Support for Government Performance and Results Act (GPRA): Fleet-Level Analysis

2013 DOE Hydrogen Program and Vehicle Technologies Annual Merit Review

May 16th, 2013

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Sponsored by Jacob Ward, EERE-VTP

Project ID # VAN007

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Overview

Timeline

FY12:

Start Date: Oct 2012

End Date: Sep 2013

Percent Complete: 100%

FY13:

Start Date: Oct 2012

End Date: Sep 2013

Percent Complete: 20%

Barriers*

- RD&D portfolio management
- Assess potential of technology to reduce petroleum consumption and greenhouse gas emissions

*from 2011-2015 VTP MYPP

Budget

Total Project Funding (DOE)

FY12: $50k

FY13: $90k

Partners

Collaborators

- A. Rousseau, ANL
- A. Birky, J. Moore, TA Engineering, Inc.

Interactions

- Z. Lin, ORNL, J. Ford, SRA
- Cummins, Peterbilt, Detroit Diesel, Daimler, Navistar® and Volvo

Objectives & Relevance

- Objective: Estimate the potential future benefits of EERE Vehicle Technologies Program (VTP) at the national fleet level. Benefits estimated include:
  - Petroleum savings
  - GHG emissions reduction
  - Levelized cost of driving (light duty vehicles)
- Relevance: Link projected reductions in petroleum use and GHG emissions to VTP technical areas:
  - Batteries and electric drive
  - Advanced combustion engines
  - Fuels and lubricants
  - Materials (Mass reduction)
- Inform EERE-VTP managers about impacts of achieving technology targets
- Satisfy requirements of the Government Performance and Results Act

Objectives & Relevance (continued)

- Results from GPRA analysis have been used in developing technology targets for VTP initiatives:
  - USDRIVE Partnership
  - EV Everywhere Grand Challenge
- Results are also used in:
  - EERE annual scenario portfolio analysis
  - EERE Levelized Cost of Driving Program Record
- The GPRA analysis process was used for evaluation of the VTP SuperTruck Partnership

Milestones

Month/ Year	Milestone or Go/No-Go Decision	Description	Status
Feb 2012	Milestone	Define assumptions and vehicle parameters	Complete
Jun 2012	Milestone	Establish baseline case	Complete
May 2012	Milestone	Estimate fuel consumption and costs for all vehicles*	Complete
Jul 2013	Milestone	Estimate fleet-wide benefits for light duty vehicles and heavy trucks	Complete
Sep 2012	Milestone	Document estimated benefits	Complete
Feb 2013	Milestone	Define assumptions and vehicle parameters	Complete
May 2013	Milestone	Estimate fuel consumption and costs for all vehicles*	On schedule
Jun 2013	Milestone	Establish baseline case	Not started
Jul 2013	Milestone	Estimate fleet-wide benefits for light duty vehicles and heavy trucks	Not started
Aug 2013	Milestone	Document estimated benefits	Not started

*Light-duty vehicle simulations performed by ANL Autonomie Team (see #VAN008)
Medium and heavy trucks analyzed by TA Engineering using TRUCK model suite

Approach: Compare Two Cases, With and Without Successful Deployment of VTP Technologies

- Target: Vehicles meet VTP performance, fuel economy and cost targets
  - Vehicle component cost and performance targets based on VTP targets, projected to 2050
  - Vehicle attributes estimated from component attributes

- Baseline (No Program): Without VTP technology improvements
  - Light duty vehicles simulated on the basis of EERE-VTP inputs for "No Program"
  - Medium and Heavy vehicles: Similar to EIA Annual Energy Outlook 2012 Ref Case, adjusted to remove the contributions of VTP-sponsored technologies

LDV (Car and Light truck):

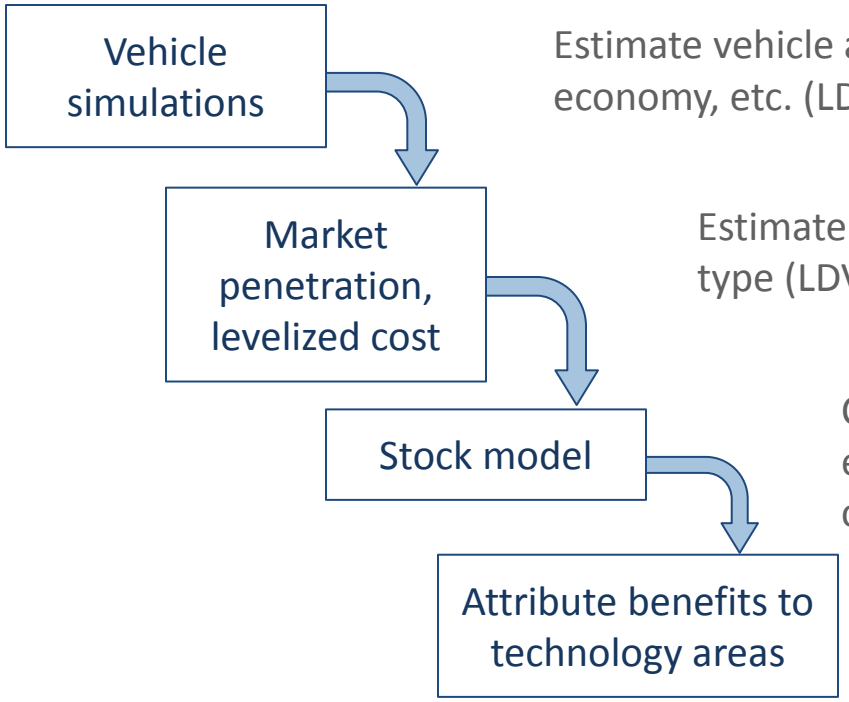
SI Conventional
CI Conventional
HEV (both SI and CI)
PHEV
Fuel cell vehicle (FCV)
All-electric vehicle (AEV)

Med and Heavy duty vehicles (Class 4-6, 7&8 Single Unit, 7&8 Combination):

Best-in-Class CI Conv
Advanced CI
Parallel HEV CI

Approach: Compare Two Cases, With and Without Successful Deployment of VTP Technologies

- For each case, estimate total fuel use, life-cycle energy, and GHG emissions



Estimate vehicle attributes, including price, fuel economy, etc. (LDVs: Autonomie; HDVs: HTEB model)

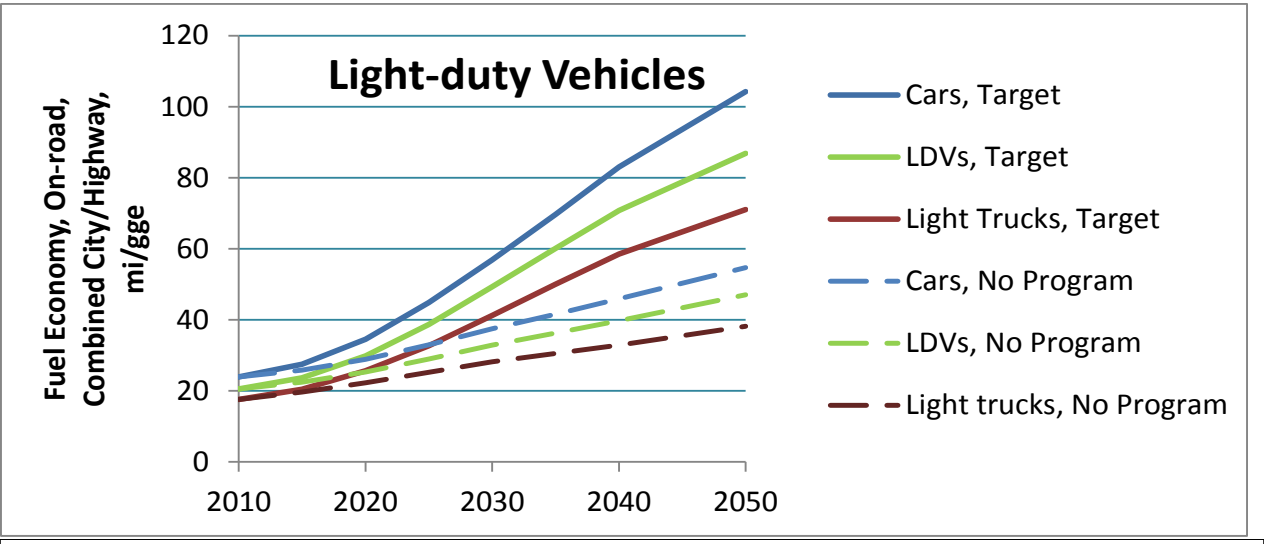
Estimate sales shares by vehicle class and drivetrain type (LDVs: MA^{3}T; HDVs: TRUCK model)

Calculate fleet stock, and fuel use and GHG emissions by the fleet (VISION model, using coefficients from GREET^{TM})

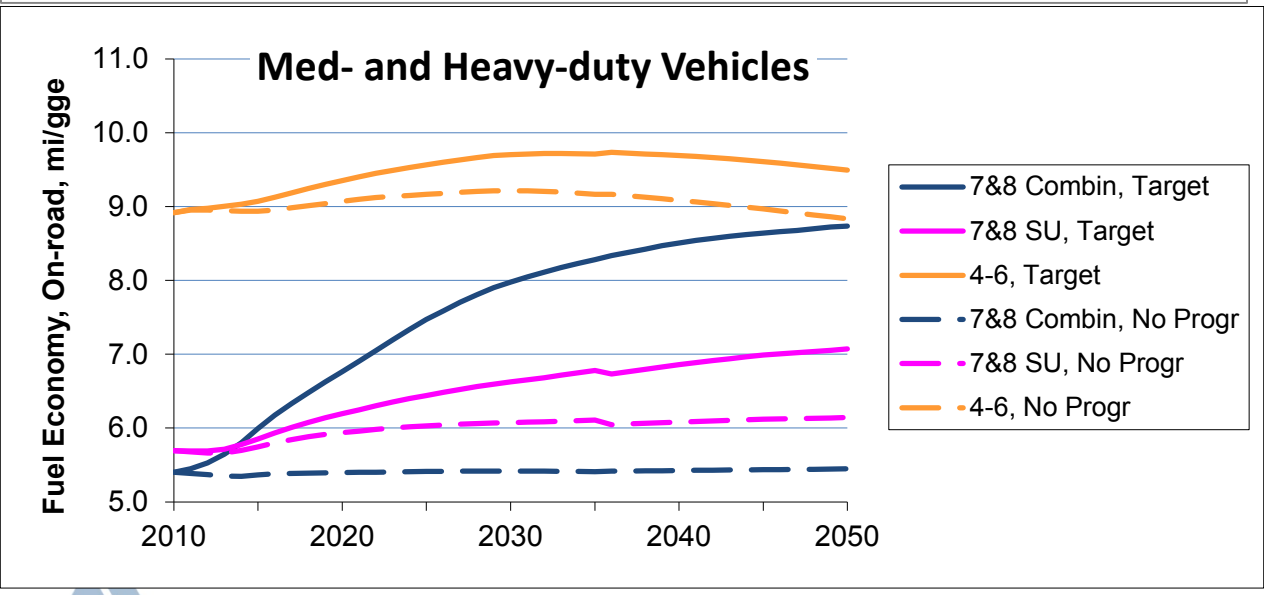
Based on estimated contribution to reduction in fuel/mi by technology

Autonomie: Vehicle simulation tool (ANL), see #VAN008; HTEB: Heavy Truck Energy Balance model (TA Engineering), : MA^{3}T: Market Acceptance of Advanced Automotive Technologies (ORNL), VISION: Stock/energy/Emissions accounting model (ANL), see #VAN006 , GREET: Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model, see #VAN002

Technical Accomplishments: Projected On-Road Fuel Economy

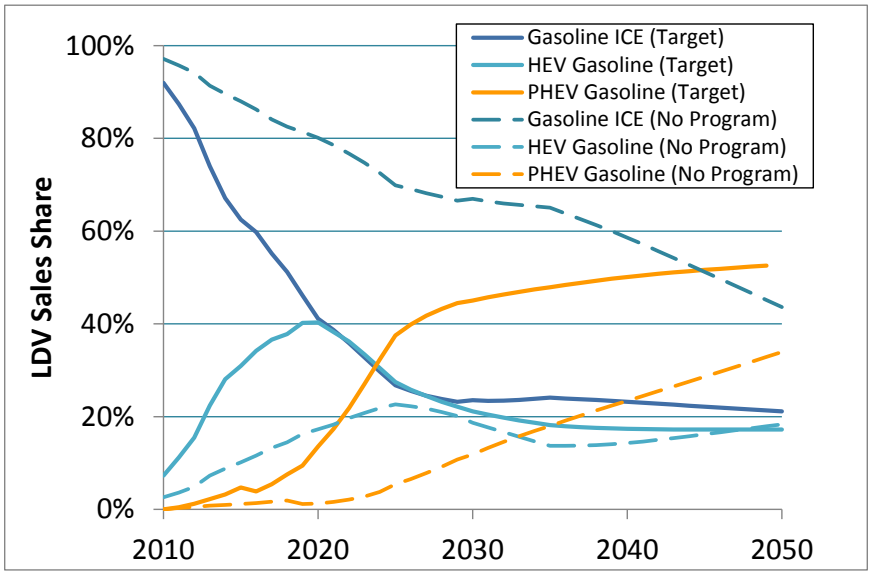


LDV fuel economy is projected to increase much faster in the Target case



Class 7&8 Combination truck fuel economy is projected to increase much faster in the Target case.

Technical Accomplishments: Projected Market Shares by Drivetrain Type

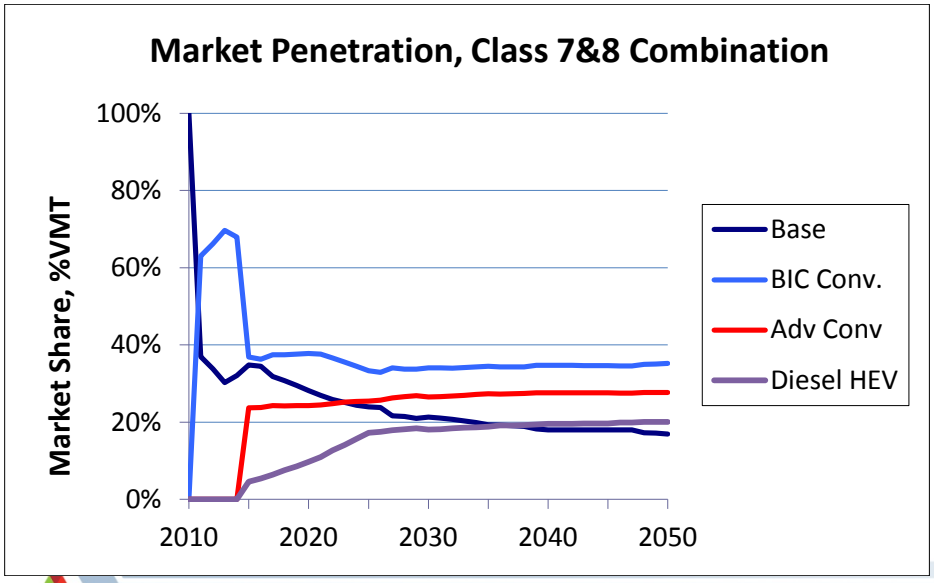


HEV: Hybrid electric vehicle

PHEV: Plug-in hybrid electric vehicle

Much more rapid market penetration by HEVs and PHEVs in the "Target" case.

Little penetration of all-electric of fuel cell vehicles in these cases (little pubic charging or hydrogen infrastructure assumed)



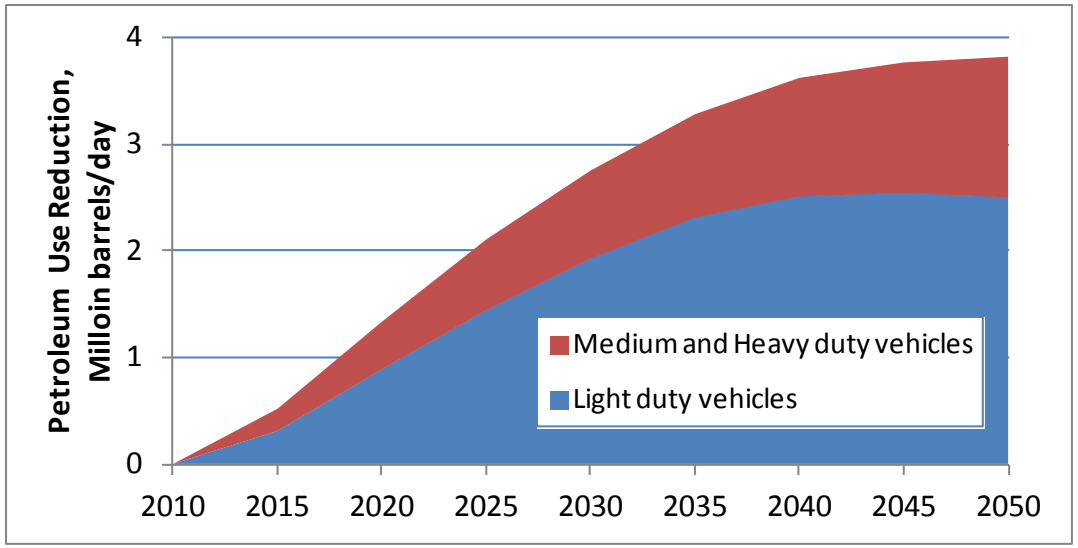
Base: Baseline technology package

BIC: Best in class conventional technology package

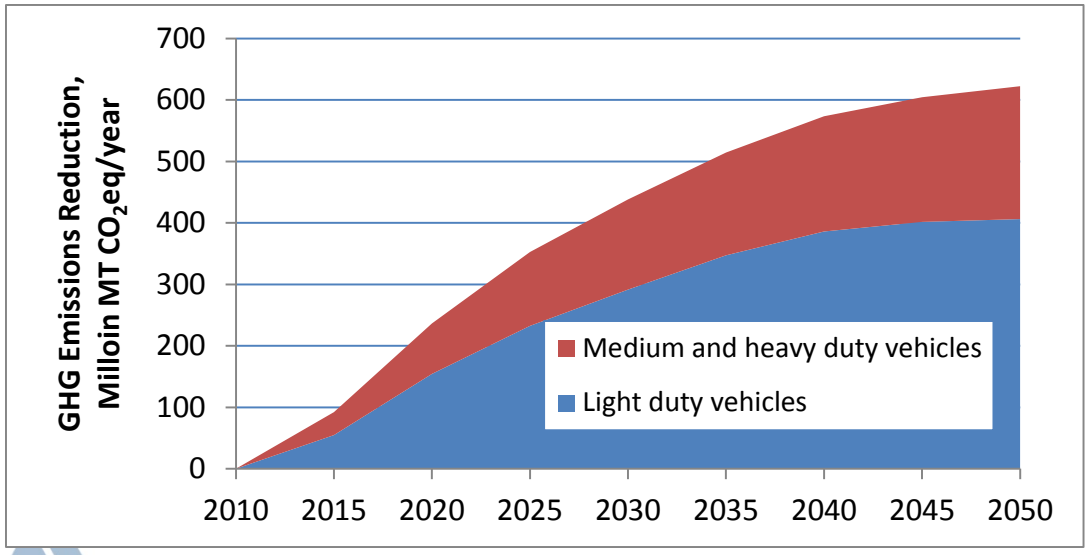
Rapid penetration by BIC, since incremental cost is low, but Adv Conv. and HEVs grow in market share

Not shown: Analogous results for Class 7&8 Single Unit trucks and Class 4-6 trucks

Technical Accomplishments: Projected Reductions in Petroleum Use and GHG Emissions

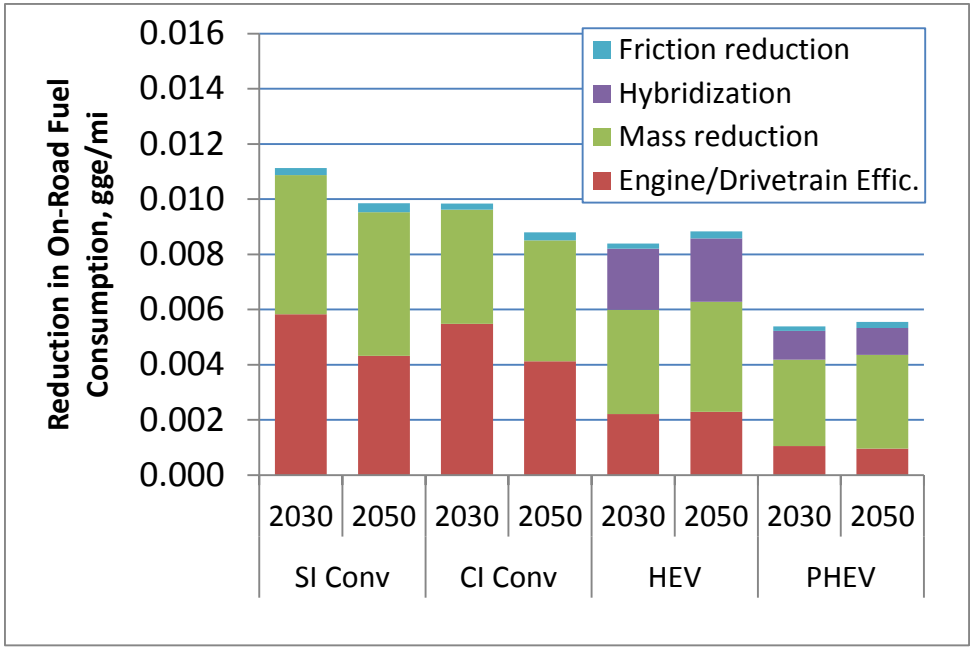


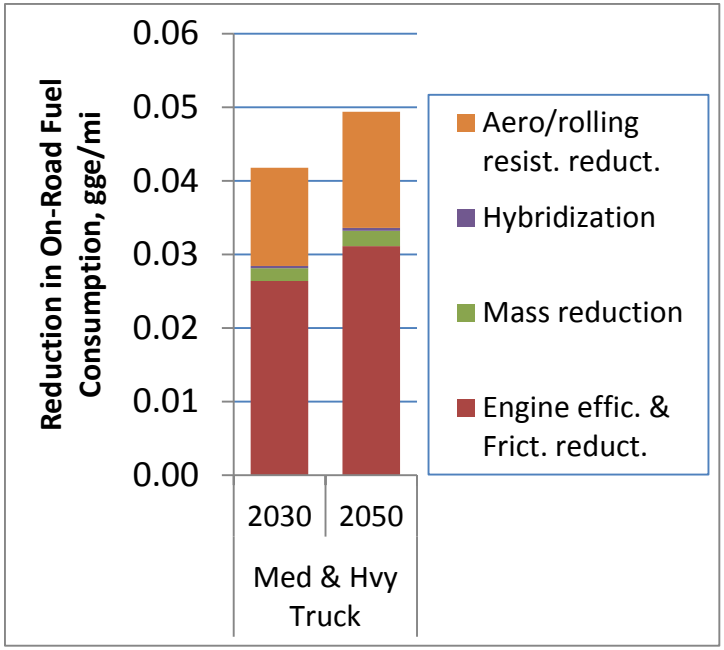
	Petroleum Use , Million barrels per day	
	No Program, 2050	Target, 2050
LDVs	5.4	2.9
M + HDVs	4.3	3.0



	Annual GHG Emissions , Million MT CO_2eq/yr	
	No Program, 2050	Target, 2050
LDVs	1070	660
M + HDVs	570	400

Technical Accomplishments: Attribution of Benefits to VTP Technology Areas

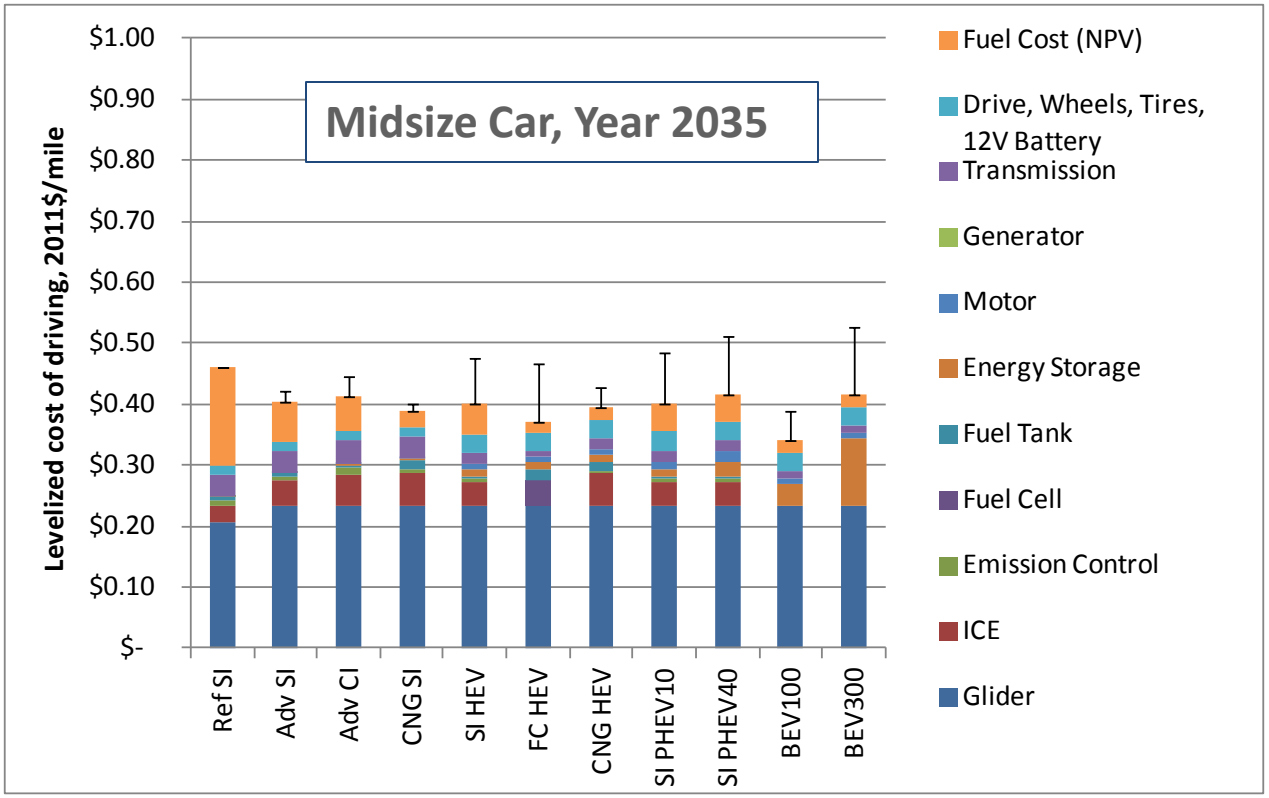




- Benefits from hybridization are significant for LD HEVs and PHEVs
- Benefits from increased engine and drivetrain efficiency are large for heavy and medium duty trucks

(No benefit attributed to reduction in aerodynamic or rolling resistance of LDVs , since VTP has no projects for these for LDVs.)

Technical Accomplishments: Levelized Cost of Driving (Light Duty Vehicles)



Levelized Cost of Driving = Purchase price of vehicle plus present value of fuel per lifetime vehicle-miles-traveled

Assuming:

- Fuel prices from AEO2012 High Oil Price Case
- 14,500 mi/year
- Ownership 5 year
- 7% discount rate
- Vehicle purchase and fuel costs only (no resale, insurance, maintenance costs)

- Cost per mile broken out by component shows tradeoff between cost of fuel and cost of advanced-technology components
- Error bars show range between Target Case and No Program Case
- HEV ad PHEVs are are cost-competitive with Advanced SI vehicle in the Target Case

Collaborations & Coordination

- Partners with TA Engineering, Inc., who perform simulations and analysis of medium and heavy trucks
- Collaborating with A. Rousseau, ANL, who performs light duty vehicle simulations
- Coordinating with Z. Lin (ORNL) on vehicle choice modeling
- Coordinating with EIA to maintain desired consistency with Annual Energy Outlook
- Working with Cummins, Peterbilt, Detroit Diesel, Daimler, Navistar and Volvo to analyze new technologies for heavy trucks

Future Work

Remainder of FY13

- Establish baseline case using AEO 2013
- Estimate vehicle performance and costs
- Estimate market shares and stock
- Estimate fuel use and emissions for U.S. fleet

Proposed future improvements

- Improve fidelity of models (under separate funding)
- Include other costs (maintenance, resale value, etc.) in levelized cost

Summary

Successful achievement of EERE-VTP technology goals is estimated to result in the following benefits

		2030	2050
On-road fuel economy improvement (%)	LDVs	50%	85%
	HTs	30%	40%
Annual oil savings (million bpd)		2.8	3.8
Annual primary energy savings (quad/yr)		6.8	9.6
GHG emission reduction (million mt CO_2eq/yr)		440	620

Scenarios analyzed provide a cause-effect link between specific program targets and future benefits

- Benefits from hybridization are significant for LD HEVs and PHEVs
- Benefits from increased engine and drivetrain efficiency are large for heavy and medium duty trucks