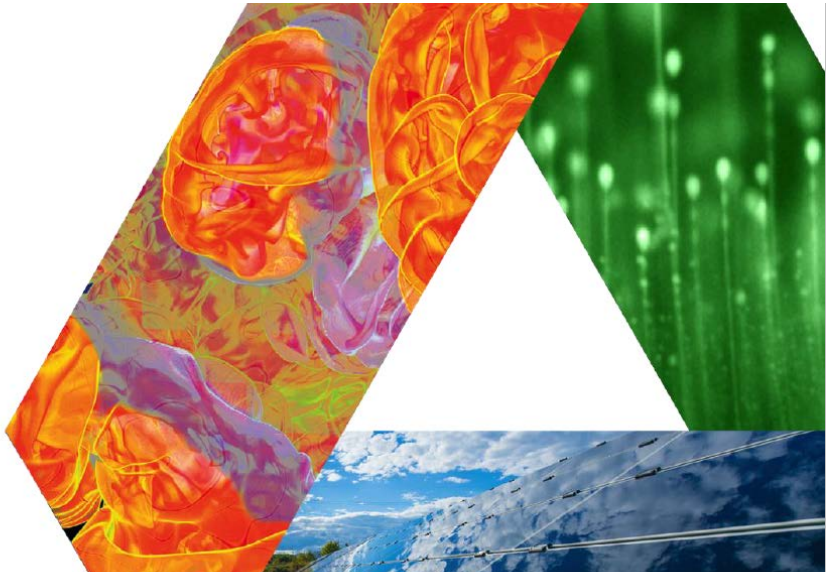
WE START WITH YES.

Argonne NATIONAL LABORATORY

VTO PROGRAM BENEFITS ANALYSIS



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Vehicle Technologies Office - 2018 Annual Merit Review
June 12, 2019

Project VAN018

Overview

Timeline

Ongoing project prior to FY 2017

Project start: 1 Oct 2016

Project end: 30 Sep 2019

Barriers

- Relating component-level technologies to national-level benefits
- Indicators and methodology for evaluating benefits

Budget

FY 2018: $229k

FY 2019: $250k

(100% DOE)

Partners

- Interactions / Collaborations
  - Energetics, Inc.
  - Oak Ridge National Laboratory
  - National Renewable Energy Laboratory
  - Sandia National Laboratories

Objective

Estimate potential future benefits attributable to the VTO Program, including national-level reductions in

- Petroleum use
- Consumer costs, oil security costs
- Emissions

VTO uses results of this analysis to communicate the benefits of the program to DOE management, other agencies, Congress and others.

Compare two scenarios, with and without successful deployment of VTO technologies

- Program Success: Vehicles meet VTO performance, fuel economy and cost targets
  - Vehicle component cost and performance based on VTO/FCTO program targets, projected to 2050
  - Vehicle attributes estimated from component attributes
- Baseline (No Program): Without VTO technology improvements
  - Vehicles simulated on the basis of VTO & FCTO inputs for "No Program"

Relevance

VTO targets for subprograms:

- Adv. combustion engines and fuels R&D
- Electric drive and batteries R&D
- Materials R&D
- Fuels and Lubricants R&D

For light-duty and heavy-duty vehicles

Addressing technical barrier:

Relating component-level technologies to national-level benefits

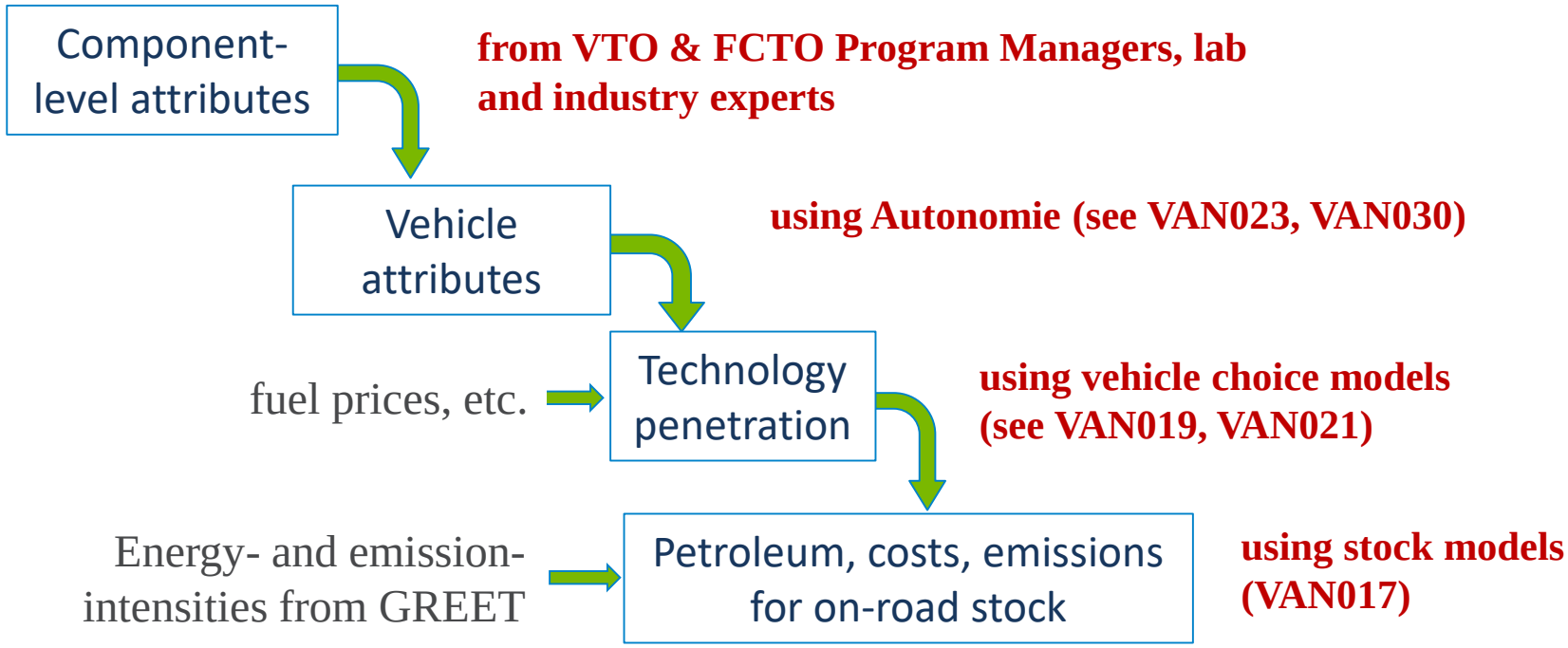
Vehicle simulations performed by ANL Autonomie Team (see presentation #VAN030)
Heavy truck technology adoption and fleet energy/emissions analyzed by Energetics Inc.

Benefits analysis process

Steps	Questions addressed	Approach
Define input assumptions	What are EERE technology targets? How will tech progress without EERE?	Review R&D programs, get inputs from DOE and other experts
Define baseline scenario	How would the on-road fleet look (fleet mix, fuel economy, energy use) without EERE R&D?	LDVs: simulate vehicles to estimate cost, mpg. Run market penetration and stock models for Base case M&HDV: Modify AEO Ref case vehicles and model on-road stock
Program Success scenario	How would the on-road fleet look (fleet mix, fuel economy, energy use) with successful EERE R&D?	LDVs and M&HDVs: simulate vehicles to estimate cost, mpg. Run market penetration and stock models for Program Success case
Estimate benefits	What are the changes due to EERE R&D?	Compare energy use, market shares, emissions, expenditures of Base and Program Success cases

Connecting program goals to on-road energy use and GHG emissions

Incorporate information from across VTO's analysis portfolio



Stock models include Argonne VISION and Energetics HDStock models

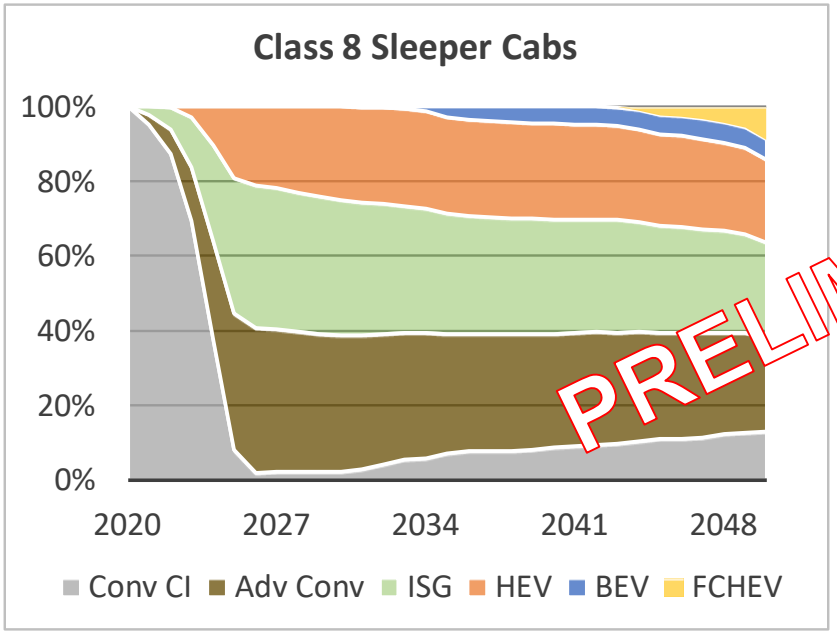
MILESTONES

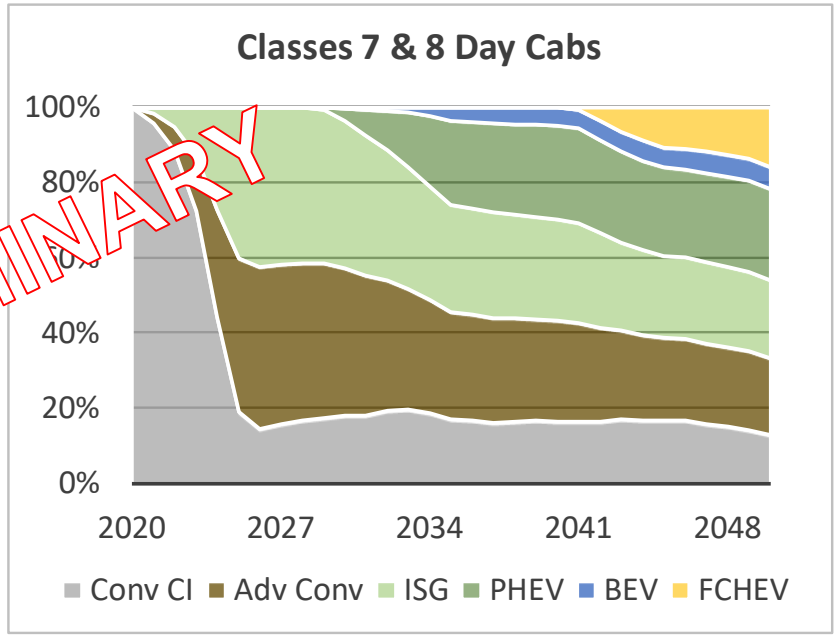
On schedule, documenting medium- & heavy-duty analysis while conducting new analysis of benefits in light-duty and update of medium- and heavy-duty

Month/year	Description	Status
Dec 2018	Presentation on M&HD analysis results	Complete
Mar 2018	Identification of inputs required for next benefits analysis	Complete
Jun 2018	Documentation of M&HD analysis	In progress
Sep 2019	Draft report on LD benefits and sensitivities	On track

Projected Shares by Technology of Vehicle-miles Traveled by New Vehicles

Tractor-Trailers

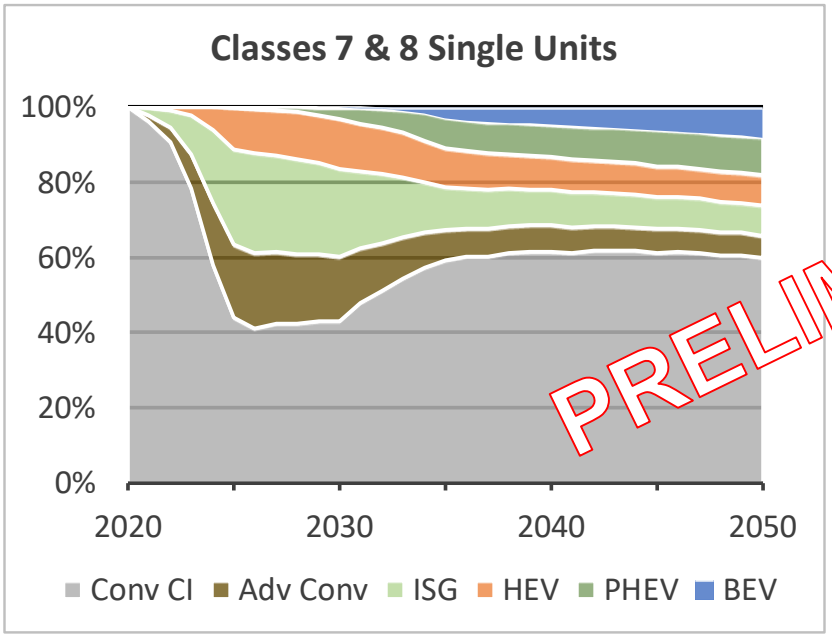


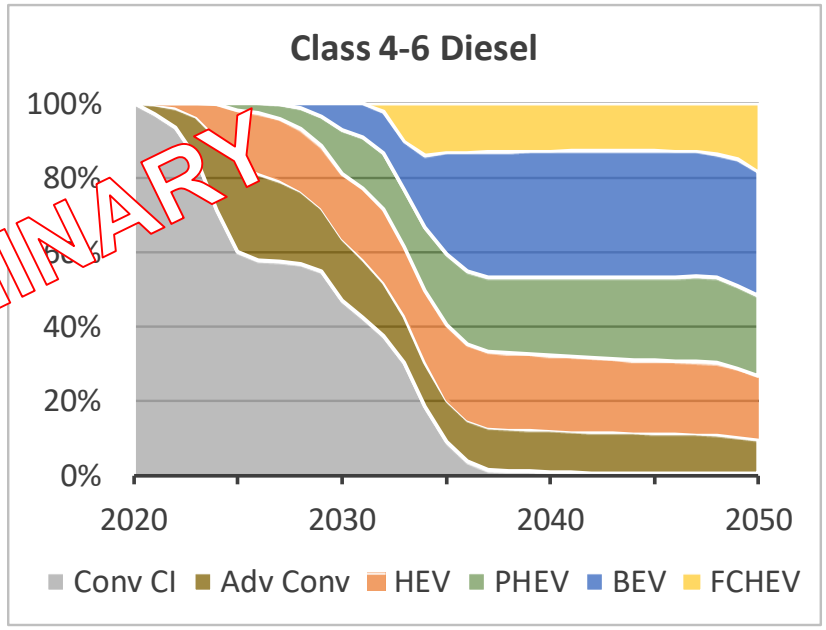


PRELIMINARY

- Hybridization penetrates the market early, but higher costs inhibit market penetration of more advanced technologies (plug-in electric and fuel cell) until later years
- Note: Baseline technology costs do not increase after 2025

Projected Shares by Technology of Vehicle-miles Traveled by New Vehicles



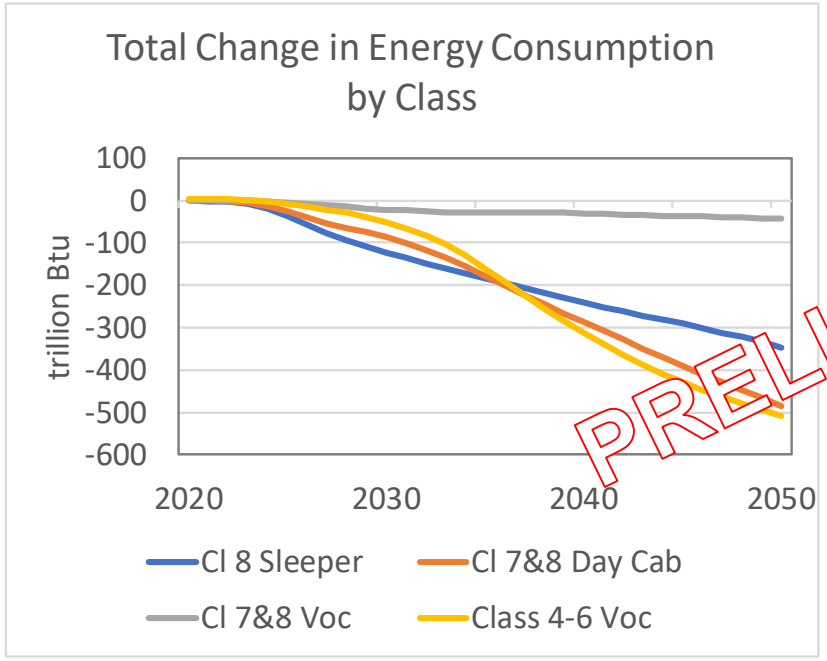


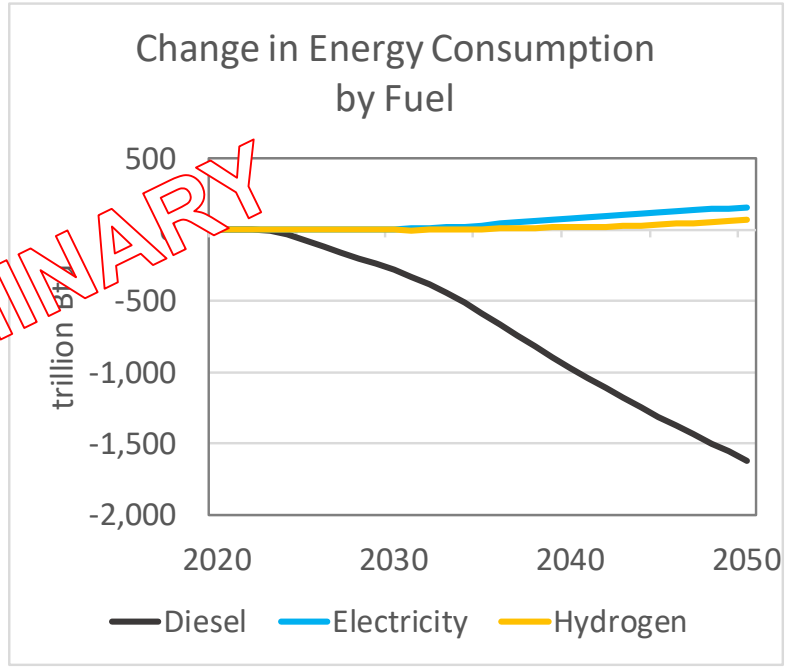
PRELIMINARY

- Somewhat lower advanced vehicle technologies penetration of the Class 7&8 Single unit market partly due to lower annual VMT (so slower payback)
- Advanced technology vehicles eventually dominate the Class 4-6 segment

Adoption of Advanced-technology Vehicles is Projected to Reduce Total On-road Energy Consumption

Difference between energy consumption: Program Success minus Baseline



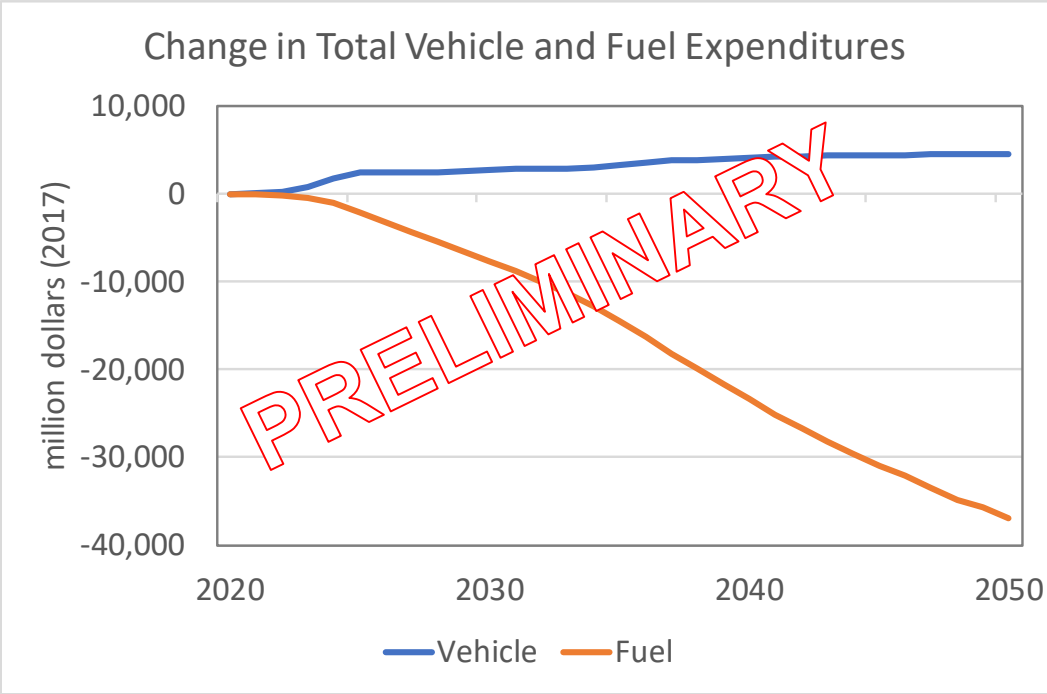


PRELIMINARY

- Large fuel savings in Class 7&8 Sleeper (large share of VMT)
- Also large savings in Vocational segments (high adoption of advanced-technology vehicles)
- Both increased efficiency of diesel trucks and replacement by other powertrains

Adoption of Advanced-technology Vehicles is Projected to Reduce Total Expenditures

Difference between expenditures on vehicles and energy: Program Success minus Baseline



- The savings in energy expenditures greatly exceeds the increase in expenditures on vehicles

Responses to Previous Reviewers' Comments (2017 AMR)

Comment: "The reviewer strongly recommended additional sensitivities and side cases."
Response: Side cases are planned to assess sensitivities to fuel prices and other assumptions. Some sensitivity results were included in 2018 AMR back-up slides.

Comment: 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."
Response: MD & HD models were extended to include more powertrains in more size classes.

Comment: "… 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."
Response: Results are intended to represent plausible future outcomes, not predictions. The Baseline case represents a future in which vehicle technology improves significantly, but more slowly than the Program Success case, based on VTO technology managers' inputs. Use of multiple market penetration models and running side cases can quantify uncertainty due to assumptions and methods.

Collaboration and Coordination

- Energetics Inc. developed the MD/HD vehicle "No Program" baselines, assisted with development of vehicle attribute inputs, modeled technology penetration and fleet stock, and assessed final fleet-level benefits
- Oak Ridge National Laboratory, and Sandia National Laboratory collaborating on technology penetration modeling
- Collaborating with Lawrence Berkeley National Laboratory and University of California at Berkeley on more comprehensive cost metrics and interactions between plug-in vehicles and the electric grid (VAN028)

Remaining challenges and barriers

- Update analysis based on updated inputs from VTO (and FCTO) including both light-duty as well as medium- and heavy-duty vehicles
- Examine uncertainties/sensitivities to assumptions about individual technologies
  - Instead of all technologies reaching “Program Success”, examine the influence of individual technologies and combinations on potential benefits
- Incorporate more comprehensive costs and benefits
  - PEV-grid interactions
  - Ownership costs

Any proposed future work is subject to change based on funding levels.

Proposed future work

- Complete updated analysis of VTO & FCTO technologies in light-duty vehicles
- Update analysis of VTO & FCTO benefits in medium- and heavy-duty vehicles
- Complete analysis of side cases for light-duty vehicles
  - Examining sensitivities to cost assumptions
- Examine uncertainties/sensitivities to assumptions about individual technologies
  - Automate/streamline analysis process to analyze many combinations
- Incorporate more comprehensive costs and benefits (in collaboration with Lawrence Berkeley National Laboratory)
  - PEV-grid interactions
  - Ownership costs
  - External costs

Any proposed future work is subject to change based on funding levels.

Summary: Successful development and deployment of VTO technologies can reduce costs and petroleum use

- Providing estimates of the potential future impacts of advanced vehicle technologies that are being developed under VTO R&D programs
- Scenarios link specific program targets and on-road future benefits component-level => vehicle-level => on-road stock
- Significant benefits from VTO technologies
  - Elucidates the contribution of VTO technologies to EERE mission
  - Provide quantitative results to communicate the impacts of VTO technologies
- Proposed future work:
  - Complete ongoing analysis, in collaboration with other labs
  - Examine side cases to assess sensitivities and understand technology interactions

Relevance

Approach

Accomplishments

Future work

Any proposed future work is subject to change based on funding levels.

Technical backup slides

ADDITIONAL RESULTS AS AVAILABLE

Maybe emissions reduction