8. Vehicle Analysis

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

The VTO Analysis (VAN) 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. The subprogram also supports integrated and applied analyses that bring together useful findings and analysis of the energy impacts of transportation systems through the integration of multiple models including vehicle simulation, traveler behavior, and energy accounting of the entire 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, VAN 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.

Subprogram Feedback

DOE received feedback on the overall technical subprogram areas presented during the 2018 Annual Merit Review (AMR). Each subprogram technical session was introduced with a presentation that provided an overview of subprogram goals and recent progress, followed by a series of detailed topic area project presentations.

The reviewers for a given subprogram area responded to a series of specific questions regarding the breadth, depth, and appropriateness of that DOE VTO subprogram's activities. For the 2018 VTO AMR, the VAN subprogram presentation (VAN000) was evaluated against a different criteria as compared to the other R&D subprogram areas. It should be noted that no scoring metrics were applied.

Responses to the subprogram overview questions are summarized in the following pages. Individual reviewer comments for each question are identified under the heading Reviewer 1, Reviewer 2, etc. Note that reviewer comments may be ordered differently; for example, for each specific subprogram overview presentation, the reviewer identified as Reviewer 1 in the first question may not be Reviewer 1 in the second question, etc.

Presentation Number: van000
Presentation Title: Overview of VTO Analysis Program
Principal Investigator Name: Rachael Nealer (U.S. Department of Energy)

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 VAN program manages a broad portfolio of analyses, public information resources, and models that are widely used by federal and state policymakers, academics, industry, and others to assess transportation-related energy, cost, and environmental impacts. Many of these are well-established and robust models that are critical to keep current through annual updates and enhancements as new technologies enter the market. For example, the reviewer noted that it was great to see significant expansions this year into medium-duty (MD)/heavy-duty (HD) electrification in Autonomie, the Greenhouse gas Regulated Emissions, and Energy Use in Transportation (GREET) model, and VISION/NEAT. Others are newer analyses and resources that can help policymakers answer key questions, e.g., the amount of charging infrastructure the United States will need under different scenarios, and the amount a given state or local government will need (Electric Vehicle Infrastructure Projection [EVI-Pro]). Finally, pulling together key transportation data in easy digestible forms such as the Transportation Energy Data Book (TEDB) and Fact of the Week (FOTW) is an important service not just for transportation stakeholders, but the general public. The reviewer pointed out that there are many specific technical barriers associated with developing and maintaining all of these resources, but the overall portfolio seems well-designed and managed.

Reviewer 2:
The reviewer reported that objectives were clearly defined and a methodology was described, which provided a context for the various initiatives funded by VTO. The reviewer appreciated increased emphasis in areas beyond primarily passenger cars, with more tools developed and applied to MD and HD trucks. New initiatives were described in advanced transportation technologies such as connected autonomous vehicles. The reviewer noted that the principal investigator referred to future plans to expand into off-highway equipment as well.

Reviewer 3:
The reviewer remarked the various parts of the program are complementary and provide data, modeling, and analytical capabilities that can provide insight into the energy and environmental impacts of various vehicle technologies. The approach is logical and can help inform a breadth of stakeholders across industry, government, and local/regional/national planning. The reviewer remarked that the capabilities in the VTO Analysis program provides a suite of tools that can enable stakeholders to enable understanding the impact of timelines, technology targets, and consumer behaviors.

While there is an overall structure for the program that indicates very logical portfolio selection and management, the reviewer was not clear how the various project activities coordinate the key questions and areas of focus. While each is relevant on its own, mapping out the strategic direction and integrated connections could enable even greater insight. The reviewer elaborated that this was not the issue with this particular presentation, but an observation after hearing from all of the program component projects.

Reviewer 4:
The reviewer remarked that the overview of VTO Analysis projects was clear and concise. The project overviews demonstrated that the analyses address the core missions and goals of the VTO program.

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

Reviewer 1:
The reviewer commented that Dr. Nealer has managed a strong set of projects, each indicating good progress.

Reviewer 2:
The reviewer said that it is difficult to provide an example of improvements to an overview presentation.

Reviewer 3:
According to the reviewer, the VAN program's broad portfolio included many technical accomplishments this year, including many significant model updates, the release of new publications and tools, and reaching the 1,000th FOTW milestone. The program does a particularly good job at balancing the need to maintain longstanding models and resources with the need to develop new tools and pathways that address emerging transportation issues (e.g., autonomous vehicles, transportation as a system, and electrification beyond the light-duty [LD] sector.)

Reviewer 4:
The reviewer would like to see more emphasis into areas related to off-highway equipment. The reviewer suspected that funding limitations are slowing the pace of including these applications into the analysis portfolio. The reviewer acknowledged having seen growth in this area, however. The reviewer has also seen effective application of tools and methods toward understanding the role of MD and HD vehicles and evaluating the technology trends, and this reviewer would like to see continued growth in this area.

Question 3: Collaboration and Coordination Across Project Team

Reviewer 1:
The reviewer found that the presentation provided demonstration of excellent collaboration and coordination across the project team.

Reviewer 2:
The reviewer commented, as noted in individual project reviews, that there seems to be strong coordination across the national laboratories and with VTO, as well as significant outreach to other agencies, industry, universities, and transportation stakeholders as appropriate.

Reviewer 3:
The reviewer stated that evidence was presented throughout the session that there was collaboration and common objectives among the team.

Reviewer 4:
The reviewer commented that projects are clearly organized to create a robust portfolio. The degree of collaboration across projects is good. As an example, the reviewer cited that the Transportation Energy Data program provides a direct resource that is used by the other projects. As another, the VTO program's benefits analysis utilizes model results to conduct the technology benefits analysis. The reviewer said that the strength of the portfolio could be even more powerfully demonstrated by conducting analyses which takes advantage of many of the models to provide unique results which can provide even greater insights for critical stakeholders.

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

Reviewer 1:
As noted in individual project reviews, this reviewer explained that researchers have identified future work that is generally well-designed and will help to either answer key questions or enhance models.

Reviewer 2:
The reviewer observed that Dr. Nealer is obviously taking a very thoughtful approach to managing the VTO analysis portfolio. The reviewer noted that the portfolio is shifting to consider key questions about practical

future mobility trends, such as sharing, fleet management, and the evolving vehicle mix, which will critically impact fuel use and greenhouse gas (GHG) emissions.

Reviewer 3:
The reviewer would like to see more details about future funding initiatives, particularly as they relate to evaluating the maturity of new technologies and the adoption rate modelling of new technologies, particularly MD/HD on-road and off-road applications.

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

Reviewer 1:
The reviewer stated yes; this program supports researchers and stakeholders in assessing the potential energy, cost, and environmental benefits of a wide range of vehicles, fuels, and transportation-activity scenarios. It also helps to answer key questions that can reduce barriers to the adoption of new technologies.

Reviewer 2:
The reviewer remarked the objectives were clearly defined and the funded projects demonstrated support of those objectives.

Reviewer 3:
The reviewer commented that the analysis program is critical to providing insight into the broader impact of the advanced technology portfolio of VTO and beyond. Considering the impact of technological improvements, consumer choice, policy decisions, and societal shifts is a valuable asset to the overall DOE program, and can help provide an integrated view of the overall environmental and petroleum consumption impact of the vehicle mix.

Reviewer 4:
The reviewer indicated yes; the project overview supports DOE VTO's overall objectives concerning analyses of the transportation sector's future energy and environmental issues.

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

Reviewer 1:
The reviewer observed sufficient resources to achieve the stated milestones. However, the reviewer recommended further increases to consider the additional barriers and transportation trends that can provide even greater impact to decision makers and to VTO for portfolio guidance. The analysis program plays a critical role, not just for internal DOE portfolio management and guidance, but also provides insights to a variety of other government and industry stakeholders who use the analysis to inform their broader set of business and investment decisions.

Reviewer 2:
All projects reviewed seemed to be meeting milestones on target from this reviewer's perspective.

Reviewer 3:
The reviewer pointed out that funding levels appear to lack clarity early in the fiscal year (FY), which may have resulted in a delay in developing and articulating a robust strategy for growing the analysis plans. There is evidence that this uncertainty may have led to less aggressive movement into new applications, technology selection, and evaluation plans until late in the budget year when a more certain plan was available.

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
van016	Transportation Data Program: A Multi-Laboratory Coordinated Project	Stacy Davis (ORNL)	8-6	3.75	3.88	3.75	3.25	**3.75**
van017	ANL VTO Analysis Modeling Program	Michael Wang (ANL)	8-10	3.38	3.38	3.50	3.25	**3.38**
van018	VTO Program Benefits Analysis	Tom Stephens (ANL)	8-14	3.13	3.50	3.38	3.38	**3.38**
van023	Assessing the Energy and Cost Impact of Advanced Technologies through Model-Based Design	Aymeric Rousseau (ANL)	8-18	3.50	3.38	3.38	3.38	**3.41**
van026	Modeling Framework and Results to Inform Charging Infrastructure Investments	Eric Wood (NREL)	8-22	3.75	3.75	3.63	3.50	**3.70**
van028	Electric Vehicle—Grid Benefits Analysis	Anand Gopal (LBNL)	8-26	3.38	3.38	3.25	3.25	**3.34**
Overall Average				**3.48**	**3.54**	**3.48**	**3.33**	**3.49**

Presentation Number: van016
Presentation Title: Transportation Data Program: A Multi-Laboratory Coordinated Project
Principal Investigator: Stacy Davis (Oak Ridge National Laboratory)

Presenter
Stacy Davis, Oak Ridge National Laboratory

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

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

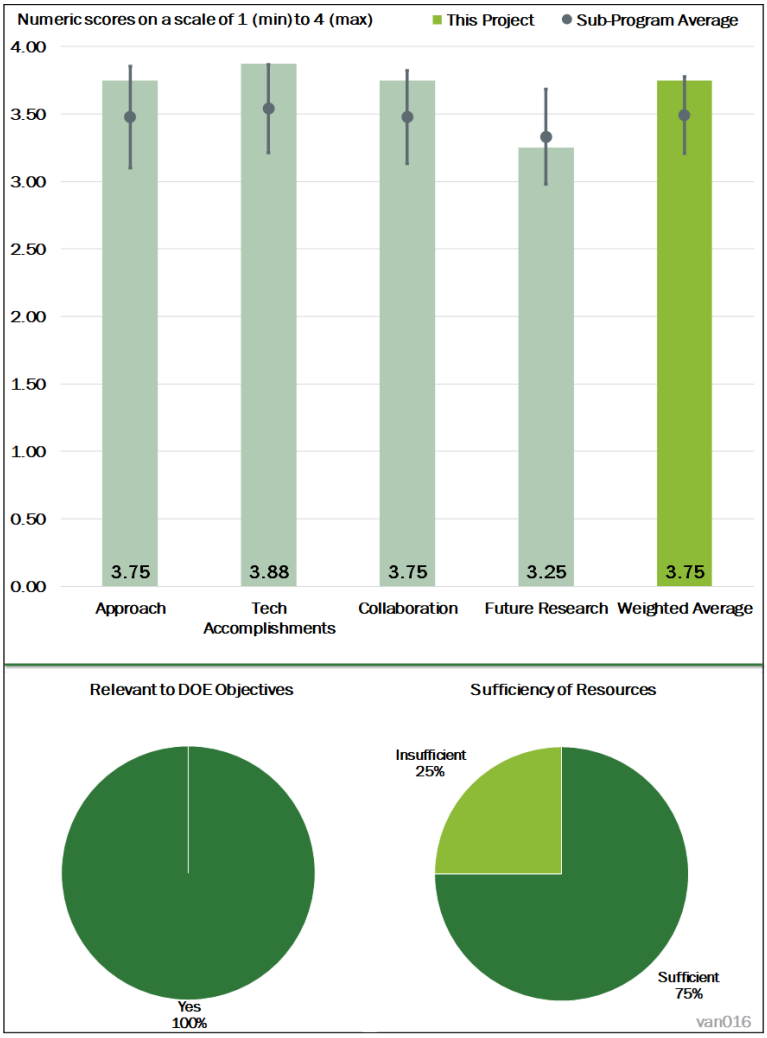

Figure 8-1 - Presentation Number: van016 Presentation Title: Transportation Data Program: A Multi-Laboratory Coordinated Project Principal Investigator: Stacy Davis (Oak Ridge National Laboratory)

Reviewer 1:
The reviewer remarked that the TEDB is an important resource to many transportation stakeholders, including other federal agencies, academics, and industry representatives. As noted by the presenter, compiling the many sources of data into one well-documented resource is an efficient way to save researcher's and stakeholder's time. The reviewer noted that the time series data is particularly helpful. One of the biggest technical challenges is presenting time series data for cases where changes in definitions or methodology of the underlying data sets cause a break in the time series. The reviewer remarked Oak Ridge National Laboratory (ORNL) addresses this by noting any such breaks and providing as much detail as possible on the changes that occurred—a reasonable approach. Likewise, FOTW and e-drive sales data is well-presented, documented, and useful to an array of stakeholders. The reviewer found that all projects seem well-designed and are clearly feasible.

Reviewer 2:
The reviewer said the project had clearly laid-out objectives and methodology. The reviewer noted how the authors expressed a commitment to providing information, data, and reports to meet the needs of the user community.

Reviewer 3:
The reviewer remarked that Ms. Davis and team provide a very thorough and methodological approach to the transportation data program. The team is very seasoned, and clearly knows the material and how to synthesize the information in a very logical and well-documented manner.

Reviewer 4:
The reviewer commented that the data system is getting better with more access options. The data system is well-defined and feasibility is not an issue.

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 all milestones for FY 2017 are complete and are either complete or on track for FY 2018. This includes posting monthly e-drive sales data, preparing and posting the FOTW, and submitting the draft TEDB to the VTO.

Reviewer 2:
The reviewer has seen an increased emphasis toward moving into new transportation technologies for passenger cars and LD vehicles, but also including fleets, HD vehicles, non-highway sectors, and other relevant energy and alternative fuel technologies.

Reviewer 3:
The reviewer remarked that the team is making very solid progress towards the overall project. The team consistently delivers and actively engages partners to make the data as useful and accessible as possible.

Reviewer 4:
The reviewer referenced a prior comment; the data system is invaluable to analysts and exceeds technical accomplishments.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer remarked that Ms. Davis and team seek out collaboration and coordination across the project team and across the VTO analysis portfolio. The team positions the TEDB as a community resource and seeks to serve the community as effectively as possible.

Reviewer 2:
The reviewer found that collaboration between ORNL and Argonne National Laboratory (ANL) partners, as well as with VTO staff, seems well-coordinated. In addition, the project partners work with many outside groups, agencies, etc., on the data sources used in the Transportation Data Program and do a good job on stakeholder outreach (e.g., through email subscriptions).

Reviewer 3:
The reviewer said that the presenter expressed a keen interest in collaborating and providing creative ways to address the needs of the user community.

Reviewer 4:
The reviewer asserted that no comment is needed; the system is improving due to coordination and collaboration.

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

Reviewer 1:
The reviewer commented that future work for this program entails continuing to publish e-drive sales data, FOTW, and the TEDB on a regular basis. Now that the TEDB is an online-only resource, it will be updated

twice per year—a good enhancement. The reviewer recommended that if possible, it could be useful to stakeholders to have e-drive sales data broken out by state (or U.S. region) in order to explore the impacts of state or regional policies and programs on plug-in electric vehicle (PEV) adoption. The reviewer explained that if this is not possible because the underlying data are proprietary, any aggregate version of this data (e.g., total electric vehicle [EV] sales for state x, rather than sales by manufacturer or model) could still be useful.

Reviewer 2:
The reviewer described the Transportation Energy Data program as a very consistent resource that could become even more valuable by seeking new sources and information that can provide an even broader resource with future shifts in mobility patterns and transportation use. For example, the reviewer suggested that information related to ride share use and the link between private and public transportation could provide additional insight and expand the project's stakeholder community.

Reviewer 3:
The reviewer reported evidence of growing research to include more off-highway data needs and expressed interest in seeing an increased effort applied in this area, particularly around technology trends.

Reviewer 4:
The reviewer said that a comment is not applicable for development of a well-regarded and used data system.

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

Reviewer 1:
The reviewer pointed out that providing timely, well-documented, and high-quality data enables researchers and other transportation stakeholders to advance studies and projects that could make passenger travel and freight movement more energy efficient and cost-effective.

Reviewer 2:
The reviewer said that the Transportation Energy Data project continues to provide a reliable and consistent resource for DOE and the community of users. Through the Data Book and FOTW, it provides a synthesis, distribution, and educational service on transportation energy use and trends that benefit stakeholders across government, academia, and the private sector.

Reviewer 3:
The reviewer asserted that the data system is a very important tool for VTO analyses.

Reviewer 4:
The reviewer observed excellent data resources for the bulk of the market trends, particularly in LD and passenger cars; however, less so in MD and HD transportation and off-highway sectors.

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

Reviewer 1:
The reviewer remarked that resources appear to be insufficient to comprehensively cover all three sectors, specifically LD passenger cars, commercial vehicles, and off-highway equipment.

Reviewer 2:
The reviewer explained that funding seems well-utilized and project partners have been able to meet all targets and milestones with the resources provided.

Reviewer 3:
The reviewer commented that the team does an admirable job of using resources appropriately to deliver weekly, monthly, and annual milestones.

Reviewer 4:
The reviewer indicated that resources seem sufficient.

Presentation Number: van017
Presentation Title: ANL VTO Analysis Modeling Program
Principal Investigator: Michael Wang (Argonne National Laboratory)

Presenter
Michael Wang, Argonne National Laboratory

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

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

Reviewer 1:
The reviewer asserted that models are an excellent resource to researchers and transportation stakeholders trying to assess the energy and environmental impacts of different vehicle and fuel pathways, as well as fleet deployment scenarios. While there are many technical challenges associated with developing and updating such extensive models, ANL works with partners to gather and vet data and try to address inconsistencies. The reviewer said that ANL consistently documents any updates to the models, including new pathways, changes to underlying data sources, and methodology.

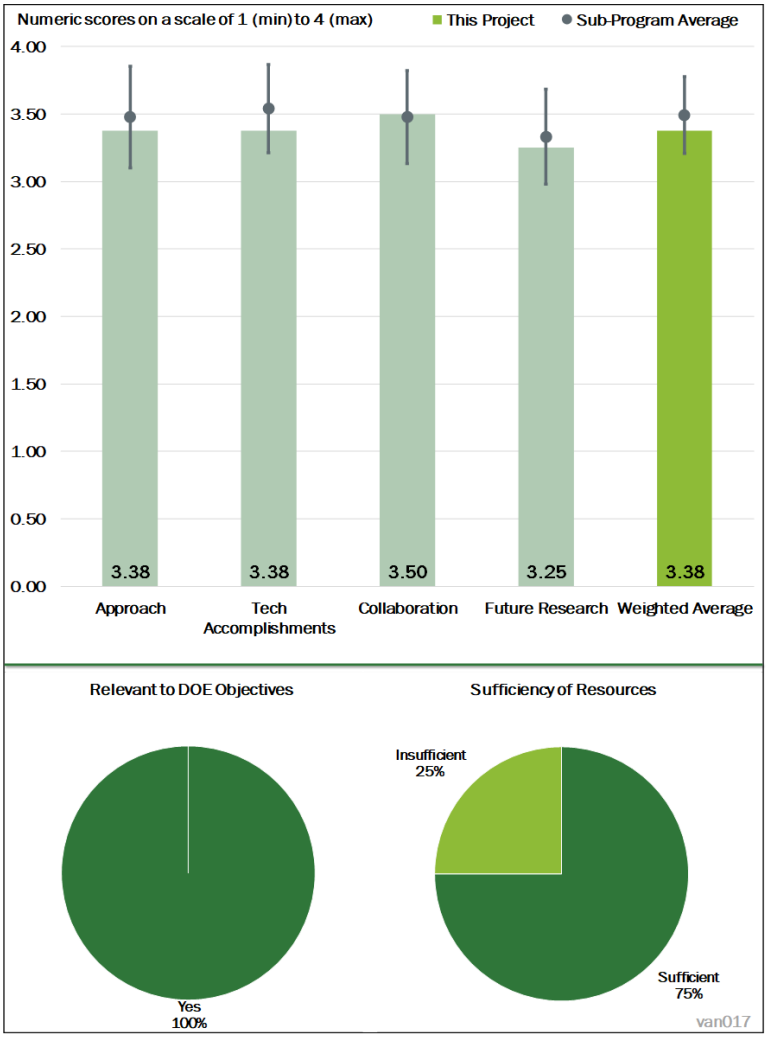

Figure 8-2 - Presentation Number: van017 Presentation Title: ANL VTO Analysis Modeling Program Principal Investigator: Michael Wang (Argonne National Laboratory)

Reviewer 2:
The reviewer observed a solid approach that has been developed over many years of research. The capabilities have expanded over time to provide a well-known and used resource for the community for calculating GHG emissions.

Reviewer 3:
The reviewer remarked that the approach provides comprehensive coverage for the GREET and VISION/NEAT models for on-highway vehicles. The reviewer cited how the project team has increased emphasis in the past year on MD and HD vehicle technologies in the EV, plug-in hybrid electric vehicle (PHEV), and fuel cell electric vehicle (FCEV) technology areas. The reviewer would like to see continued growth in this direction as well as including off-highway sectors in these technology areas, particularly construction, industrial, and agricultural sectors.

Reviewer 4:
The reviewer remarked that the GREET and VISION tools are a good basis for evaluating the life cycle analysis (LCA) of emissions and energy consumption under different assumptions and scenarios. The reviewer agreed with last year's commenter that system boundaries could use further development. In particular, the temporal boundaries for some energy system change, i.e., crude oil production; emission and energy use for certain reservoir types change over the life of the well or reservoir. The reviewer thought it would be helpful if GREET addressed this issue in the future.

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 ANL made many significant updates to the models in the past year, in particular, the regional water analysis in GREET and incorporating EV/FCEV pathways beyond the LD sector in VISION and NEAT. The reviewer noted that milestones appear on time.

Reviewer 2:
The reviewer observed excellent progress toward stated goals.

Reviewer 3:
The reviewer acknowledged that the project continues to make progress year over year. However, the presentation and materials focused much more on the approach rather than articulating the progress, impact, and priorities for expanding the model. The reviewer said that it would be good to clarify up front what the priorities are for additional development and the desired set of results, and stakeholders who would be impacted by the additional development for the year.

Reviewer 4:
The reviewer found that the technical accomplishments and progress of GREET and VISION is excellent. However, the reviewer reiterated a previous comment on progress on the temporal boundaries of GREET.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer stated that ANL seems to do an outstanding job of collaboration both within DOE and with external stakeholders spanning industry, the U.S. Environmental Protection Agency, the U.S. Department of Transportation (DOT), and research organizations. This is a critical component of the modeling work given the large number of inputs, assumptions, and external models that inform GREET and VISION/NEAT.

Reviewer 2:
The reviewer commented GREET and VISION model development collaboration and coordination.

Reviewer 3:
The reviewer remarked that collaboration and coordination appear to be strong with other stakeholders at the federal and national laboratory levels. The reviewer suggested that perhaps increasing interaction with industry stakeholders would add some outside, market-driven influence into the areas of growth for future technologies and additional market sectors. The reviewer appreciated the proposed future work toward developing a simplified online version of VISION/NEAT. This could encourage industry use of these valuable tools.

Reviewer 4:
The reviewer commented that the project continues to work consistently with partners and continued users of GREET. However, it is unclear whether there were a key set of questions or issues driving the additional development. The project updated results based on the Annual Energy Outlook 2017 reference cases and included MD and HD vehicles, but it was unclear how or whether this linked to the activities in the water

stress index work. The reviewer said that clarity on the priorities for model expansion would be helpful in articulating decisions for model expansion and subsequent analyses.

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

Reviewer 1:

The reviewer detailed that ANL's future plans for GREET include adding new vehicle technologies and pathways such as plug-in MD/HD vehicles and autonomous vehicles. The reviewer remarked that these are timely additions will enhance the usefulness of the model for stakeholders trying to understand the energy and environmental impacts of new technologies that are just starting to enter the market. The reviewer noted how identifying default input assumptions for such new technologies are a challenge across the modeling and transportation communities. However, ANL's approach of gathering information from a wide variety of stakeholders, clearly documenting sources, allowing model users to easily change input assumptions, and regularly updating assumptions helps mitigate this risk. The reviewer noted that work to address LCA regional boundary issues, vehicle lightweighting, and continued improvement on assumptions for water consumption will also enhance the model. The reviewer suggested that ANL might consider expanding the well-to-wheels calculator to include additional pathways (e.g., MD/HD vehicles) in future years.

Reviewer 2:

The reviewer recommended that additional areas for consideration are off-highway sectors, particularly construction, industrial, agricultural, and marine equipment and relevant technologies. The reviewer noted that these possess a similar technology suite to MD/HD on-highway commercial vehicles, but applications and duty cycles as well as economic assumptions influencing technology trends will vary for these industry sectors. The reviewer suggested that the project team's considerations should include alternative fuels, connected and autonomous vehicles, EVs, FCEVs, PHEVs, hybrid electric vehicle (HEV) technologies, and other emerging technologies.

Reviewer 3:

Regarding the future work capabilities list, the reviewer suggested it would be good to include context on including these capabilities for the drivers (e.g., additional questions that will be addressed, key stakeholders driving the prioritization, and what the desired outcome will be). The reviewer pointed out that the GREET model can be expanded in many directions, and so understanding how to have the biggest impact with the given resources should drive prioritization.

Reviewer 4:

The reviewer found that proposed future work for GREET and VISION is effective, but could be better if GREET addressed the boundary condition issues mentioned in prior comments.

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

Reviewer 1:

The reviewer noted that GREET provides a well-documented and accepted methodology for calculating well-to-wheels emissions for a variety of vehicles and fuels. According to the reviewer, having such a tool accessible to the broad transportation community clearly supports the overall DOE objectives of reducing emissions by providing a tool to calculate emissions.

Reviewer 2:

The reviewer stated yes; these models help researchers and stakeholders analyze the energy and environmental impacts of a wide range of vehicle and fuel pathways. As such, they can help assess the potential energy benefits of programs and policies to advance energy goals.

Reviewer 3:
The reviewer said there is no question that the GREET and VISION tool development is highly relevant for DOE and VTO program and mission.

Reviewer 4:
The reviewer had no additional comments.

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

Reviewer 1:
The reviewer explained that resources appear sufficient to manage the current breadth of applications and technologies, but may lack sufficient resources to expand beyond the current scope into the suggested areas included in prior response.

Reviewer 2:
The reviewer commented that resources seem sufficient, project milestones have been met or are on target, and future work seems well-planned.

Reviewer 3:
The reviewer remarked that resources seem sufficient, however, and the team needs to more clearly articulate priorities for the project's next steps.

Reviewer 4:
The reviewer noted that resources seem sufficient.

Presentation Number: van018
Presentation Title: VTO Program Benefits Analysis
Principal Investigator: Tom Stephens (Argonne National Laboratory)

Presenter
Tom Stephens, Argonne National Laboratory

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

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

Reviewer 1:
The reviewer commented that the team uses the VTO-developed models to conduct their analyses. The approach is reasonable, and the team utilizes multiple approaches and compares results to better understand what factors will impact the desired outcomes of petroleum use and GHG emissions.

Reviewer 2:
The reviewer described that the objective of this analysis—assessing the benefits of VTO program targets—is interesting and potentially useful for VTO in making future program decisions. The researcher has established a reasonable modeling framework to approach the question. However, there are many technical challenges associated with drawing boundaries for, and attributing benefits to, the different technologies being assessed as well as in determining how sensitive results are to different assumptions (e.g., fuel prices).

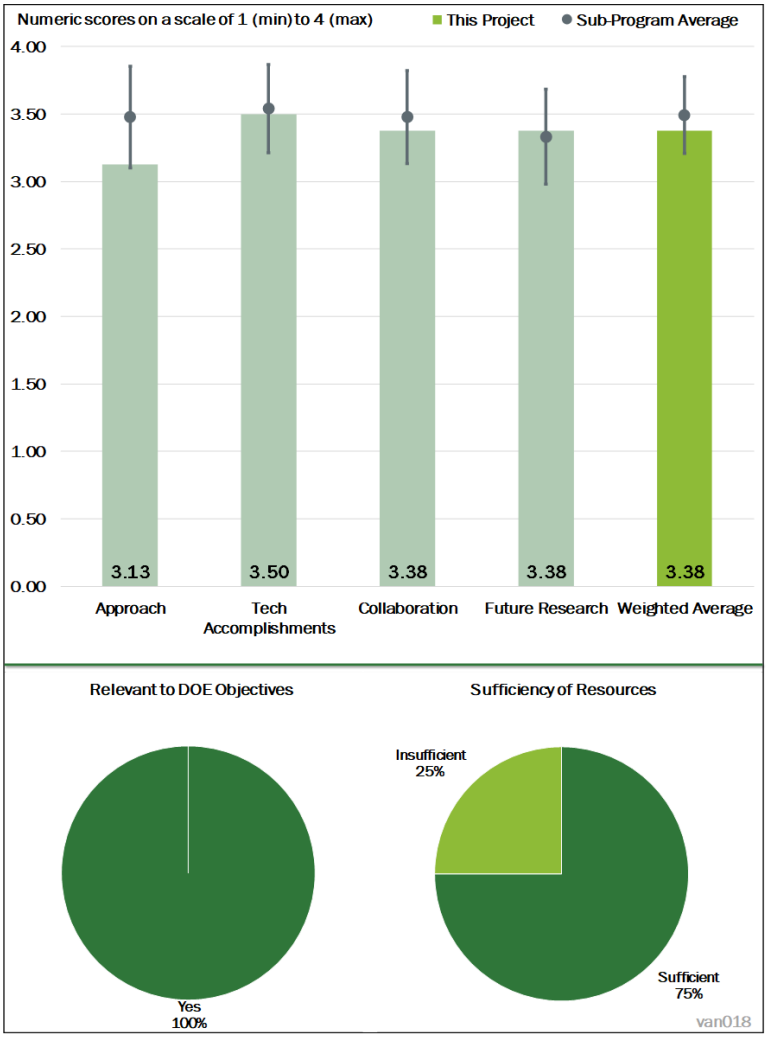

Figure 8-3 - Presentation Number: van018 Presentation Title: VTO Program Benefits Analysis Principal Investigator: Tom Stephens (Argonne National Laboratory)

The reviewer noted that the researcher has conducted some initial tests addressing some of these challenges; e.g., varying the order that different technologies are applied. The reviewer strongly recommended additional sensitivities and side cases. In particular, it would be useful to look at program success scenarios one at a time for individual technology/subprogram targets, i.e. how big are potential program benefits if fuel cell targets are reached but battery electrification and other program targets are not achieved (base case) and vice versa. The proposal to explore sensitivity to fuel costs also seems critical as this may be a significant driver of vehicle choice models and would likely not impact subprogram areas equally.

Reviewer 3:
The reviewer said the project team has demonstrated that additional applications and technologies have been taken into consideration, particularly in the areas of MD and HD trucks. The reviewer expected to see

continued future growth in this area, but appreciated that there has been a growing level of commitment this past year.

Reviewer 4:
The reviewer commented the issue with the approach is that the analysis results are from assumptions that may not play out in the real world. If that is stated upfront, there should not be a problem if everyone understands the initial set assumption. The reviewer acknowledged not having a suggestion to overcome this, except to reiterate that the results are not predictors but possible outcomes that do not assign a level of uncertainty.

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 project milestones seem complete or on track.

Reviewer 2:
The reviewer asserted that the project is effective at overcoming most barriers. There is a good recognition of the importance of all on-highway sectors, specifically, LD, MD, and HD vehicles.

Reviewer 3:
The reviewer remarked that accomplishments and progress in the presentation indicate that the project is well-managed and strives to reach the intended outcome.

Reviewer 4:
The reviewer commented that the team conducted a methodological assessment of the technology components of the DOE program and their potential impact on fuel consumption. The analysis provides insight into the factors that contribute to reductions in petroleum use over time. Moreover, the reviewer highlighted that the team also shows initial results indicating that lower fuel costs may offset the additional cost of the vehicle improvements. This type of analysis can provide broader context to help inform decision makers.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer remarked that the project seems well coordinated with VTO, the national laboratories, and other project partners, which is critical given that the analysis uses multiple models (and model types) to assess program benefits.

Reviewer 2:
The reviewer noted how this project uses models across the VTO analysis portfolio to examine the impact of the VTO program advanced technology R&D. The team collaborates closely with the other performers and clearly indicated how each of the collaborators is engaged.

Reviewer 3:
The reviewer reported that collaboration and coordination presented appear to be more than adequate.

Reviewer 4:
The reviewer said that collaboration and coordination among federal and national laboratory stakeholders and supporting organizations seems to be good. The reviewer suggested more industry outreach to involve more stakeholders to influence future direction.

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

Reviewer 1:
The reviewer described how proposed future work includes analyzing sensitivities and uncertainties associated with inputs/assumptions, and conducting additional scenarios/cases to look at the influence of meeting subprogram targets individually. As noted earlier, this seems critical to assessing (and properly attributing) the benefits of meeting technology targets in different areas. The reviewer is glad to see this in future plans.

Reviewer 2:
The reviewer remarked that proposed future work is reasonable. In particular, the ability to consider sensitivities and consider hundreds of combinations would be useful for understanding the range of impact each factor may have. The reviewer said that the team should also consider including the impact of other advances in both technology and future vehicle utilization models to identify whether additional synergies may exist within the program investments.

Reviewer 3:
The reviewer detailed how plans include increased analysis of VTO technologies in MD and HD vehicles, including more effort in this calendar year. The reviewer would like to see continued growth in this sector, and suggested including industry's view toward off-highway applications as well, including construction, industrial, agriculture, and marine applications. The reviewer pointed out that there is some overlap of relevant technologies in the commercial vehicle sector that is relevant for study here.

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

Reviewer 1:
The reviewer said yes, assessing the benefits of VTO technical targets (if done with sufficient rigor) can directly inform DOE's programmatic decisions in order to help maximize potential energy, cost, and environmental benefits.

Reviewer 2:
The reviewer pointed out that the project supports overall DOE objectives by providing a venue for identifying the potential impact of advanced DOE technologies. It provides a venue for scenario analyses and considers a mix of technological impacts on emissions' given costs.

Reviewer 3:
The reviewer indicated that this work must be performed to support DOE senior management decisions.

Reviewer 4:
No further comments were offered 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 advised that resources may be insufficient to grow into the additional market sectors and relevant technologies stated in previous comments.

Reviewer 2:
The reviewer said that resources seem sufficient given that milestones have been met or are on target.

Reviewer 3:
The reviewer commented that resources seem sufficient to keep the team on track for milestones.

Presentation Number: van023
Presentation Title: Assessing the Energy and Cost Impact of Advanced Technologies through Model-Based Design
Principal Investigator: Aymeric Rousseau (Argonne National Laboratory)

Presenter
Aymeric Rousseau, Argonne National Laboratory

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

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

Reviewer 1:
The reviewer reported that the presentation clearly explained the approach. The team has transitioned from LD into MD/HD on-highway applications and defined 15 target application/vehicle types.

Reviewer 2:
The reviewer pointed out that ANL is expanding Autonomie to include additional vehicle classes, vocations, and powertrain combinations, increasing its utility to analysts and members of the transportation community. There are significant technical barriers associated with identifying vehicle specifications and inputs, particularly for new technologies that are less well-established in the market, such as MD/HD electric and fuel cell vehicles. The reviewer pointed out that ANL addressed these barriers by conducting its own analyses of the power levels /battery sizing and other specifications that would be needed to match the performance of a baseline vehicle (e.g., using FleetDNA). The reviewer remarked that this seems like a reasonable approach for establishing an initial modeling framework for new technologies. The reviewer noted that future plans to formally gather feedback from original equipment manufacturers (OEMs) on MD/HD electrification and other new technologies as the market evolves will further enhance the model.

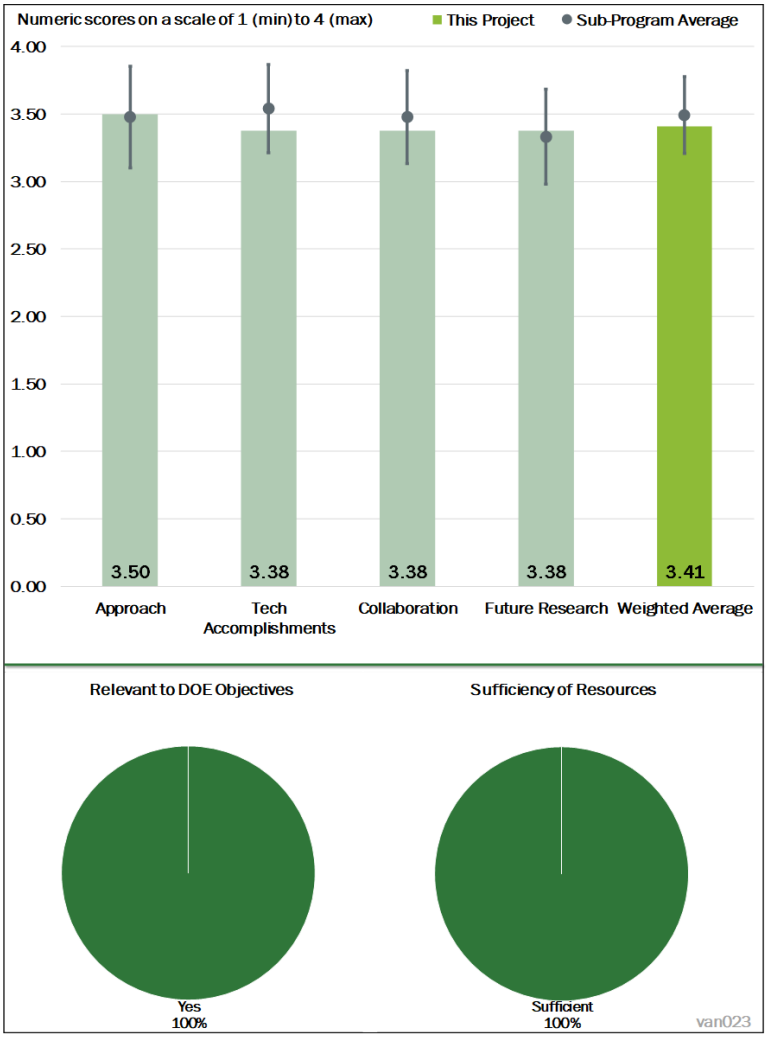

Figure 8-4 - Presentation Number: van023 Presentation Title: Assessing the Energy and Cost Impact of Advanced Technologies through Model-Based Design Principal Investigator: Aymeric Rousseau (Argonne National Laboratory)

Reviewer 3:
The reviewer noted that the majority of the effort has been focusing on building up the capability to include MD and HD vehicles. The approach seems sound, building upon work from other agencies and extending the LD model to account for MD and HD vehicles with various powertrains. The reviewer noted that significant attention has been on gathering appropriate input parameters from DOT and DOE, including previous studies and roadmaps. Moreover, according to the reviewer, the team has engaged relevant stakeholders, which is

critical given the diversity of MD & HD vehicles and for creating foundational models that can support a broad community.

Reviewer 4:
The reviewer commented that the Autonomie model is extremely data, and assumption intensive, and recommended that the model be benchmarked and/or compared to lumped parameter models and empirical data. The results and costs of development of the two modeling approaches should be evaluated and compared on an ongoing basis.

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

Reviewer 1:
The reviewer remarked that the technical accomplishments and progress presented indicate that the project is well-managed to achieve the goals of the VTO analyses program.

Reviewer 2:
The reviewer reported that the LD report is complete, and MD and HD work seems to be on target. The reviewer pointed out that initial assumptions for new MD and HD combinations are complete.

Reviewer 3:
The reviewer pointed out that a comment made on Slide 3 that the "benefits of vehicle technology improvements for the [MD and HD] vehicles are not well understood." This is not a criticism, but perhaps an acknowledgement that the transition from studying LD vehicles into the MD and HD sector has just begun within the past 8 months. The reviewer remarked this is a welcome transition. The opportunities seem to be significant in effectively deploying technologies into this sector. The reviewer speculated that perhaps more study is needed to understand the potential value that can be achieved in this sector. Similarly, the same question can be asked of the off-highway sectors, although the chart on Slide 3 suggests diminishing returns from marine, rail, and other. The reviewer wondered if perhaps further study is necessary to understand the implications in these sectors.

Reviewer 4:
The reviewer said the team has incorporated input data and verified the model results against other established reports and studies. The team has been explicit about assumptions and scope, and has been guided by OEM, DOT, DOE, and other partner input. The reviewer suggested it would be good for future reviews to be more explicit about how stakeholders are using the results, whether and how many requests for analyses the team has received and executed, and what outcomes resulted from those analyses and queries.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer commented that the project team is collaborating and receiving input from a number of stakeholders and partners across DOE, DOT, and OEMs, which is guiding the model development appropriately.

Reviewer 2:
The reviewer remarked that the collaboration and coordination across multiple internal and external model uses is excellent. The reviewer did not have any suggestions for improvement except for maintaining collaboration and coordination efforts.

Reviewer 3:
The reviewer stated yes, ANL is coordinating with VTO and the Fuel Cell Technologies Office as well as with other national laboratories, agencies, OEMs, suppliers, universities, and other organizations on modeling inputs and assumptions.

Reviewer 4:
The reviewer said that collaboration is good as currently defined. The reviewer suggested more industry collaboration to help identify questions relevant to industry that modeling by ANL can support, and to give industry the opportunity for greater input into the direction that future work may take in evaluating both on-highway and off-highway technology applications.

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

Reviewer 1:
The reviewer noted how ANL has identified multiple ways to continue to enhance the Autonomie model (e.g., adding additional powertrains and vehicle classes, cost estimation) as well as to make current inputs more robust. Given the technical challenges associated with developing assumptions for MD/HD electrification, this reviewer commented that ANL's plans to more formally gather feedback from OEMs on these assumptions may be particularly useful, and likewise for the proposal to develop a vehicle technology database.

Reviewer 2:
The reviewer found that the proposed future work is appropriate. It would be further strengthened by identifying key questions and issues of interest to the stakeholder community and clarifying how those questions are guiding model development and publishing the resulting analyses.

Reviewer 3:
The reviewer requested more information into how Autonomie has been used by the MD/HD vehicle OEMs, and to explore how to further exploit these capabilities in the future. The reviewer would suggest a similar extension to the off-highway sectors of construction, industrial, agriculture, forestry, and marine as the on-highway work transitions into next steps and into the off-highway sector.

Reviewer 4:
The reviewer referenced prior comments made in question 2, about comparing results with empirical data and other simpler models.

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

Reviewer 1:
The reviewer said yes, the Autonomie model can help researchers and stakeholders analyze the energy and cost impacts of advanced technologies, which are important to assessing the potential energy benefits of transportation policies and programs.

Reviewer 2:
The reviewer stated the project supports overall DOE objectives by providing an energy and cost assessment model for examining the impact of light, MD, and HD vehicles with a variety of system components and alternative powertrains.

Reviewer 3:
The reviewer commented that the project supports the VTO mission because it is important to have analyses result from this project that can help direct and evaluate R&D future benefits and costs.

Reviewer 4:
The reviewer had no further comments.

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

Reviewer 1:
The reviewer explained that a more clearly defined approach to other sectors, such as off-highway, can identify if resources are sufficient to study MD/HD on-highway and the off-highway applications, with its higher degree of application and equipment proliferation.

Reviewer 2:
The reviewer said that resources seem sufficient to achieve the stated milestones.

Reviewer 3:
Resources seemed sufficient to this reviewer. Project milestones have been met or are on target, and future work seems well-planned. The reviewer was unclear to what extent additional funding would be needed for future work.

Reviewer 4:
This was a difficult question for this reviewer to answer. The reviewer asked whether project costs justify the results, or whether there is another modeling technique and other data to gather that can provide comparable results with less resources. This reviewer also referenced prior comments.

Presentation Number: van026
Presentation Title: Modeling Framework and Results to Inform Charging Infrastructure Investments
Principal Investigator: Eric Wood (National Renewable Energy Laboratory)

Presenter
Eric Wood, National Renewable Energy Laboratory

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

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

Reviewer 1:
The reviewer remarked that the modeling framework and analyses presented can help significantly inform U.S. public charging infrastructure needs at both the national and state/local levels, and thus help to reduce a key barrier to PEV adoption. Modeling potential load profiles of direct-current (DC) fast charging, and analyzing the effectiveness of different strategies (e.g., onsite storage, renewable generation) to reduce demand charges can likewise help to reduce barriers to consumer adoption of these new technologies.

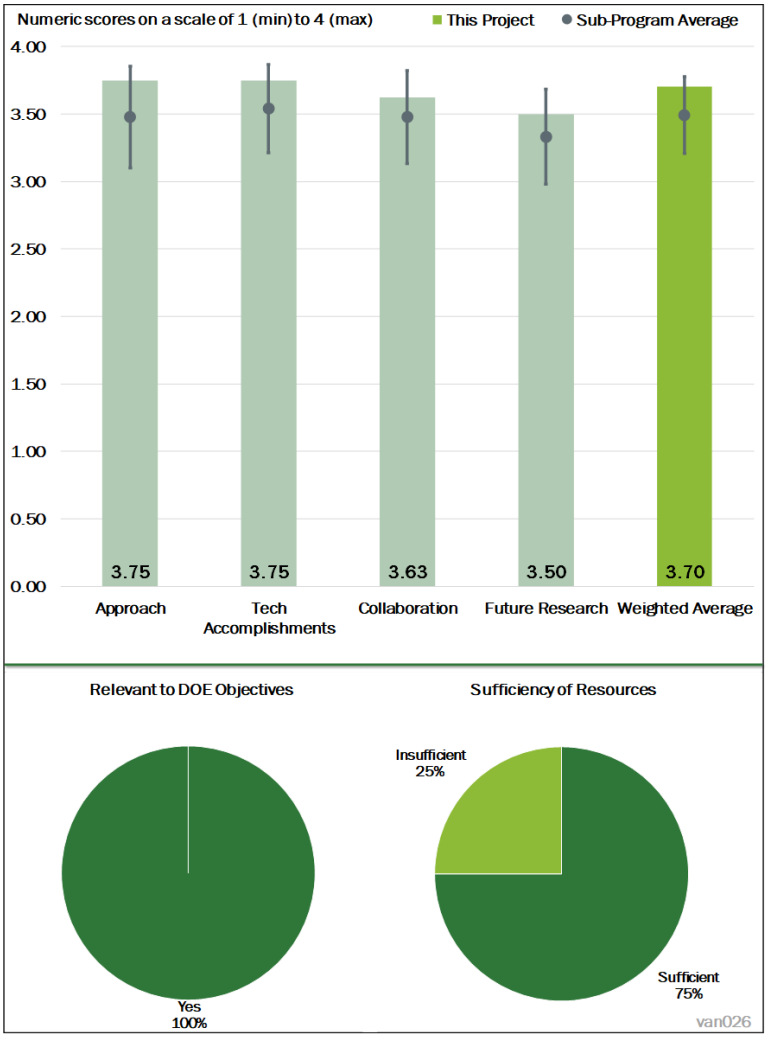

Figure 8-5 - Presentation Number: van026 Presentation Title: Modeling Framework and Results to Inform Charging Infrastructure Investments Principal Investigator: Eric Wood (National Renewable Energy Laboratory)

The reviewer described the five completed projects as well-defined and feasible. There are many uncertainties associated with estimating future infrastructure needs such as technology developments and consumer preferences. The reviewer pointed out that the National Renewable Energy Laboratory (NREL) addressed this technical barrier by using sensitivity analyses to test the impact of different variables and input assumptions. While shared mobility (or other factors that could significantly shift how vehicles are used and how much infrastructure is needed) was outside the scope of this modeling framework, the researchers are considering this in future work. The reviewer remarked that from the information presented, plans for the multi-unit dwelling (MUD) charging work also seem well-designed and feasible.

Reviewer 2:
The reviewer observed a good approach to developing a better understanding of the issues and factors of electric vehicle supply equipment (EVSE). The reviewer pointed out this is necessary work to provide a foundation for developing future strategies around charging infrastructure.

Reviewer 3:
The reviewer remarked the project team has done an excellent job of looking at a variety of geographies, approaches, and issues associated with creating charging infrastructure EVs. The project team is combining local, regional, and national consumer travel data, utility cost models, and other existing reports and models for EV charging requirements as inputs for their modeling and analyses. The reviewer said the team is also making the tools available online to enable a broad community of stakeholders to access the capabilities. This will enable greater impact and leverage the investments.

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

Reviewer 1:
The reviewer pointed out that the team has completed five of the six analyses, with several publications and the EVI-Pro Lite tool released for public use. Other project papers and work seem on target. The reviewer noted that the team has done extensive technical work to date to establish, test, and perform sensitivity analyses on modeling framework and results. The work was appropriately informed by national and local travel data, an examination of utility rate structures, and stakeholder and expert input.

Reviewer 2:
The reviewer said the project provides a good foundation of evaluation and case studies, and it is also helpful to define future challenges and the need for information around the uncertainties of PEVs, MUDs, transportation network company (TNCs), etc. The reviewer remarked that it seems like more study is needed to understand these uncertainties.

Reviewer 3:
The reviewer stated that the team has produced an impressive set of capabilities and results that have been well-documented and shared with a variety of stakeholders. The reviewer pointed out that, based on previous reviewer comments, the team has also focused efforts to include large PEV market areas, and explicitly focused on broad stakeholder engagement, which will further amplify and extend the impact of the tools and results.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer observed project partners coordinated across national laboratories, and with state and local governments, federal agencies, universities, EVSE providers, utilities, automakers, and other stakeholders.

Reviewer 2:
The reviewer noted good collaboration with government and industry in the target sectors. The reviewer suggested more representation from the commercial vehicle sector would be useful, particularly the area of LD and MD urban commercial vehicles.

Reviewer 3:
The reviewer remarked the team has conducted workshops and targeted engagements with relevant stakeholder communities for PEV charging infrastructure. This not only improved collaboration and coordination across the project team, but also engaged a broad set of stakeholders who can benefit from the project.

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

Reviewer 1:
The reviewer remarked that the proposed future work is sound and looks to gain greater insight into the future use of EVs and infrastructure needs given the shifts in consumer and public needs. The reviewer pointed out that charging at MUDs will be significant with increasing urbanization, and ride-hailing and car-sharing will create additional shifts in the way consumers utilize transportation—with potentially significant impact on EV adoption and ownership models. The reviewer noted that these are critical issues for the DOE to consider. This proposed work is well-aligned with addressing barriers to EV adoption.

Reviewer 2:
The reviewer detailed that proposed future work on charging access for MUD residents, electrification of TNCs, and market uncertainty will help address key questions about future infrastructure needs. The reviewer pointed out that plans to enhance and utilize existing models (e.g., ADOPT, EVI-Pro, and Behavior, Energy, Autonomy, and Mobility [BEAM]) for these efforts in coordination with partners increases the likelihood of success.

Reviewer 3:
The reviewer said that there are clearly many issues that need a better understanding in the LD vehicle sector, particularly how urban mobility will change in the foreseeable future, and the implications for EVs. The reviewer noted it is important to understand the various plausible scenarios for LD vehicles first, but perhaps it is not too soon to begin discussing LD commercial vehicles and the implication for other commercial vehicle types.

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

Reviewer 1:
The reviewer stated yes; these projects help remove barriers to the adoption of advanced technology vehicles.

Reviewer 2:
The reviewer found that this project is well-aligned with DOE objectives for reducing petroleum consumption and GHG emissions. This project is particularly well-positioned to have impact across a variety of stakeholders at DOE, other federal agencies, and the broader transportation stakeholder community.

Reviewer 3:
The reviewer had no further comments.

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

Reviewer 1:
The reviewer commented that the resource profile for FY 2018 seems low to continue progress and achieve goals. FY 2019 funding was not shared in the review materials. There is a tremendous set of output from the project given the resources, and the reviewer suggested increasing support to further accelerate progress and dissemination of the model and results.

Reviewer 2:
The reviewer noted that resources seem sufficient for current work, and project milestones have either been met or are on target. The reviewer was not clear if proposed future work would need additional resources.

Reviewer 3:

The reviewer remarked that the questions needing answers are broad, and collaboration with others who are also studying these questions is essential. The reviewer thought the project approach and collaborators listed suggest that collaboration is good and leveraging these resources should be a focus for future work.

Presentation Number: van028
Presentation Title: Electric Vehicle—Grid Benefits Analysis
Principal Investigator: Anand Gopal (Lawrence Berkeley National Laboratory)

Presenter
Anand Gopal, Lawrence Berkeley National Laboratory

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

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

Reviewer 1:
This reviewer reported that the team links mobility and grid models to estimate costs and benefits of integrating millions of PEVs onto the grid. The team used the accepted BEAM charging model and PLEXOS power sector model to conduct the analyses to look at integration in California, and then extend the results nationally for various charging schemes. The reviewer found that the approach is sound and addresses important the important barrier of PEV charging on the grid.

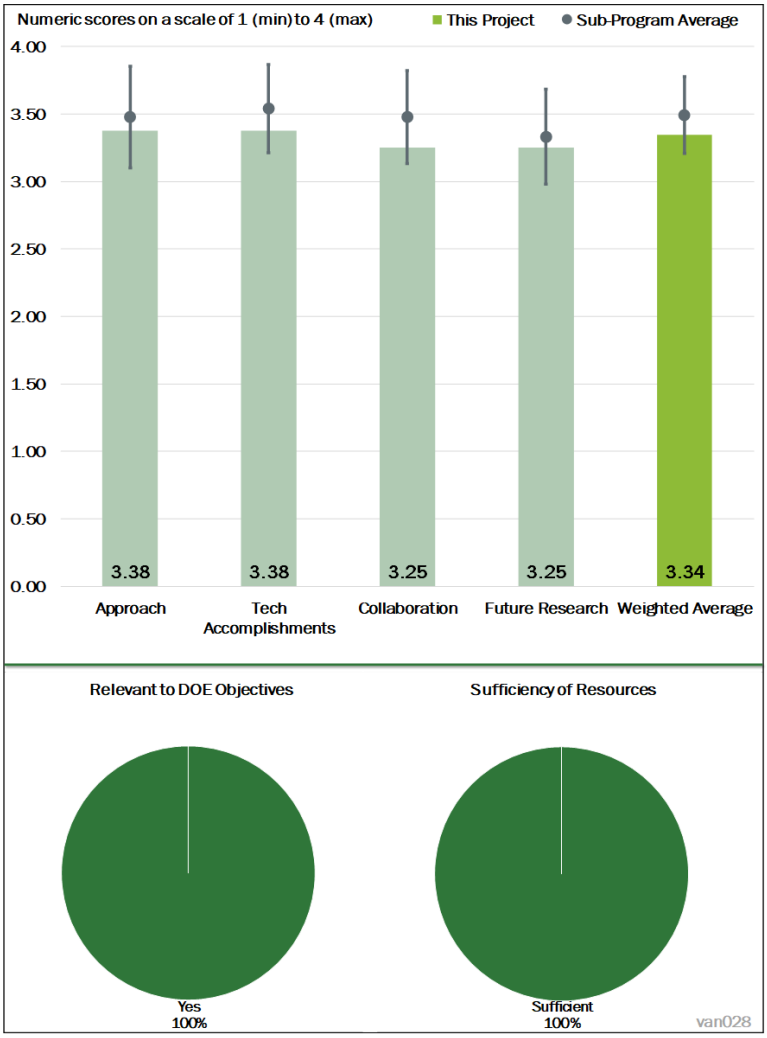

Figure 8-6 - Presentation Number: van028 Presentation Title: Electric Vehicle—Grid Benefits Analysis Principal Investigator: Anand Gopal (Lawrence Berkeley National Laboratory

Reviewer 2:
The reviewer described the approach as clearly defined and appropriate.

Reviewer 3:
The reviewer said that this research addresses interesting questions on how EVs could impact the grid under different charging scenarios (unmanaged, smart, and time of use [TOU] charging). The researchers seem to have developed a reasonable initial framework for approaching these questions and found some interesting preliminary results. However, the reviewer observed many technical challenges, particularly in scaling the very detailed California analysis to a national one, and pointed out that there is detail lacking in the presentation to evaluate plans for that analysis.

The reviewer cited that some factors researchers might consider in scaling to the national level are whether PEV energy consumption will be significantly different in colder regions of the country due to cold weather effects on the batteries, and how TOU rate structures might vary (i.e., is the time at which lower rates kick in the same everywhere). The reviewer noted that researchers might also consider doing a few additional, detailed local analyses (similar to the one conducted for the San Francisco Bay area) in different parts of the country to

help inform the national analysis. The reviewer suggested seeing the question on future work for additional sensitives that might be useful.

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

Reviewer 1:
The reviewer pointed out that project milestones seem to be met or on target.

Reviewer 2:
The reviewer commented progress to-date is satisfactory based on the October 2017 project start.

Reviewer 3:
The reviewer remarked the team has made solid progress on examining managed charging strategies in California and the impact on the electric grid for a variety of adoption levels taken from the California Energy Commission forecasts. Results include the impact on renewable curtailment and the benefit of various charging schemes on more effectively utilizing renewables. The reviewer noted that results provide relevant new insights into the potential impact of managed charging strategies to better utilize renewables.

Question 3: Collaboration and Coordination Across Project Team.

Reviewer 1:
The reviewer acknowledged that some key uncertainties have been identified. The reviewer recommended that it would be helpful to add collaborators from industry to help explore some of these uncertainties and alternative approaches to the issues of grid impact, consumer reluctance to purchase new technologies, and other technology alternatives and grid options. As an example, this reviewer asked how micro-grids and distributed power can help address some of the current grid infrastructure limitations or challenges, and how renewables and energy storage enable some of these solutions.

Reviewer 2:
The reviewer noted that researchers are coordinating with ANL and a university team. For future work, the reviewer suggested the team might consider additional coordination or outreach to NREL (i.e., the team that conducted the national PEV charging infrastructure analysis) and Idaho National Laboratory (for work on charging profiles).

Reviewer 3:
The reviewer said the project is well-coordinated with government and university partners in California. The reviewer explained that input from national stakeholders and increased interaction with the other VTO analysis performers should enable the project to have even more impact as well as benefit other projects within the portfolio.

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

Reviewer 1:
The reviewer topics for consideration as future work, including how micro-grids and distributed power can help address some of the current grid infrastructure limitations or challenges; how renewables and energy storage enable some of these solutions; and how hydrogen production and storage can provide synergies with the grid limitation issues and the need for productive use of excess renewable energy during non-peak hours.

Reviewer 2:
The reviewer noted that this proposed future work will address key shifts—such as ride hailing—that will impact future vehicle use and charging requirements. The reviewer stated exploring the potential impact of future mobility trends on PEV charging will be of significant interest in understanding the impact on the grid and the costs/benefits from both a system and consumer perspective.

Reviewer 3:
The reviewer commented there is not enough detail on the slides to evaluate planned work to scale California results to a national-level analysis. Proposed future work includes looking at the potential impacts of autonomous and ride-hailing fleets. These are interesting and important questions, and the reviewer encouraged the researchers to pursue these. However, even in the current individual ownership (and non-autonomous) model, there are additional case studies that could be considered. The reviewer noted how researchers suggested looking at a case with significantly more workplace charging. This seems important given that workplace charging is the second most common after home charging and could grow as more workplaces add infrastructure and/or more MUD residents purchase PEVs. The reviewer suggested that researchers might also consider side cases that incorporate additional public charging, particularly DC fast-charging and extreme fast-charging, which have different load profiles than residential and workplace charging. The reviewer said the project could also benefit from conducting sensitivities around key parameters for the vehicle mix (e.g., longer ranges, different battery electric vehicle/PHEV splits) as these could significantly impact charging behavior.

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

Reviewer 1:
The reviewer agreed yes, this work can help researchers understand the potential energy, cost, and environmental benefits of advanced technology adoption.

Reviewer 2:
The reviewer commented that this project directly looks at the impact of PEVs on the electric grid and the impact on renewable energy utilization. This provides insights into the DOE objectives of reducing GHG emissions and petroleum consumption.

Reviewer 3:
The reviewer had no further comments.

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 resources appear to be sufficient for the current questions in scope. Other issues have been raised in these comments that may require additional resources, or at least more collaboration with those who are studying these questions.

Reviewer 2:
The reviewer indicated that resources seem sufficient to meet stated milestones.

Reviewer 3:
The reviewer pointed out that while the presentation specific total funding and support for FY 2017, FY 2018 and FY 2019 levels were not. However, it appears that only a small amount of total project funds was used in prior years, so the remaining support is likely sufficient for the proposed work.

Acronyms and Abbreviations

ANL	Argonne National Laboratory
BEAM	Behavior, Energy, Autonomy, and Mobility
DC	Direct-current
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EV	Electric vehicle
EVI-Pro	Electric Vehicle Infrastructure Projection
EVSE	Electric vehicle supply equipment
FCEV	Fuel cell electric vehicle
FOTW	Fact of The Week
FY	Fiscal year
GHG	Greenhouse gas
GREET	Greenhouse gas, Regulated Emissions, and Energy use in Transportation
HD	Heavy-duty
LCA	Life cycle analysis
LD	Light-duty
MD	Medium-duty
MUD	Multi-unit dwelling
NREL	National Renewable Energy Laboratory
OEM	Original equipment manufacturer
ORNL	Oak Ridge National Laboratory
PEV	Plug-in electric vehicle
PHEV	Plug-in hybrid electric vehicle
R&D	Research and development
TEDB	Transportation Energy Data Book
TNC	Transportation network company
TOU	Time of use

VAN	Vehicle Analysis (VTO program)
VTO	Vehicle Technologies Office