transportation units—VTO, Hydrogen and Fuel Cell Technologies Office, and Bioenergy Technologies Office—and also represents a connection to the 21st Century Truck Partnership.

Reviewer 6:

The reviewer stated that the team has regular meetings with collaborators and solicits input. It was somewhat unclear to the reviewer, however, what the connections are between this effort and others in the MD and HD spaces, including other scenario modeling, adoption modeling, and improving cost and other assumptions.

Reviewer 7:

The reviewer noted that this project would not be successful without tight integration and collaboration with VTO, HFTO, and BETO Program Managers and what can, at times, be somewhat conflicting goals in terms of market penetration. The reviewer remarked that the National Renewable Energy Laboratory (NREL) team expertly walked this line for the 2020 analysis. The reviewer remarked that it would be interesting if the team could do scenarios for each office's "dream" case, rather than trying to balance all of the offices' targets. The reviewer reported that the likelihood of simultaneous success for the three offices' competing long-term MD and HD goals—full electrification (VTO), an H_2 economy (HFTO), and biodiesel/other (BETO)—is slim.

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

Reviewer 1:

The reviewer noted that the planned future research is logical and has clear decision points.

Reviewer 2:

The reviewer indicated that the presenter shares a clear and thorough description of appropriate future research, with a recognition of data availability weakness concerns.

Reviewer 3:

The reviewer indicated that the specific future tasks were laid out by year in a clear manner. The reviewer observed that further research into the various MD and HD segments is valuable, but that the importance of this work to long-term decarbonization analysis is unclear. The reviewer encouraged more policy scenarios integrated with technology.

Reviewer 4:

The reviewer asked, regarding benefits analysis, what the economic/policy conditions under consideration are. The reviewer asserted that there are a couple of possible policy impacts (and there is probably more guidance with administration priorities), but that the economic condition models are a bit more uncertain. The reviewer asked if these conditions focus on the rate at which technologies improve, costs fall, or something else. The reviewer added that these are also important to include for the FY 2022 scenario developments. When it comes

to modeling, the reviewer asked if there are opportunities to bin similar vehicle types into categories to streamline the model expansion process.

Reviewer 5:

The reviewer expressed concern regarding the limited data availability that was noted, which could be a big barrier to the success of this project.

Reviewer 6:

The reviewer encouraged more details on the factors affecting adoption rate for the new technologies model and the cost trends that could influence adoption.

Reviewer 7:

The reviewer started that the remainder of FY 2021 tasks is logically mapped out, although it is not clear how the team plans to balance all three offices' unique (and not always entirely overlapping) approaches to decarbonizing the MD and HD space. As mentioned elsewhere in this review, the reviewer suggested separately modeling each office's approach, assuming that the three have not collaborated in terms of mapping out different modes or truck types. The reviewer added that the team has incorporated an appropriate decision point regarding the development progress of ADOPT, at which point TRUCK will continue being used if ADOPT is not ready later in FY 2021.

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

Reviewer 1:

This reviewer commented that the researcher presents a clear correlation between project activities and DOE VTO Analysis goals.

Reviewer 2:

The reviewer stated that the modeling approach is already in use for LDVs and could be integrated into broader analyses of transportation emissions.

Reviewer 3:

The reviewer indicated that the PIs provided a slide explicitly cross walking the goals of their project to the Vehicle Analysis Program's overarching goals. The reviewer reported that the project aims to improve VTO's suite of modeling tools (specifically TRUCK, HDStock, ADOPT) to enable more accurate and comprehensive assessment of the potential benefits from broader VTO technology programs.

Reviewer 4:

The reviewer noted that the combination of FASTSim and ADOPT is beneficial for multiple aspects of techno-economic modeling.

Reviewer 5:

The reviewer observed that this is a good study of relevant alternative technologies to support decarbonization in the MD and HD truck sectors.

Reviewer 6:

The reviewer mentioned that the project has high relevance to VTO priorities. Generally, the MD and HD sectors need more attention, and the focus here on benefits analysis will help move things forward.

Reviewer 7:

The reviewer indicated that this work is directly relevant to DOE objectives—estimating the benefits of technological investments through energy and emissions savings.

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

Reviewer 1:

The reviewer indicated that the project supports multiple modeling efforts, and has ambitious goals for improving the scenarios analyzed.

Reviewer 2:

The reviewer noted that the staff resources are sufficient and fully capable of completing the work, and added that both PIs have years of experience in these specific models and VTO benefits analysis more generally.

Reviewer 3:

The reviewer had no additional comments on resources as the budget seems sufficient.

Reviewer 4:

Given the diversity of this sector, the reviewer suggested that fleshing out the details across segments is a big task that likely warrants the high cost.

Reviewer 5:

The reviewer observed appropriate resources.

Reviewer 6:

The reviewer noted sufficient resources for the project to achieve its stated milestones in a timely fashion.

Reviewer 7:

The reviewer remarked that several barriers exist but do not appear to be related to resources. The reviewer suggested more collaboration with industry, including technology developers, to address the need for additional information related to cost-effective solutions.

Presentation Number: van035 Presentation Title: Assessing Vehicle Technologies Benefits in a Transportation Energy Ecosystem Principal Investigator: Vincent Freyermuth (Argonne National Laboratory)

Presenter

Vincent Freyermuth, Argonne National Laboratory

Reviewer Sample Size

A total of seven 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.

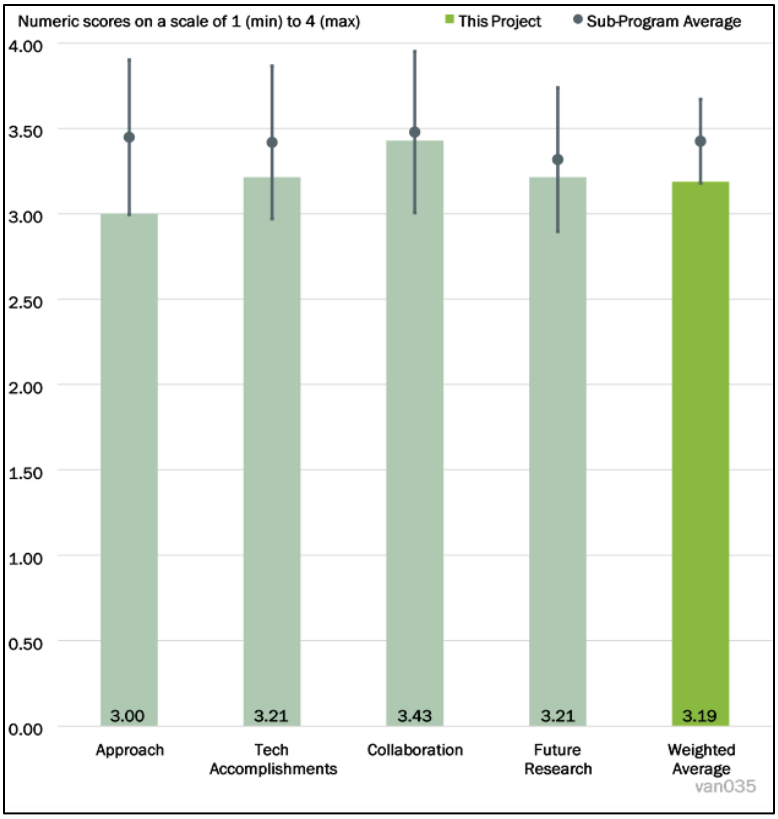

Figure 8-4 - Presentation Number: van035 Presentation Title: Assessing Vehicle Technologies Benefits in a Transportation Energy Ecosystem Principal Investigator: Vincent Freyermuth (Argonne National Laboratory)

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

Reviewer 1:

The reviewer commented that the approach was clearly described and appropriate to the task. The reviewer remarked that the use of the Planning and Operations Language for Agent-based Regional Integrated Simulation (POLARIS) model suits the analysis objectives, and that the selection of vehicle and powertrain configurations are appropriate for the MD and HD truck applications noted. The reviewer observed, that while too early for large-scale deployment, consideration of FCEVs would be appropriate, and suggested it as a future addition, recognizing that this is not an issue for plug-in charging infrastructure.

Reviewer 2:

The reviewer indicated that the POLARIS model is very valuable for understanding the broader system-level effects and network interactions. The reviewer added that the main question would be if the level of detail and computing resources needed are worth the added granularity, especially as the results might be city specific.

Reviewer 3:

This reviewer described the project as well designed. Regarding objective 2—EV Penetration and Utilization of Charging Stations—the study's definition of "Street Charging" does not seem to relate to real-world charging application or current charging infrastructure proliferation.

Reviewer 4:

The reviewer stated that both objectives—MD/HD cost of driving minimization impact to market share and PEV penetration impact to charging stations—utilize robust methodologies. The reviewer suggested, however, that the framing and approach of the PEV penetration impact work led to somewhat less interesting results. The reviewer noted that the outcomes of constrained, compared to unconstrained, charging align with expectations. The scenarios of low/high ownership and home chargers add little nuance to our understanding of penetration and charging dynamics.

Reviewer 5:

The reviewer stated that the model includes good data on energy consumption for different vehicle types using Autonomie. The reviewer suggested that a weakness of the model is the lack of detail on the charging speed, which would have a substantial impact on the cost of charging, but also may be extremely relevant for drivers (especially commercial drivers). The reviewer remarked that a queuing function to schedule charging at public stations would help with some modeling of the electricity load, but the way that costs are calculated does not incentivize any fast charging, which does not seem to match with observed behavior. The reviewer suggested that because the objective of this work is to examine how charging contributes to an overall energy system, it would be useful to adapt the model to look at different charging speeds, especially for public charging.

Reviewer 6:

The reviewer said that, as the presenters noted, the research involves a large number of simulations, which is computationally quite expensive. However, the reviewer remarked that some of the main results from these simulations are somewhat intuitive, so it is unclear what new insights are being gained from these exercises. The reviewer suggested that concluding that home charging is the most desirable alternative for EV owners, for example, and that, when constrained, those drivers will charge out of home is not particularly surprising. The reviewer raised concerns about the benefits of these exercises given the computational cost. The reviewer added that there did not appear to be a choice model backend to the model, which is problematic in terms of modeling adoption patterns. Also, the reviewer noted that there are limited behavioral aspects in the simulations, and that missing these aspects may significantly limit the validity of the simulation results.

Reviewer 7:

The reviewer stated that the project appears to be targeting a “micro” VTO benefits analysis, where rather than using nationally representative drive cycles to estimate energy and costs, the team is using simulated drive cycles in Chicago. The reviewer mentioned that the approach to meeting the main problem statement and questions (Slide 3)—use an agent-based, high-resolution model (POLARIS) to simulate “real-world” behavior on a micro-scale—is reasonable. The reviewer added that the team uses Autonomie to generate different technology impacts by vehicle mode/type, which allows them to penetrate that micro-market and assess the energy and cost impacts.

The reviewer suggested that the steps following the generation of energy and cost impacts for Objective 1 are not as well reasoned and may not be representative of how fleets make purchase decisions. The reviewer indicated that the approach takes the model outputs and generates an “optimum powertrain distribution” based entirely on minimizing cost (i.e., vehicle purchase based entirely on an estimated cost of driving). The reviewer suggested that the issue is that this cost of driving was calculated based on a single route and duty cycle—some fleets purchase vehicles for dedicated routes and duty cycles, but most require some level of mission flexibility and would not buy, for example, a Class 8 electric refuse truck because it is the cheapest to operate on a specific 25-mile route. The reviewer observed that flexibility is critical for fleets, particularly when vehicles are in and out of the shop frequently (need a substitute while out) and/or routes change. When it comes to Objective 2, the reviewer highlighted that the approach—run an unconstrained scenario to inform

charging infrastructure deployment, then run a constrained scenario with that infrastructure in place—is reasonable. The reviewer recommended that the team replace the somewhat vague "Machine Learning for Energy Consumption" step description with a more informative description.

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

Reviewer 1:

The reviewer said that the milestones are on track, and valuable technical progress has been made. The reviewer added that the light-duty (LD), MD, and HD results are interesting and make an important contribution.

Reviewer 2:

The reviewer asserted that both objectives—MD/HD cost of driving minimization impact to market share and PEV penetration impact to charging stations—are on track, and initial findings are interesting. The reviewer reported that the barriers are noted and, based on current progress, are likely to be overcome.

Reviewer 3:

The reviewer noted that technical tasks appear to have been well implemented.

Reviewer 4:

The reviewer indicated that the team has produced some estimates of vehicle adoption, and has established some assumption frameworks about the availability of at-home and public charging stations. However, the reviewer noted that the model of vehicle shares by fuel type is dependent on a simplified cost model that does not account for fast charging or other non-energy costs (or benefits) associated with EVs. The reviewer added that the model for the charging network does not include a time resolution, either for charging speed or for scheduling the charging of multiple vehicles looking to use the same charger. The reviewer observed that a queuing protocol was mentioned, but that additional details were not provided about how cars would make use of the shared resources.

Reviewer 5:

The reviewer mentioned that it would be interesting to get a broader view of the forces driving change in this market, and that considerations are given to regulatory drivers, policy, economics of technology advancement, TCO, or other. The reviewer added that charging categories were described as home and street charging, but noted that there are other categories that could be considered separately, such as workplace charging, fleet-domiciled vehicle charging, public DC fast charging, etc., to provide greater fidelity to the charging scenarios considered. The reviewer remarked that Slide 21 mentions that the share of highly electrified powertrains could be higher than assumed in previous studies and suggested that an explanation of the reasons why would be helpful. The reviewer encouraged the team to clarify the battery cost assumptions and forecast for battery cost decreases over time (based on volume increases or technology advancements).

Reviewer 6:

The reviewer stated that the team has successfully met past milestones and is on track to meet the remainder for both objectives. Regarding Objective 1, the reviewer suggested that there should be more explanation around the assumed vehicle class composition and simulated drive cycles in order to answer whether it is worth all of the additional computational power to generate and simulate these scenarios rather than simply relying on nationally representative values. The reviewer added that agent-based models like these provide an incredible amount of resolution in exchange for an incredible amount of input data. The reviewer suggested that, if validated and vetted input data are not available to fuel such a model and, thus, generating the data will be based on national averages, it is hard to see the added value of such a modeling framework. The reviewer

suggested that additional thought or research could be dedicated to fleet and vehicle-miles traveled (VMT) distributions, and to the drive cycles. The reviewer said that there is also some overlap here with the comments on the approach above, but that the "share of electrified powertrains" based on cost-of-driving (Slide 10) is likely not a particularly accurate estimate of real-world response to the model's cost outputs. The reviewer reiterated their earlier point that fleets make purchase decisions based on their entire operations, not on single trips or routes. The reviewer suggested that the team should also include backup slides with the most important assumptions clearly displayed, e.g., battery cost projections for low and high technology cases. Regarding Objective 2, the reviewer reported that results of this analysis were fascinating, and that seeing the model respond to public charging constraints (agents "deciding" to charge at home rather than detour) was a helpful insight.

Reviewer 7:

Solid progress has been made, but it appeared to the reviewer that there is significant future work required and only one-third of the project budget remaining.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer reported good collaboration and coordination.

Reviewer 2:

The reviewer indicated that there is a good collaboration with national laboratories, the 21st Century Truck Partnership, and others.

Reviewer 3:

The reviewer commented that the collaboration across labs and the coordination with stakeholders is evident.

Reviewer 4:

The reviewer said that the cooperation and collaboration are outstanding as they include a diverse use of inputs and numerous stakeholders. The reviewer suggested a dialogue with the work at Pacific Northwest National Laboratory (PNNL) on charging availability (EVs at Scale).

Reviewer 5:

The reviewer observed that the team has some good collaborations with other organizations working to electrify the HD vehicle sector. However, the reviewer remarked that some additional partnerships, perhaps with local utilities, would be helpful if the goal is to work on transportation within the electricity/energy ecosystem. The reviewer mentioned that understanding the network of transmission lines and distribution feeders within the region studied is extremely important.

Reviewer 6:

Only project collaboration with the 21st Century Truck Partnership was observed by this reviewer; future work should seek to collaborate with other academia or lab teams.

Reviewer 7:

The reviewer stated that there does not appear to be much collaboration with partners in the MD and HD modeling, aside from pulling some input assumptions from DOE staff. The reviewer noted that the collaboration with NREL (Electric Vehicle Infrastructure Projection Tool [EVI-Pro]) appears to be working quite well and is producing interesting technical results.

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

Reviewer 1:

With respect to Objective 1, the reviewer commented that future research is logically planned out, and that the team's aim to compare results of the relatively simplistic cost of driving market penetration models with standard VTO tools (e.g., TRUCK and ADOPT) is good. When it comes to Objective 2, the reviewer reported that future research includes several important considerations. The reviewer reiterated that the team should not use the term, "machine learning [(ML)] models," as a description for a process (as this could mean anything from fitting a trendline to implementing a neural network).

Reviewer 2:

The reviewer noted that there is a good plan for future research, particularly for the analysis of individual classes and applications, and the comparison of results with market penetration predictions. The reviewer recommended that in future work the team should consider workplace charging as separate from street or public charging.

Reviewer 3:

Proposed future research seemed significant to this reviewer and presents many variables to add to the study. Researchers should consider utility-provided load management scenarios in future work.

Reviewer 4:

The reviewer observed that the proposed future research seems appropriate. The reviewer encouraged more work on charging station type, location, and usage across MD and HD segments. The reviewer stated that the home charging piece is the most interesting, and wondered if the installation cost of home chargers matters, and if anything can be learned from these results from a policy perspective.

Reviewer 5:

The reviewer indicated that, for the MD and HD work, the proposed future research is well reasoned and planned. The reviewer added that, for EV penetration work, the proposed future research is similarly logical. However, the reviewer highlighted that the incorporation of behavioral models and station queuing emphasis, while important work, is predicated on a dataset and framing that seem slightly limited. The reviewer suggested questions that the researchers may want to ask: For example, how would a decision-maker interpret the results of this work for planning purposes? In a constrained low home charging situation, where do owners opt to charge? In turn, what is the feedback loop of charging availability on PEV purchasing?

Reviewer 6:

The reviewer observed that the project has produced some results regarding the possibility for fleet electrification, but that, overall, the results for the energy system services side are still somewhat lacking, and the path forward suggests using some workarounds to get around some fundamental challenges of the approach. The reviewer suggested that charging speed is very important to both the cost of charging and the impact on the electricity system, but noted that it is not included in the current model. The reviewer added that the move to include queuing is important to accurately estimate how charging infrastructure could be shared, but that it does not address the challenges associated with providing fast charging access at scale, especially if commercial vehicles are included.

Reviewer 7:

The reviewer expressed concern that the proposed future work might take longer to implement than the 1-year time frame left as it will involve considerable computational power as well as new, complex logic incorporated into the simulations.

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

Reviewer 1:

The reviewer stated that the researcher presents clear correlation between project activities and DOE VTO Analysis goals.

Reviewer 2:

The reviewer stated that the questions this project aims to address are important, as local impacts to electricity grid infrastructure could have a substantial impact on the cost or availability of fast charging resources.

Reviewer 3:

The reviewer said that, yes, the project does in that it evaluates the impacts of existing VTO technologies.

Reviewer 4:

The reviewer responded that the project supports the objectives as stated on Slide 3.

Reviewer 5:

The reviewer asserted that the project has high relevance and uses a framework that allows for a detailed analysis of emerging vehicle modes and use patterns. However, the reviewer commented that the direction going forward should continue to carefully examine the project relevance. The reviewer wondered if other factors beside operating cost, alone, could influence route choice, and stated that it is unclear where policy fits in and how exactly the scenarios translate to the real world. The reviewer also wondered how battery size, range, and other vehicle attributes could play into the results on MD and HD. The reviewer cautioned that these could change quite a bit in the future scenarios.

Reviewer 6:

The reviewer said that, yes, assessing benefits of VTO investments in more nuanced ways is directly in line with DOE objectives.

Reviewer 7:

The reviewer mentioned that the team should clearly identify where this project fits into the VTO Analysis program's specific goals and mission statement to save time for the reviewers. The reviewer highlighted some of the language from the Vehicle Analysis (VAN) goals, and how this project fits:

- "Provide critical information and analysis to inform VTO research portfolio planning ... including program benefit estimation." This project appears to be targeted at estimated program benefits, and that is relevant.
- "Provide essential vehicle modeling and simulation and applied analysis ... integrate multiple models to yield useful findings." (Autonomie, POLARIS, EVI-Pro).

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

Reviewer 1:

The reviewer noted sufficient resources for the project to achieve its stated milestones in a timely fashion.

Reviewer 2:

The reviewer said that the resources are adequate.

Reviewer 3:

The reviewer remarked that no barriers or resource constraints were identified.

Reviewer 4:

The reviewer stated that the PI is knowledgeable about Argonne National Laboratory's (ANL) vehicle analysis tools and appears to be capable of using them to complete the remaining milestone tasks.

Reviewer 5:

The reviewer observed that the project budget is sufficient, but suggested that resources could be redistributed to focus more on the electricity/energy systems side of the challenge.

Reviewer 6:

The reviewer observed that there are sufficient resources for the stated goals, but that the value of these detailed runs needs to be balanced with the high computing effort.

Reviewer 7:

The reviewer reiterated that the only concern is on the timeline. The reviewer noted that it is possible that the resources are sufficient, but also that more time may be needed to complete all of the proposed future tasks. This reviewer also suggested that this might require a slightly larger budget.

Presentation Number: van036
Presentation Title: Distributions of Real-World Vehicle Travel
Principal Investigator: Dave Gohlke (Argonne National Laboratory)

Presenter

Dave Gohlke, Argonne National Laboratory

Reviewer Sample Size

A total of seven 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. 86% of reviewers felt that the resources were sufficient, 14% 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.

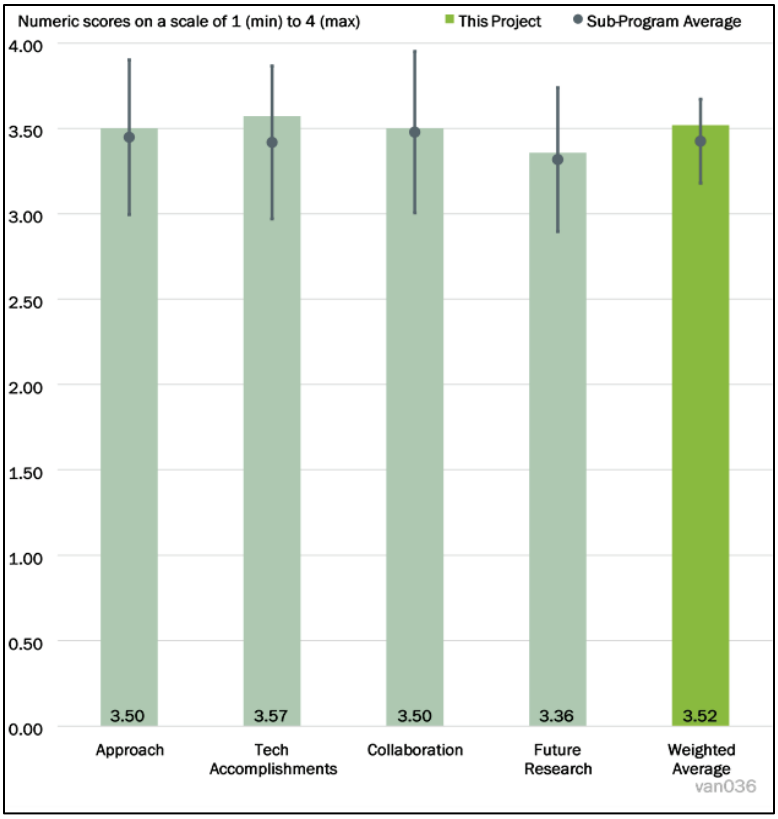

Figure 8-5 - Presentation Number: van036 Presentation Title: Distributions of Real-World Vehicle Travel Principal Investigator: Dave Gohlke (Argonne National Laboratory)

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

Reviewer 1:

The reviewer observed that the work is on track and has clear objectives, and reasonable outputs.

Reviewer 2:

The reviewer stated that the approach is appropriate, as it is starting with LDV, continuing into MD and HD fleet commercial vehicles, and mentioned that the TCO and levelized cost of driving (LCOD) perspective is real.

Reviewer 3:

This reviewer remarked that the research team has made significant progress with a relatively small project budget. Publication of results has not yet occurred; however, the presenter describes clear near-term plans to do so.

Reviewer 4:

The reviewer noted that the project appears well designed and feasible for LD. However, the reviewer said that, given the lack of MD and HD data, it is unclear how much progress can be made in the timeframe.

Reviewer 5:

The reviewer remarked that the study develops and refines methods for quantitative comparisons of alternative vehicle fuel and powertrain technologies, including a novel approach to modeling vehicle scrappage. The

reviewer noted that the robust data on vehicle activity, particularly for MD and HD vehicles and for traffic on local streets, in addition to representative average VMT estimates for ZEVs, are well identified data gaps for travel and emissions modeling. The reviewer observed that it is somewhat unclear how this study addresses these barriers to VMT data. The reviewer suggested that additional focus could also be paid to how household or sociodemographic characteristics impact LCOD, in addition to emissions impacts for historically disadvantaged communities.

Reviewer 6:

The reviewer stated that there are a lot of interesting data associated with the project. The reviewer mentioned that the results and study for the upcoming Transportation Research Board (TRB) meeting are an interesting start, but future plans remain somewhat unclear. The reviewer suggested that, for the TRB study, it might make sense to look at locations where emissions inspections are required (usually in urban/suburban areas, but not rural, which may be a factor in vehicle age as well). The reviewer noted that finding transaction or sales data seems like a key challenge to estimating how vehicle driving patterns change over the vehicle lifetime.

Reviewer 7:

The reviewer reported that the project goal is to develop more granular LDV operational characteristics (VMT, LCOD, survival) using real-world data, where available, to improve VTO's understanding of how advanced vehicle technologies will enter and impact different segments of the market. The reviewer explained that the approach—using historical NHTS survey data to develop VMT distributions for use in several follow-on analyses—is reasonable, given the fact that NHTS is one of the few public datasets with this level of information about vehicle registrations and operation. The reviewer said that this means the project results will be easy to reproduce. The reviewer cautioned that the downside (noted by the PI in Slide 16) is that it only covers a very limited timeframe (days) out of the year, and it may not be representative of average full-year driver behavior and vehicle operations. The reviewer suggested that the PI/team should consider obtaining at least a year of more granular non-survey data like IHS Polk registrations to validate the VMT distributions presented, particularly because they underpin all of the project's analysis and are being proposed for use in other VTO models and analyses. The reviewer added that there was mention of using additional data sources (Slide 16) and suggested that the PI should explicitly list the sources that were used and generally how the data were fused and/or synthesized.

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

Reviewer 1:

The reviewer reiterated that the project is on track and yielding interesting and valuable results for all portions (VMT, LCOD, fleet metrics, and vehicle survivability). The reviewer highlighted that the survivability graphic is particularly useful and intriguing as it directly notes and addresses challenges and barriers.

Reviewer 2:

The reviewer noted the progress in VMT, LCOD, fleet metrics, and scrappage. The reviewer expressed interest in scenario analysis based on an investigation of variables related to technology deployment, cost down of technology as production volume grows, disruptive technologies as technical breakthroughs are achieved, and the effect of remanufacturing and recycling, etc.

Reviewer 3:

The reviewer stated that significant results are shown from the modeling exercise, in addition to the methods proposed. The reviewer added that more information on the data gathering process and data sources for VMT would be helpful in providing a more robust evaluation of this category.

Reviewer 4:

With a relatively small project budget, the research team has made significant progress from this reviewer's perspective. Publication of results has not yet occurred, but the presenter describes clear near-term plans to do so.

Reviewer 5:

The reviewer mentioned that the project is meeting initial targets for analysis and publications for FY 2021, but future research questions are still a bit undefined.

Reviewer 6:

The reviewer noted that the project is on schedule with all milestones. The reviewer remarked that the main project goal—heterogenous travel behavior characterization, or VMT distributions—appears to have been achieved (Slide 6). The reviewer mentioned that this is a great accomplishment, and should enable the remainder of the project milestones to be reached. The reviewer added that the follow-on analyses using the new VMT distributions are very interesting and relevant to the issue at hand (i.e., the impact of assuming LDV use is homogenous). The reviewer suggested that the LCOD and energy consumption impact analysis seem somewhat simplistic, and that hopefully the LCOD will include maintenance costs for the survivability analysis. The reviewer indicated that the survivability correlation matrix is fascinating, although it would have been beneficial to have more explanation on how the PI intends to develop a scrappage model based on VMT/LCOD, particularly given the data difficulties. The reviewer suggested that it might be interesting to collaborate with NREL on how the heterogenous VMT assumption impacts energy consumption estimates. The reviewer said that the TRUCK model (for MD and HD vehicles) could be a template for the LDV energy consumption impact analysis, as it uses several VMT cohorts, where different powertrains can penetrate each cohort at different rates based on the cost/benefit calculation for that cohort.

Reviewer 7:

The reviewer observed that the progress appears to be on track, and looked forward to seeing the publications. The reviewer cautioned that data availability is a critical barrier, especially for MD and HD, and that the milestones presented did not specify deliverables for LD compared to MD and HD.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer remarked that the project team is well integrated with other partners and projects on TCO and other efforts.

Reviewer 2:

The reviewer noted that the work has already fed into other projects (e.g., TCO), and that there is a clear connection to additional users and audiences.

Reviewer 3:

Cross-lab (ANL, NREL, LBNL, ORNL) coordination and collaboration on this project was described by this reviewer as a strength.

Reviewer 4:

The reviewer stated that a significant number of partner laboratories are identified for the project team, but that no information was provided on specific partner roles and activities.

Reviewer 5:

The reviewer observed that there was not much discussion around how the PI collaborated with other national laboratories, but that many of the results from this project and VAN038 (same PI) are interdependent and involved regular communication with the other labs listed in the quad chart and those on the TCO project.

Reviewer 6:

The reviewer remarked that the collaboration is good. The reviewer encouraged outreach to other industry stakeholders, original equipment manufacturers (OEMs), fleets, industry groups, etc., to keep analysis relevant to the interests of users and to the decision criteria related to forecasting adoption rates of candidate technologies.

Reviewer 7:

The reviewer reported that there are clear inputs into the TCO framework. The reviewer added that the VMT and scrappage assumptions are used in many travel models, and that there may be other potential points of coordination.

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

Reviewer 1:

The reviewer noted that the proposed future research is a logical progression from where the accomplishments left off and follows the plan laid out in Slide 4.

Reviewer 2:

This reviewer stated that proposed future research may benefit to answer more direct policy questions related to encouraging heavy-emitting MD and HD vehicle scrappage turnover.

Reviewer 3:

The reviewer stated that the proposed future research plan addresses a needed gap. The reviewer said that more details on how the research team will approach data acquisition could be provided. The reviewer added that it would be helpful if this project could provide a comparative analysis with other emerging mobility data sources, including location-based services data.

Reviewer 4:

The reviewer observed that the challenges and barriers raised bring up interesting areas for possible analysis, but that the research plans for estimating VMT for HD vehicles and trends that vary with vehicle ownership are a bit undefined.

Reviewer 5:

The reviewer remarked that studying VMT and scrappage is good, as well as MD/HD fleets. The reviewer suggested emphasizing the items noted above regarding remanufacturing, recycling, repair, etc., in the useful life of the vehicle and in the second life of batteries and technologies. The reviewer added that it is important to consider life-cycle analysis (LCA) evaluation of alternative technologies in understanding the economic impact of these technology rollouts.

Reviewer 6:

The reviewer reported that the presentation could have been more detailed in how barriers will be addressed. The reviewer cautioned that, given the project timeframe, waiting for the Vehicle Inventory and Use Survey (VIUS) or other data might not be the best approach.

Reviewer 7:

The reviewer stated that the proposed future research considers barriers and challenges adequately and has an appropriate timeline and plan. The reviewer was especially interested in future work on changes in ownership and, particularly, anything related to alternative powertrains.

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

Reviewer 1:

The reviewer observed that the study outputs support performing robust analysis of the costs of alternative fuel and ZEVs, as well as potentially enhancing existing mobile source activity models.

Reviewer 2:

The reviewer stated that understanding how different types of vehicles are actually driven is important to the overall goal of estimating energy consumption and emissions from the transportation sector, beyond just estimating the makeup of the vehicle fleet.

Reviewer 3:

The reviewer expressed that the project is essential to understanding how new technology will support the ambitions of environmental and economic improvement goals.

Reviewer 4:

The reviewer reported that the project is directly relevant to DOE objectives, and that this work adds nuanced understanding to metrics that are frequently used in modeling and analysis in order to make major technology and public policy decisions.

Reviewer 5:

The project clearly correlates with overall DOE objectives from this reviewer's perspective.

Reviewer 6:

The reviewer asserted that this work contributes important analysis that is needed for a variety of research avenues. The reviewer stated that it would be interesting to see what impacts would result from the addition of newer data that are more representative of future mobility trends, especially because new technology and vehicle applications have the potential to drastically change VMT and scrappage patterns.

Reviewer 7:

The reviewer noted that this work aims to explore one of the key assumptions that goes into all of VTO's energy consumption projection models—annual VMT per vehicle schedules. The reviewer added that it could more clearly pinpoint where advanced vehicle technologies will be most attractive. The reviewer indicated that the fusion of large public datasets will improve VTO's understanding of the LDV market.

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

Reviewer 1:

The reviewer reported that more funding should be directed toward enhancing fleet and activity data for MD and HD vehicles with sufficient spatial and temporal resolution to support analysis of impacts at the community scale.

Reviewer 2:

The reviewer noted that the project has fairly open goals of data analysis and has appropriate resources given overlap with other collaborators.

Reviewer 3:

The reviewer indicated that resources are sufficient for the project to achieve the stated milestones in a timely fashion.

Reviewer 4:

The reviewer mentioned that the PI is capable of achieving the stated milestones.

Reviewer 5:

The reviewer observed that no resource barriers were identified.

Reviewer 6:

The reviewer stated that the resources seem sufficient for the level of analysis and timeframe.

Reviewer 7:

The reviewer remarked that the resources are adequate.

Presentation Number: van038
Presentation Title: The Department of Energy's (DOE) More Comprehensive Total Cost of Ownership (TCO) Franework
Principal Investigator: Dave Gohlke (Argonne National Laboratory)

Presenter

Dave Gohlke, Argonne National Laboratory

Reviewer Sample Size

A total of nine 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. 89% of reviewers felt that the resources were sufficient, 11% 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.

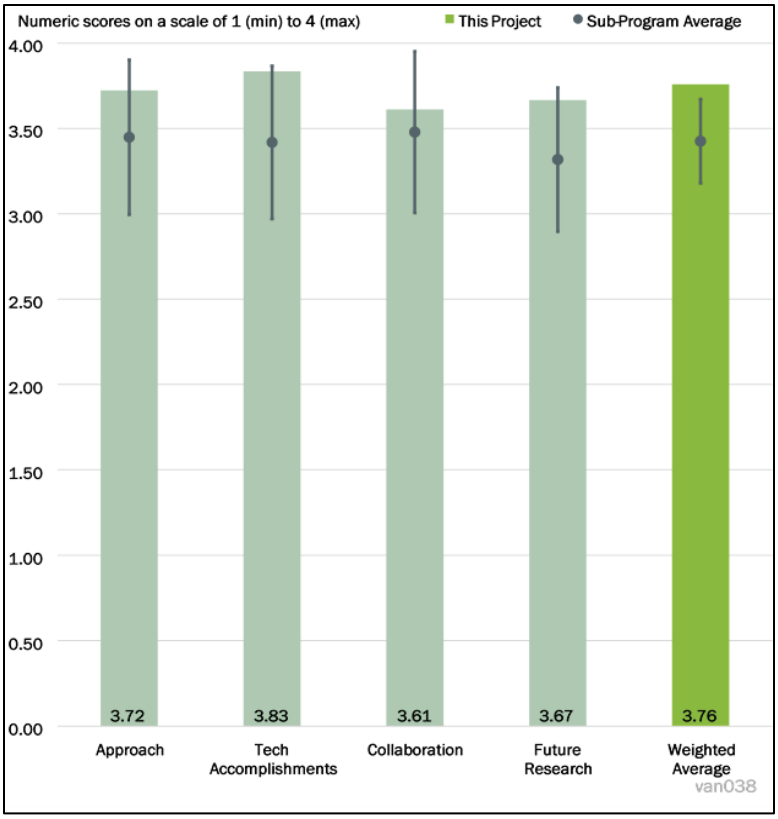

Figure 8-6 - Presentation Number: van038 Presentation Title: The Department of Energy's (DOE) More Comprehensive Total Cost of Ownership (TCO) Franework Principal Investigator: Dave Gohlke (Argonne National Laboratory)

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

Reviewer 1:

The reviewer reported that good, reliable, data-driven TCO analyses are difficult to find. Yet, every policymaker and decision-maker wants to know about it. The reviewer applauded the good work and highlighted that this analysis does an excellent job of breaking down different cost factors and doing so more thoroughly than seen elsewhere.

Reviewer 2:

The reviewer stated that the project has a good approach to TCO modeling and to LCOD for LD, MD, and HD vehicles.

Reviewer 3:

This reviewer noted the research team had a strong approach to addressing technical barriers with a well-designed and well-planned undertaking.

Reviewer 4:

The reviewer observed that the project combined outputs from previous models on the technical side of operating EVs with data about other expenses. The reviewer added that the use of focus groups with industry partners was a good strategy for verifying the data collected for the other factors that go into TCO.

Reviewer 5:

The reviewer mentioned that this approach was well designed and well executed, as it identified barriers and clearly overcame them. The reviewer added that the scope was challenging, yet well prioritized.

Reviewer 6:

The reviewer noted that the project develops and refines a method for assessing TCO of vehicles. The reviewer added that the project provides several important technical contributions related to refining TCO inputs, most notably related to maintenance costs for MD and HD vehicles. The reviewer mentioned that the payload capacity and penalty assessment for zero-emission trucks is also an important contribution. The reviewer said that potential weaknesses are the reliance on modeled outputs and the high variability in fuel/capital costs.

Reviewer 7:

The reviewer agreed that the approach is sound, but hoped that this effort can continue in the future to better capture costs related to future trends in vehicle technology and usage. The reviewer said that, with most of the available data from privately owned ICE vehicles, it will be important to flesh out new cost factors as PEVs gain market share and as batteries, infrastructure and behavior continue to evolve.

Reviewer 8:

The reviewer indicated that the approach to developing a methodology for DOE VTO to compare economics of vehicle operation across multiple technologies is well designed. The reviewer stated that it leverages past DOE VTO work by using the same metrics (TCO and LCOD) and leaning heavily on the substantial repository of past national lab research (i.e., lab collaboration). The reviewer said that the approach includes a wide range of vehicle classes and powertrains over a long timeframe to provide some relative comparisons within and across the entire on-road vehicle fleet. The reviewer noted that the inclusion of all on-road classes is a sizable feat, but that the multi-lab team assembled is likely the best available to investigate. The reviewer observed that data availability issues make it difficult to say that this effort (as stated on Slide 4) was 100% feasible. The reviewer mentioned that, while possible to estimate some of the knowledge gaps, the project approach should have more clearly stated that some of the assumptions would be best guesses based on data that may be outdated, not fully representative, and/or incomplete (particularly the MD and HD components).

Reviewer 9:

The reviewer reported that this project was well organized and well thought through in terms of the technical barriers. The reviewer believed that the largest limitation was in getting better data to improve each of the sub-modules within the overall TCO. To that extent, the reviewer added that the overall framework is rather modular, so the team should be able to quickly incorporate improvements as better data become available. The reviewer indicated that each of the sub-modules has small components that could be improved, such as including vehicle mileage in the price depreciation models (again, limited by data availability).

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

Reviewer 1:

The reviewer applauded the great progress and the launch of the report.

Reviewer 2:

The reviewer explained that the most valuable aspects of this research are those that ensure other parties can utilize the findings of this work beyond VTO staff. This includes publications and development of software tools for third parties to make their own total cost of ownership calculations.

Reviewer 3:
The reviewer noted a good balance of reports, journal publications, and open-source modeling tools that others can use.

Reviewer 4:
The reviewer observed that progress was completed on schedule.

Reviewer 5:
The reviewer stated that the work is on time and largely complete, with reporting remaining.

Reviewer 6:
The reviewer noted that the team conducted industry workshops and delivered a report, software, and a voluminous literature review. The reviewer reported that this project did an outstanding job of meeting milestones and providing valuable deliverables. The reviewer looked forward to seeing follow-on work and decisions that rely on the efforts.

Reviewer 7:
The reviewer stated that the project has produced a significant body of technical reporting, publications, outreach, and tools. The reviewer added that the project team was obviously very productive, given the project timeline. The reviewer suggested that more activity data on MD and HD vocational vehicles would benefit this project.

Reviewer 8:
The reviewer indicated that the project was completed with time to spare, and that the results were recently published in a valuable report. The reviewer added that a literature review and the publicly available tool were also completed. The reviewer remarked that the technical results were presented for several of the cost components, which were interesting additions given the gaps in previous work. The reviewer said that, given that early market entrants and low sample size could skew results for PEVs, it would be helpful to somehow indicate the distribution in these categories for context. For example, on BEV maintenance costs, the reviewer asked how many BEV models are driving the result, whether they are representative of the BEVs on the market today, and if they are applicable to future BEVs.

Reviewer 9:
The reviewer said that the methodology (the metrics for which were included in the TCO calculation) was briefly but sufficiently explained and is more comprehensive than any past effort. The reviewer reported that the team completed a significant amount of work, both a literature review and data analysis, in order to drop data into each of the equation's components. The reviewer stated that the report will be a valuable starting (and perhaps ending) point for many stakeholders working on transportation energy consumption models and others. The reviewer suggested that it would have been helpful to include data sources for the charts and assumptions throughout the presentation. The reviewer added that data are likely the most difficult piece of this project, but that they were not covered in much detail. The reviewer noted that results were presented as if they were nationally representative and comprehensive without specifically offering much supporting evidence. The reviewer indicated that admitting the difficulties upfront (perhaps a table with all of the datasets used and identifying the gaps that were filled with assumptions) would not devalue the project results, but would more accurately communicate how little we actually know about some of these topics. The reviewer stated that VTO could then get a clearer vision of which gaps could be slowly whittled away with research dollars and which need to be filled with scenario analyses. The reviewer added that, in a similar vein, it would be beneficial to include whiskers on some of the bar charts (maybe inner quartile range), if possible, to demonstrate the uncertainty underlying much of this.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer stated that there is excellent collaboration among experts at several national laboratories and emphasized the great work observed.

Reviewer 2:

The reviewer noted good involvement from the project team on research reporting and a relatively small amount of funding spread over a large project team.

Reviewer 3:

The reviewer remarked that there is good collaboration across multiple labs, and that the use of industry workshops was helpful in collecting and verifying the data.

Reviewer 4:

The reviewer remarked that everything seems to be well aligned with regard to the project team.

Reviewer 5:

Solid cross-lab coordination between ANL, Sandia National Laboratories (SNL), LBNL, NREL, and ORNL was noted by this reviewer.

Reviewer 6:

The reviewer mentioned that this work is of interest to many and that the project team had a good representation of several relevant lab groups. The reviewer added that the team collaborated with industry and others via workshops and interviews, which appeared to be an honest attempt to get and incorporate feedback from many different perspectives.

Reviewer 7:

The reviewer observed that this work represents a massive collaboration effort across numerous national laboratories incorporating diverse stakeholders, which is a testament to both the project management and communication abilities of both the performers and DOE.

Reviewer 8:

The reviewer had no concerns with regard to collaboration with this project, although there are fewer collaborators than some longer running projects (hence the "good" rating in Question 5). The reviewer stated that once the Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool gets re-parametrized, a lot of collaboration can be claimed through that tool.

Reviewer 9:

The reviewer encouraged more collaboration with industry and fleet stakeholders. The reviewer stated that this would be a good source of information to address remaining challenges and barriers (Slide 16), especially for understanding cost projections for evolving technology and the economics associated with new technology deployment.

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

Reviewer 1:

The reviewer reported that the project has ended.

Reviewer 2:
The reviewer noted that the project ended March 31, 2021.

Reviewer 3:
The reviewer indicated that the project has ended.

Reviewer 4:
The reviewer reported that the project has ended.

Reviewer 5:
The reviewer said that the project has ended.

Reviewer 6:
The reviewer commented that proposed future research seems broad and should be more defined if additional funding is applied to the work.

Reviewer 7:
The reviewer encouraged continued research toward understanding the economics and potential pathways of technology development. The reviewer stated that of particular interest is the contribution from battery life, including issues such as recycling, remanufacturing, second life reuse, or scrap. The reviewer added that the TCO model can be enhanced by considering operational factors., such as the cost of downtime (including lost revenue and penalties).

Reviewer 8:
The reviewer remarked that no specific steps were identified to address noted data gaps. The reviewer suggested that additional economic barriers for historically disadvantaged communities, including lack of infrastructure or local built environment conditions, should be considered in the context of TCO and LCOD.

Reviewer 9:
This reviewer had no comments.

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

Reviewer 1:
The reviewer noted that the project supports a more robust comparative estimate of alternative fuel vehicle economics.

Reviewer 2:
The reviewer said that this is a good step toward understanding the costs beyond vehicle purchase and fueling that drive decisions in EV adoption, especially for MD and HD vehicles, where there are additional labor impacts on charge time to consider.

Reviewer 3:
The reviewer asserted that this project supports DOE's ability to compare economics of vehicle operation across multiple technologies in a balanced manner.

Reviewer 4:
The reviewer mentioned that this project supports DOE VTO objectives across the board by informing the baseline assumptions for many of the cost/benefit and consumer choice modeling frameworks currently in use. The reviewer added that it also fostered collaboration between several experts across the DOE labs and ensured that results were published and publicly available for all stakeholders (reproducible results that can be built and improved upon).

Reviewer 5:

The reviewer agreed that having a solid model of TCO for various vehicle types is a critical component of other related models that need an estimate of vehicle TCO. The reviewer added that it also serves as a reference for other research by other entities, so there are considerable broader impacts for others to build upon with this model.

Reviewer 6:

The reviewer indicated that this is an essential tool toward understanding the economics of technology advancement and deployment.

Reviewer 7:

The reviewer reported that this work is important across a range of different research avenues and is a great addition.

Reviewer 8:

The reviewer said that, yes, this project is deeply relevant to the objectives of DOE as it fills a large gap in the state of knowledge regarding TCO for vehicles (and does so in a consistent way) and will help improve energy and technology modeling and decision making.

Reviewer 9:

The reviewer stated that, yes, this project is relevant because it addresses the barrier of lack of information on TCO. using a rigorous, data-driven analysis.

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

Reviewer 1:

The reviewer indicated that funding appears to be insufficient to support future work as this is reported to be the end of this project's funding, with no continuing work planned.

Reviewer 2:

Sufficient project resources were observed by this reviewer to achieve the stated milestones in a timely fashion.

Reviewer 3:

The reviewer stated that the funds supported a large project team and yielded a significant body of work.

Reviewer 4:

The reviewer noted that the project budget was justified by the number of collaborators.

Reviewer 5:

The reviewer reported that the team is capable of completing the work; it is published and done.

Reviewer 6:

The reviewer remarked that this project was completed on schedule and met the desired tasks. The reviewer added that it appears that the budget was adequate.

Reviewer 7:

The reviewer said that the resources were used within the project timeframe and that the project was completed on time.

Reviewer 8:

The reviewer observed that the resources for the project were appropriate.

Reviewer 9:

The reviewer had no comments.

Presentation Number: van039
Presentation Title: Electric Vehicles at Scale
Principal Investigator: Michael Kintner-Meyer (Pacific Northwest National Laboratory)

Presenter

Michael Kintner-Meyer, Pacific Northwest National Laboratory

Reviewer Sample Size

A total of eight 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.

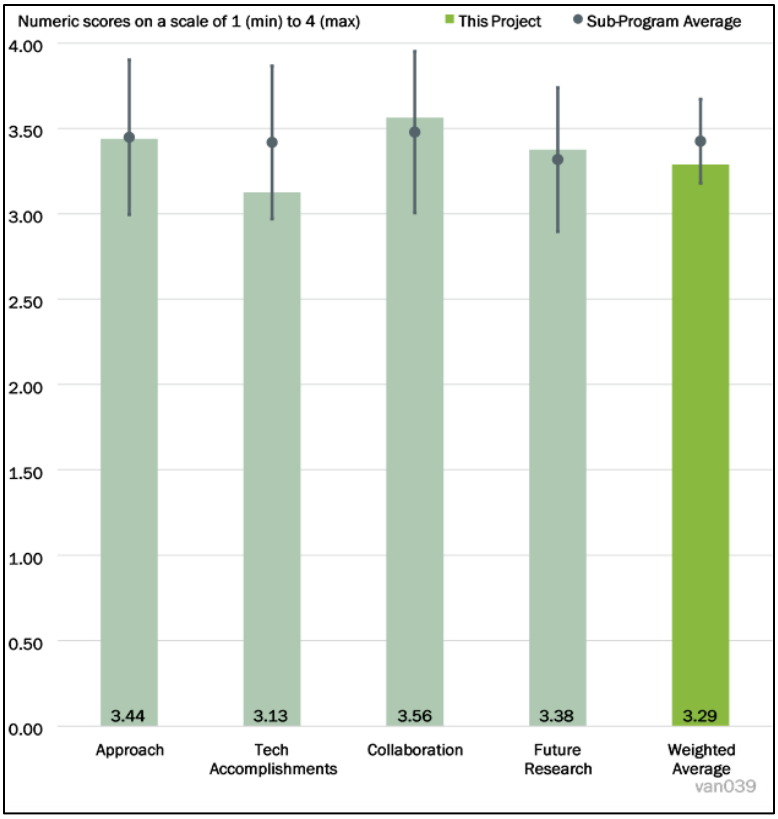

Figure 8-7 - Presentation Number: van039 Presentation Title: Electric Vehicles at Scale Principal Investigator: Michael Kintner-Meyer (Pacific Northwest National Laboratory)

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

Reviewer 1:

The reviewer highlighted that this is a detailed and deeply granular project, and that the approach is fascinating and well designed.

Reviewer 2:

The reviewer stated that the study develops a robust and novel approach to linking EV deployment with grid operations and electricity distribution. The reviewer added that the outputs of this work will potentially be of great value to utilities and support broader goals for developing infrastructure to meet electrification goals.

Reviewer 3:

The reviewer noted a well-designed and feasible project. The socio-economic EV adoption forecast methodology addresses barriers by providing household-level and feeder-level forecasts.

Reviewer 4:

The reviewer indicated that the approach is relevant to the study in California, and suggested that it may be helpful to expand to investigating trends, barriers, and enablers in other states.

Reviewer 5:

The reviewer noted that the project is well positioned to model impacts on the grid distribution feeder level. The reviewer remarked that some additional modeling may be necessary to estimate charging behavior. The reviewer suggested that the project team should also be cognizant of any broad differences in the distribution systems of high-income neighborhoods, where EV adoption rates have been higher than in lower income neighborhoods or neighborhoods with more multifamily housing. The reviewer highlighted that the differences in population density could prove more challenging to the grid than would be captured in models that estimate adoption based on historical trends, which cover a time period when most EV early adopters have been higher income and have owned homes.

Reviewer 6:

The reviewer indicated that the overall project approach—develop an EV adoption model that can feed a grid model to determine EV impacts on local grid infrastructure and use that modeling framework to explore the potential value of smart charging management—is well designed. The reviewer added that the grid impact exploration is feasible, given PNNL's expertise in this space as well as the large amount of data they have available on grid infrastructure. The reviewer noted that building an EV adoption tool that operates at the distribution-circuit and customer levels to get more localized load curves seems somewhat less feasible. The reviewer suggested that the availability of high-quality data that meet the needs of such a model (e.g., household income, vehicle registrations, home charging capability, and all by home) would be a limiting factor. The reviewer asserted that it is not clear that the model development aspirations are feasible without making quite a few assumptions, which works against the main stated goal of the tool to minimize uncertainty. The reviewer posed a few key unanswered questions:

- How does the tool forecast EV adoption without a forecast of household income, home prices, home characteristics, and vehicle registrations? Does it assume that they all remain at historical levels?
- How does the tool estimate EV adoption from household income and charging availability? What mathematical relationship is assumed?
- Given a set "ZEV" goal, how does the tool determine which neighborhoods adopt the EVs? What if all of the EVs needed to meet a state goal are sold in a single high-income Zone Improvement Plan (ZIP) code?

The reviewer suggested that it might have been less work and perhaps more feasible for the team to use existing VTO models to estimate local EV adoption. The reviewer stated that if the tool is actually intended to be a method for distributing a pre-conceived number of EVs, per the language in Slide 7 about forcing California Energy Commission (CEC) and Southern California Edison (SCE) sales goals and calibrating the model to other targets, then these gaps are less relevant, but that the team should have clearly stated that intention up front if it is the case.

Reviewer 7:

The reviewer thought that, in general, this was a good project, but cautioned against making future projections based on current adoption trends. The reviewer noted that most EVs have been adopted by wealthier car buyers, and that future adoption patterns may be very different from historical adoption patterns. The reviewer stated that things like whether they have a dedicated parking spot or if their neighbors bought an EV may be better predictors than income in the future, and encouraged these sorts of considerations to be incorporated into future analyses.

Reviewer 8:

The reviewer noted that this line of inquiry is important and the approach is novel. The reviewer remarked that there is some question as to whether the historical data used to inform the adoption model will be adequate for longer term scenarios, where adoption patterns and behavior could be very different. The reviewer explained that the scenarios may be able to account for the uncertainty, but was not sure if that is the case. The reviewer added that, if using current data that is largely based on wealthy early adopters, then there might be some equity concerns in that this approach may in fact help to improve distribution first in the places that reflect patterns from primarily early adopters. The reviewer suggested that perhaps there is an opportunity to consider how policy could change adoption behavior. The reviewer stated that it is also unclear if the project was well designed to be able to inform utilities nationally because it might not work for other locations and utilities.

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

Reviewer 1:

The reviewer stated that the team displayed good progress toward study goals and development of the EV adoption model, and that the open-source tool development sounds promising, particularly regarding the linkage with the project partner.

Reviewer 2:

The reviewer asserted that the technical modeling is great and appreciated the local level insights, e.g., which transformers may blow sooner rather than later due to local EV adoption.

Reviewer 3:

The reviewer noted some challenges associated with non-disclosure agreements (NDA) and data sharing agreements, but that contracts have been signed. The reviewer indicated some preliminary estimates of transmission line/other hardware failures as a result of EV adoption.

Reviewer 4:

The reviewer observed that the first milestone was met, but that the remaining milestones were all delayed due to NDA signing delays. The reviewer said that the team appears confident that the work can be completed by the project end date (September 2021), but that there seems to be a substantial amount of work remaining. The reviewer added that the technical accomplishments so far are good. The reviewer indicated that the case study demonstrates on a basic level how the EV adoption model works and how it reports results, although more explanation is warranted, as discussed in the approach question response. The reviewer commented that more detailed results are shown for the grid impacts, which are promising and represent clear steps toward meeting the future milestones.

Reviewer 5:

Although challenges pertaining to NDA processing have delayed completion of project deliverables, this reviewer reported that technical accomplishments and progress have been made with regard to the New High-Resolution Socio-Economic LDV EV Adoption Model.

Reviewer 6:

The reviewer mentioned that the progress is behind schedule due to delays in signing NDA with the California Department of Motor Vehicles (DMV) and SCE.

Reviewer 7:

The reviewer observed that this project has experienced significant delays, which seem to be mostly external. The reviewer stated that there is some question as to whether all project deliverables can be completed on time given the compressed schedule.

Reviewer 8:

The reviewer said that the project has been delayed due to progress on NDA. The reviewer noted that it was signed in May, but that the project is behind by approximately 3–4 months. The reviewer added that, while the performers have demonstrated that they will be able to deliver quality work and make up for some lost time, they considered the delays as a barrier to a higher rating.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer stated that there is clear evidence of strong coordination and collaboration between the lab and a utility partner.

Reviewer 2:

The reviewer mentioned that SCE and PNNL appear to be working quite closely on this project. The reviewer reported that SCE is providing the grid data required to complete the analysis, and PNNL is building an open-source tool that could potentially improve its EV forecasting.

Reviewer 3:

The reviewer remarked that there is good collaboration.

Reviewer 4:

The reviewer indicated that the team is working closely with the utility, which enhances the impact of this research. The reviewer added that the open-source tool will help make the research accessible more broadly. The reviewer suggested that there may be other avenues for coordination with other research groups doing EV adoption forecasting.

Reviewer 5:

The reviewer applauded the excellent work in building a relationship with SCE and encouraged more concretely tying/translating it to smaller utilities. Although a plan is discussed in future work, this reviewer expressed interest in seeing specific utilities and relationship building.

Reviewer 6:

The reviewer stated that the project represents a high-value private sector data provision partnership that requires strong coordination and relationship building. VTO coordination with the Office of Electricity would be beneficial for this project.

Reviewer 7:

The reviewer noted the good relationships with SCE, and some challenges getting other California data that impacted the project schedule. The reviewer added that having access to feeder data is helpful to verify the results and compare to actual infrastructure.

Reviewer 8:

The reviewer suggested considering additional collaboration partners in order to gather additional input and remove possible bottlenecks or constraints for input information and data. The reviewer encouraged broader regional coverage outside of California as additional inputs.

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

Reviewer 1:

The reviewer noted that the proposed future work appears to be well thought out and adequate.

Reviewer 2:
The reviewer said that the proposal of technology transfer and making the work more accessible to multiple utilities, including scaling the methods and approach to smaller public utility districts (PUDs), is fantastic.

Reviewer 3:
This reviewer concurred with the presenter's oral comments that a version of this model could ideally be developed via technology transfer so that utilities of all sizes could take advantage of the learnings and apply them to their grids.

Reviewer 4:
The reviewer remarked that future work might also consider the value of additional distributed storage, vehicle-to-grid integration, or managed public charging on grid operations and costs. The reviewer suggested that MD and HD vehicle adoption, particularly in fleets, should be a key focus of future work, given existing and planned targets in the region. The reviewer added that it would be useful to see an evaluation of the impacts of distributed storage investments either behind or in front of the meter on EV adoption.

Reviewer 5:
The reviewer stated that the approach is effective and accounts for possible variability in the future scenarios. The reviewer mentioned that the timeline might be a bit compressed, given the holdup from the data NDA challenges.

Reviewer 6:
The reviewer reported that future research aligns with the remaining milestones, and jumps off from the completion into a technology transfer stage. The reviewer said that it seems like the EV adoption tool may be in need of more development, and suggested that the team should consider working with other VTO modelers to further improve the methodology.

Reviewer 7:
The reviewer indicated that future plans would help address some constraints on the work to date. The reviewer suggested that additional consideration be given to workplace charging and domiciled charging for last-mile delivery applications. The reviewer posed the following questions:

- How does the study recognize any effects of the possibility that BEVs become the low-cost consumer choice at the end of the decade?
- Has consideration been given to an LCA approach for evaluating alternative technologies?
- What about policy implications for ICE bans, ZEVs, etc.?

The reviewer noted that mention was made about a lack of information regarding consumer charging preferences. The reviewer suggested referring to the Fuels Institute study and other references included in the report, which may be of some assistance.

Reviewer 8:
The reviewer reported that future research goals are logical next steps, but that it is somewhat unclear how the items align with the milestones laid out, especially considering the project delays.

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

Reviewer 1:
The reviewer remarked that understanding EVs at scale impact on the distribution grid across the United States correlates directly to DOE objectives of ensuring grid reliability.

Reviewer 2:
The reviewer reported that the project is well aligned with reducing barriers and identifying infrastructure upgrades necessary to enable high rates of electrification in surface transportation systems.

Reviewer 3:
The reviewer mentioned that this work expands VTO's limited research into grid-side impacts of and barriers to EV market penetration.

Reviewer 4:
The reviewer said that the distribution system planning practices do not reflect the local characteristics of EV adoption, and that this modeling initiative is the first that addresses this need.

Reviewer 5:
The reviewer noted that this work is relevant to objectives.

Reviewer 6:
The reviewer remarked that this project addresses important questions relevant to DOE objectives on EVs and the grid.

Reviewer 7:
The reviewer said that, yes, this work provides data and an approach that is directly relevant to DOE's mission.

Reviewer 8:
The reviewer stated that, while the project is somewhat limited by using historical (first-adopter) data as the model input, the grid modeling is detailed and helps in understanding the infrastructure upgrades necessary to support widespread EV adoption with home charging. The reviewer added that final reports should make note that there may be other impacts depending on EV adoption in higher density neighborhoods with more multi-family housing or public charging infrastructure.

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

Reviewer 1:
The reviewer observed that more funding and time are needed to really build out this approach so that it is broadly applicable.

Reviewer 2:
The reviewer noted sufficient project resources to achieve its stated milestones in a timely fashion.

Reviewer 3:
The reviewer mentioned that significant funding has been awarded, but that extensive data have been acquired and modeling is likely computationally intensive. The reviewer added that the remaining budget seems sufficient.

Reviewer 4:
The reviewer said that the project budget is sufficient to support the DOE side, as SCE is also contributing resources to support the project.

Reviewer 5:
The reviewer stated that staff and computational resources appear to be sufficient.

Reviewer 6:
The reviewer had no further comments on budget as it appears to be adequate.

Reviewer 7:

The reviewer indicated that the resources are reasonable.

Reviewer 8:

The reviewer noted the constraints in the availability of cluster commuting and technology transfer funding.

Presentation Number: van040
Presentation Title: Energy Impacts of Electrified Passenger Air Transport
Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

Presenter

Dominik Karbowski, Argonne National Laboratory

Reviewer Sample Size

A total of seven reviewers evaluated this project.

Project Relevance and Resources

86% of reviewers felt that the project was relevant to current DOE objectives, 14% 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.

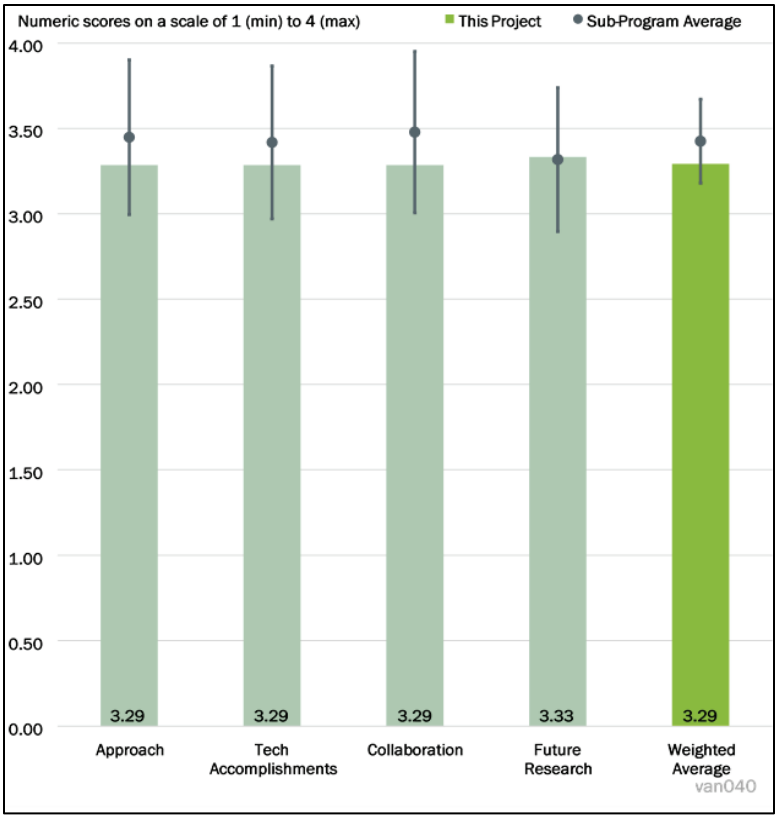

Figure 8-8 - Presentation Number: van040 Presentation Title: Energy Impacts of Electrified Passenger Air Transport Principal Investigator: Dominik Karbowski (Argonne National Laboratory)

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

Reviewer 1:

The reviewer noted an excellent first cut at modeling electrified air transport. The reviewer remarked that the assumptions, attributes, and aircraft choices are well reasoned, as is the Urban Air Mobility (UAM) demand model.

Reviewer 2:

The reviewer indicated that this is a well-thought-out study and framework for developing a new model. The reviewer added that it has clear objectives and goals, even if a bit ambitious, and that the assumptions seem appropriate.

Reviewer 3:

The reviewer stated that the study addresses an important and emerging issue. The reviewer noted that the team explores both energy intensity of intercity and intracity air travel, as well as potential demand for UAM service through a travel choice model. The reviewer mentioned that the study has developed and refined a disaggregate energy model for fixed-wing and vertical takeoff and landing (VOTL) aircraft that can be refined as additional data are made available. The reviewer concluded that the study appears well designed and implemented.

Reviewer 4:

Research appeared to be somewhat preliminary in nature to this reviewer, who also acknowledged a well-designed project.

Reviewer 5:

The reviewer expressed interest in seeing the approach consider the anticipated growth of battery technology to achieve the 1,500 Watt-hours per kilogram (Wh/kg) power density that is projected to be required. The reviewer remarked that it would be helpful to the overall study to have a frame of reference for what technologies exist or are being developed to achieve the desired power density, thereby helping to establish the feasibility of passenger air transport.

Reviewer 6:

The reviewer emphasized that no milestones were listed in the presentation. The reviewer indicated that the approach to determine intercity market size—estimating share of existing air travel demand that can be met by an electric fixed-wing aircraft given varying battery assumptions—could be better designed, and that the technology itself (i.e., battery-powered fixed-wing aircraft) may not be feasible without making very ambitious assumptions. The reviewer noted that National Academy of Sciences (NAS) published a study a few years back that placed electric aircraft in the "not thinking about it right now" (reviewer's words) category, i.e., beyond the 2050 timeline, and that neither Boeing nor Airbus has a strong desire/ambition to jump into that field. The reviewer did note that the intracity approach, which used current battery and other technology assumptions along with a utility-based mode choice model within specific cities, is well designed and its implementation is feasible, given reasonable assumptions. The reviewer said that, while not "trendy," the team could have considered including non-electric VTOL in the analysis as a baseline for fuel consumption.

Reviewer 7:

The reviewer observed that the researchers use a set of hypothetical battery performance futures to assess the feasibility of electrifying commercial fixed-wing air travel miles and VTOL aircraft. The reviewer noted that, as a first analysis, it is interesting, although future work on electrified or decarbonized air transportation would need to start to engage with aircraft designs that could substantially improve energy efficiency (possibly from a move away from current engine configurations) to help close the gap with battery energy density. The reviewer added that the UAM model is highly speculative.

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

Reviewer 1:

The reviewer mentioned that the project is on track and has yielded a highly useful UAM energy model and demand model, as well as interesting results regarding the percentage of all passenger-miles replaced by all electric.

Reviewer 2:

The reviewer indicated that model development appears to be very useful at establishing the conditions that could allow battery-powered air transport.

Reviewer 3:

This reviewer stated that the project has been made to a satisfactory degree.

Reviewer 4:

The reviewer noted good progress on model development and very interesting results about potential electric share of passenger miles. However, the reviewer noted that the project appears to be somewhat behind schedule.

Reviewer 5:

The reviewer noted that the project team has developed a parameterized model of energy requirements for air travel that allows for comparisons of technologies along different route structures. The reviewer warned that one potential issue for the choice model is the extent to which the availability of a low-cost air transport option might induce additional travel. The reviewer added that post-COVID-19 travel patterns may be significantly altered, which could change the motivations for mode changes.

Reviewer 6:

The reviewer stated that some COVID-19-related hiring delays may have impacted publication. The reviewer expressed some concern regarding changes to the modeling inputs for the timelines considered and whether that might impact publication timelines.

Reviewer 7:

The reviewer commented that, overall, it would have been nice to have the energy consumption comparisons in this final presentation rather than waiting to publish them this summer because they are the real output of interest.

When it comes to the intercity part of the project, the reviewer emphasized that the battery assumptions are highly optimistic. The reviewer added that the team had to double current highly ambitious solid-state battery developer specific energy goals (700–800 Wh/kg) to meet just one third of the current U.S. domestic travel demand. The reviewer stated that seeing this result (Slide 6) suggests that UAM will not be a concern for jet-engine aircraft's market share of travel demand for the foreseeable future (solely looking at reasonable projections of battery technology and cost). The reviewer suggested that the team may have benefitted from a go/no-go of sorts, perhaps to switch gears and dig into mode-switching from on-road vehicles if significant mode-switching from jet aircraft appeared unachievable. The reviewer mentioned that this could have been a result from this project rather than presenting electrification as a potential pathway for air travel decarbonization. The reviewer observed that the case was not fully made for how the intercity piece of the project provided more than what a literature review might have offered. The reviewer asserted that the project also does not seem to explicitly account for the fact that jet-engine aircraft lose weight as they fly (burning fuel), while electric aircraft do not. The reviewer hoped the team will include an energy consumption comparison calculation for intercity travel. The reviewer added that the fuel consumption per mile, passenger-mile, and ton-mile are all available by aircraft type (make and model) in the Bureau of Transportation Statistics (BTS) Schedule T2 dataset.

Regarding the intracity part of the project, the reviewer stated that the team built out what appears to be a nice modeling framework for UAM travel demand, including mode switching for two cities. The reviewer reported that there was not sufficient detail regarding the assumptions (e.g., wait times, value of travel time, value of not traveling with 10 other people, and price to ride). The reviewer concluded that the UAM vehicle level modeling (CAD/energy consumption) looks thorough.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted that the project appears to have meaningful collaboration with the Georgia Institute of Technology (Georgia Tech).

Reviewer 2:

The reviewer remarked that the team appears to have collaborated well.

Reviewer 3:

The reviewer mentioned that the partnership between Georgia Tech and ANL was clearly highly productive and coordinated well. The reviewer agreed with another commenter who mentioned that it would be great to see further dialogue with the National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), and other relevant federal agencies.

Reviewer 4:

The reviewer stated that the project team and shared responsibilities are described. The reviewer added that a private sector partner or technology company would significantly strengthen the study by providing access to data or validation.

Reviewer 5:

Collaboration with the U.S. Department of Transportation Federal Transit Authority was described by the reviewer as lacking but otherwise satisfactory across the project team.

Reviewer 6:

The reviewer noted good collaboration with air mobility technology experts, especially on UAM, but observed limited interaction with FAA and other agencies that focus on aviation, especially commercial aviation.

Reviewer 7:

The reviewer suggested enhancing the usefulness of the model by having a battery technology company or researcher as one of the collaboration partners. The reviewer asked if ANL or Georgia Tech is providing this input, noting that it was unclear from the presentation and the questions and answers. This reviewer speculated that perhaps this is in the next steps and/or proposed future research.

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

Reviewer 1:

Proposed future research has been effectively planned from the reviewer's perspective.

Reviewer 2:

The reviewer stated that the remaining tasks are on track to be completed and no significant barriers exist.

Reviewer 3:

The reviewer stated that the next steps are well articulated and follow a logical progression from the current status.

Reviewer 4:

The reviewer remarked that the project is near completion, but that there is still some work that needs to be finalized and some results to be written up.

Reviewer 5:

The reviewer noted that the project has ended.

Reviewer 6:

The reviewer expressed special interest in the future research related to "finalizing technical assumptions 2030-2050" to provide a reference point for the timeline for battery research and development and to achieve the goal of 1,500 Wh/kg power density.

Reviewer 7:

The reviewer mentioned that the team plans to publish a final report this summer with some additional analysis regarding energy consumption. The reviewer agreed that this is the logical next step, although indicated that there was not a clear project timeline anywhere in the presentation explaining where the project was supposed to end up.

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

Reviewer 1:

The reviewer indicated that this study addresses an emerging field with significant implications for low carbon mobility and transportation access.

Reviewer 2:

The reviewer stated that this project supports VTO's efforts to stay abreast of advanced vehicle technologies. The reviewer added that VTO does not have much work on air travel energy consumption, and that this project provides a base level of modeling and analysis support for UAMs and some initial work on larger fixed-wing aircraft.

Reviewer 3:

The reviewer said that, yes, the project established the scenario and potential impact of electrified aviation and the ability to displace liquid fuels for a portion of air travel.

Reviewer 4:

The reviewer said that, yes, this is an understudied area of research that could have large implications for future transportation system and energy impacts. The reviewer indicated that sustainable aviation opportunities need to be fully explored by DOE due to the difficult nature of decarbonizing this sector.

Reviewer 5:

The reviewer reported that the assessment of electrified aviation on energy consumption is directly relevant to DOE's mission.

Reviewer 6:

This reviewer asserted that the project supports overall DOE objectives satisfactorily.

Reviewer 7:

The reviewer remarked that these are interesting ideas, although more robust analysis of commercial aviation energy consumption would require a more detailed analysis of improvements to fixed-wing aircraft design. The reviewer added that looking at other, more energy-efficient micromobility/public transit options and ways to improve those would be more relevant, especially with large goals of decarbonization and equitable access to low-carbon transportation.

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

Reviewer 1:

The reviewer remarked that the project budget appears sufficient and recommended that additional funding should be applied to this research area.

Reviewer 2:

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

Reviewer 3:

The reviewer observed that no resource constraints were identified.

Reviewer 4:

The reviewer indicated that the resources are in line with the project.

Reviewer 5:

The reviewer reported that the resources are reasonable.

Reviewer 6:

The reviewer stated that the team struggled to hire staff at the beginning, but that it appears to have the workload covered.

Reviewer 7:

The reviewer noted that funding was sufficient for a pilot-level study, and that more private sector interest and development is necessary before building a larger portfolio of UAM-focused projects.

Presentation Number: van041
Presentation Title: Location History
Principal Investigator: Venu Garikapati (National Renewable Energy Laboratory)

Presenter

Venu Garikapati, National Renewable Energy Laboratory

Reviewer Sample Size

A total of seven reviewers evaluated this project.

Project Relevance and Resources

86% of reviewers felt that the project was relevant to current DOE objectives, 14% of reviewers felt that the project was not relevant, and 0% of reviewers did not indicate an answer. 86% of reviewers felt that the resources were sufficient, 14% 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.

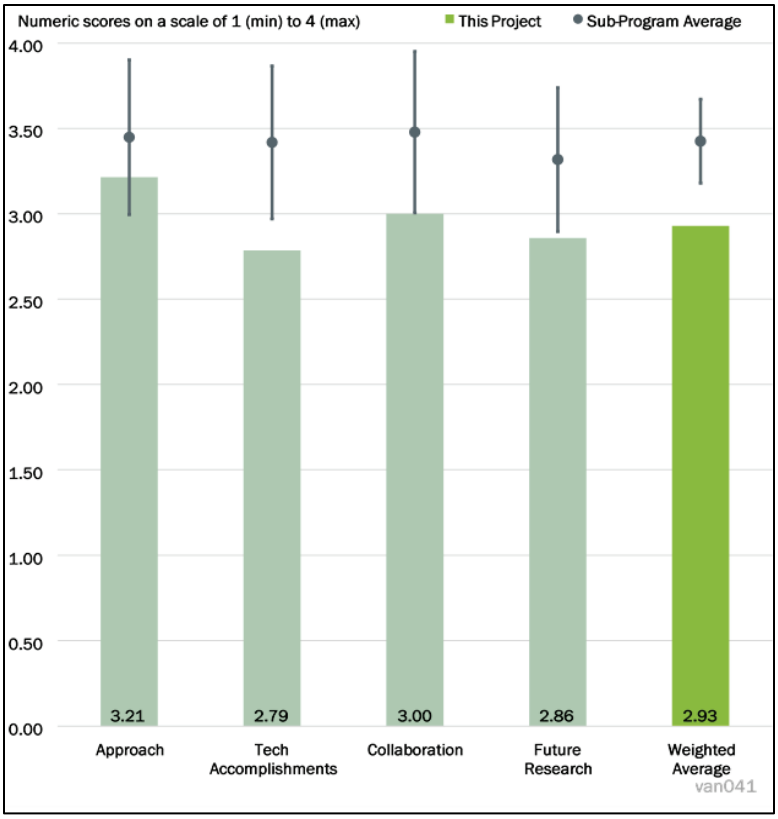

Figure 8-9 - Presentation Number: van041 Presentation Title: Location History Principal Investigator: Venu Garikapati (National Renewable Energy Laboratory)

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

Reviewer 1:

The reviewer indicated that the approach to performing the work addresses technical barriers. Furthermore, the project is well designed and feasible.

Reviewer 2:

The reviewer observed that it is unclear how this study addresses one of the primary barriers described, namely acquiring accurate and representative travel history data from a large sample of travel from which to estimate choice, travel, or activity models. The reviewer suggested that, in order to maximize the benefits of the modeling exercise, modelers from metropolitan planning organizations (MPOs) should perhaps be engaged earlier in the process. The reviewer noted that there are issues in mapping location-based service (LBS) data to the transportation network that the study could address. The reviewer questioned how to assure that samples are equitable and representative when pairing LBS data with survey responses.

Reviewer 3:

The reviewer stated that the ML implementation side and comparison to a traditional logit model seems to have gone relatively smoothly. The reviewer noted that most of the challenges were associated with the data collection process. The reviewer suggested that some delays are probably attributable to COVID-19, and that some additional care to schedule and clear privacy hurdles might have been helpful because it is important for future projects that are considering using native data collection to map travel patterns.

Reviewer 4:

The reviewer indicated that the approach to exploring location history data as an alternative to traditional travel surveys is well designed. The reviewer mentioned that the team is collecting a small sample of location history data and pushing it through ML and traditional choice models to see how accurately they each project travel behavior. The reviewer added that the app-based approach seems much simpler for respondents to use than traditional surveys, but that it is not clear how feasible this approach is, given privacy and security issues. The reviewer suggested that the team should explain how those barriers will be (or are being) overcome.

Reviewer 5:

The reviewer noted that the approach of using cell phone data to establish location history seems well suited to this methodology. The reviewer suggested applying this to other modes of transportation in addition to bikes, but said that this is a good place to start to establish the feasibility of this method of data collection.

Reviewer 6:

The reviewer acknowledged that this is an important area of research and that the approach makes sense. The reviewer suggested expanding the project to larger sample sizes and to include more data.

Reviewer 7:

The reviewer stated that the thinking behind this work was well reasoned, and that finding an alternative to traditional travel surveys is important and time/cost-saving work. The reviewer explained that the approach overall was well specified and logical; however, the approach to data collection has been less successful and has not contributed to overcoming barriers.

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

Reviewer 1:

The reviewer reported that the presenter indicates solid progress toward overall project objectives.

Reviewer 2:

The reviewer commented that it looks like the team was slowed due to COVID-19 and was unable to accomplish as much as was anticipated. The reviewer believed the methodology is established with good potential to apply to a broader set of transportation modes.

Reviewer 3:

The reviewer observed that, unfortunately, the timing of the project in relation to COVID-19 impacted this work. The reviewer added that, given this constraint, the project was still able to move forward and yield some interesting results.

Reviewer 4:

The reviewer stated that, while the project is set to conclude on time, the technical progress has somewhat lagged. The reviewer observed that certainly COVID-19 has delayed/impacted both the ability of researchers to collect information and changed the nature of underlying data. However, the reviewer suggested that better data contingencies could have been potentially planned before the project began.

Reviewer 5:

The reviewer remarked that a small sample model was completed, but that the results are likely not generalizable, given the limited data. The reviewer added that some trip data were collected from the survey and smart app, but that the integration with the choice model is planned for future work.

Reviewer 6:

The reviewer stated that the results based on the pilot study are compelling, but that the number of respondents is very limited. The reviewer said that even if native data collection was not held up because of privacy concerns, the data collected during the peak of the pandemic would have not been representative of more normal transportation patterns. The reviewer noted that, according to the presenter, data collection permissions have now been cleared and the Colorado Energy Office (CEO) may be able to provide more data.

Reviewer 7:

The reviewer noted that the presentation did not include any milestones or project tracking information. The reviewer stated that the team was not able to complete the approach as initially stated, as COVID-19 delayed internal permissions. The reviewer added that the team pivoted to using an existing dataset to test drive the location history approach. The reviewer remarked that these data were, unfortunately, much less comprehensive and only included 13 participants and bikes (no other modes). The reviewer said that the results of both ML and traditional mode-choice were not great (39% and 50%, respectively), and suggested that the team might explore other mode choice equation specifications. The reviewer suggested trying the approaches on a larger aggregate dataset rather than overfitting to 13 people's choices.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:

The reviewer noted great collaboration with the CEO and the Colorado Department of Transportation (CDOT) and encouraged broader academic collaboration on this topic.

Reviewer 2:

The reviewer remarked that the partnerships, particularly with the CEO group, were the saving grace of this project in a COVID-19 year when native data collection was stalled. The reviewer added that including them in developing some future research questions to focus on if the model proves to be useful with non-COVID-19 data would be helpful for ensuring that the tools are most useful for mobility planners.

Reviewer 3:

Collaboration and coordination across the project team was described by this reviewer as sufficient for the scope of the project.

Reviewer 4:

The reviewer suggested that there was not much planned collaboration, but that the team ended up having to collaborate more with CEO to get data for an initial analysis due to data delays. The reviewer added that the two groups appear to have a good relationship and plan to work together on this in the future.

Reviewer 5:

The reviewer indicated that the researchers intend to review results with CDOT, but that not much collaboration appears to have been conducted thus far. The reviewer stated that further collaboration with CEO is anticipated.

Reviewer 6:

The reviewer said that it is good that the modeling work will be shared with CDOT and that the performers plan to work with CEO for access to data. However, the reviewer added that these seem like less coordinated and fully engaged partners.

Reviewer 7:

The reviewer stated that only one partner is identified, and suggested that the partner appears to not have been engaged with the research project.

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

Reviewer 1:

The reviewer noted a clear path forward to collect individual data via the app now that permissions have been worked out.

Reviewer 2:

The reviewer observed that the proposed future research aligns with finishing the project, and that the biggest barriers seem to finally be out of the way.

Reviewer 3:

Proposed future research has been effectively planned in a logical manner from this reviewer's perspective.

Reviewer 4:

The reviewer said that future work would focus on running the analysis on natively collected data or a larger dataset from CEO. The reviewer remarked that additional details about plans for results dissemination would be helpful.

Reviewer 5:

The reviewer mentioned that the proposed future research is logical, given the initial approach. The reviewer suggested that there could have been some additional risk mitigation regarding the future goal to "attempt native data collection for 50-100 individuals." The reviewer explained that the team had already struggled to complete this before, and suggested that it is likely there will be additional barriers (not least the end of the project and its funding).

Reviewer 6:

The reviewer encouraged the team to consider broader application of this methodology beyond bikes.

Reviewer 7:

The reviewer stated that this project is lacking a concrete plan for future data acquisition and research partnerships, with few to no alternatives for future work proposed.

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

Reviewer 1:

The reviewer remarked that this project is highly relevant to overall DOE objectives. The reviewer explained that, by exploring the potential for improving VTO's understanding of human decision-making (with respect to transportation), the project could improve the real-world representation of assumptions going into VTO's agent-based models. The reviewer added that, specifically, this project aims to improve VTO modeling and simulation tools using applied analysis of a unique dataset.

Reviewer 2:

The reviewer stated that this project supports overall DOE objectives.

Reviewer 3:

The reviewer observed that this work is relevant to understanding the range of customer/user choice models.

Reviewer 4:

The reviewer said that, yes, given the enormous effort and money put into modeling the transportation system and to the rapidly changing technology and behavior in the sector, it makes a lot of sense to focus on getting better data. The reviewer encouraged more exploration of novel methods and data collection efforts.

Reviewer 5:

The reviewer indicated that this work is highly relevant to DOE's modeling activities, and that opportunities for new datasets and better prediction enhance quality decision-making and save time and taxpayer dollars.

Reviewer 6:

The reviewer stated that this work is an important benchmarking activity to show how well ML methods perform when compared to other models, especially with large datasets, and that it is important given research trends and the goals of modeling how transportation contributes to energy consumption in the United States.

Reviewer 7:

The reviewer noted that there is a wide range of academic and private companies building ML models based on location-based services data and sociodemographic information, and suggested that this project could do a better job at addressing methodological or data gaps. The reviewer added that the project could be improved by focusing on partnerships with the local MPO agency and focusing data collection on ensuring an equitable and representative sample.

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

Reviewer 1:

The reviewer mentioned that the project would benefit from short-term and relatively inexpensive COVID-19 time extensions to allow for additional data collection.

Reviewer 2:

Sufficient project resources to achieve stated milestones in a timely fashion were observed by this reviewer.

Reviewer 3:

The reviewer remarked that the project funding appears appropriate for the milestones described.

Reviewer 4:

The reviewer noted that project staff resources are sufficient to complete the work.

Reviewer 5:

The reviewer indicated that the resources are in line with the scale of the project.

Reviewer 6:

The reviewer noted adequate resources to complete the project.

Reviewer 7:

The reviewer observed that the barrier was noted, although it was not clear if this is resource constrained (related to data sources and modeling techniques).

Acronyms and Abbreviations

ADOPT	Automotive Deployment Options Projection Tool
AEO	Annual Energy Outlook
AFLEET	Alternative Fuel Life-Cycle Environmental and Economic Transportation
ANL	Argonne National Laboratory
BETO	Bioenergy Technologies Office
BEV	Battery electric vehicle
BTS	Bureau of Transportation Statistics
CAD	Computer-aided design
CDOT	Colorado Department of Transportation
CEC	California Energy Commission
CEO	Colorado Energy Office
COVID-19	Coronavirus disease 2019
CV	Commercial vehicle
DMV	Department of Motor Vehicles
DOE	U.S. Department of Energy
EV	Electric vehicle
EVI-Pro	Electric Vehicle Infrastructure Projection tool
FAA	Federal Aviation Administration
FASTSim	Future Automotive Systems Technology Simulator
FCEV	Fuel-cell electric vehicle
FY	Fiscal Year
GEM	Greenhouse gas Emissions Model
Georgia Tech	Georgia Institute of Technology
GHG	Greenhouse gas
GREET	Greenhouse gases, Regulated Emissions, and Energy use in Transportation model
H	Hydrogen
HD	Heavy-duty
HDV	Heavy-duty vehicle
HFTO	Hydrogen and Fuel Cell Technologies Office
ICEV	Internal combustion engine vehicle
LBNL	Lawrence Berkeley National Laboratory

LBS	Location-based service
LCA	Life-cycle analysis
LCOD	Levelized cost of driving
LD	Light-duty
LDV	Light-duty vehicle
MA3T	Market Acceptance of Advanced Automotive Technologies model
MD	Medium-duty
ML	Machine learning
MPO	Metropolitan planning organization
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NDA	Non-disclosure agreement
NG	Natural gas
NHTS	National Highway Travel Survey
NREL	National Renewable Energy Laboratory
OEM	Original equipment manufacturer
ORNL	Oak Ridge National Laboratory
PHEV	Plug-in hybrid vehicle
PI	Principal Investigator
PNNL	Pacific Northwest National Laboratory
PUD	Public utility district
Q	Quarter
RDD&D	Research, development, demonstration, and deployment
SCE	Southern California Edison
SOC	State of charge
SNL	Sandia National Laboratories
TCO	Total cost of ownership
TEEM	Transportation Energy Evolution Modeling
TRB	Transportation Research Board
UAM	Urban Air Mobility model
UC Davis	University of California at Davis
VAN	Vehicle Analysis Program

VIUS	Vehicle Inventory and Use Survey
VMT	Vehicle-miles traveled
VTO	Vehicle Technologies Office
VTOL	Vertical takeoff and landing
Wh/kg	Watt-hour per kilogram
ZEV	Zero-emission vehicle
ZIP	Zone Improvement Plan