

Program Analysis

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- Analytical Models
 - MA³T Vehicle Choice Model
 - Levelized Cost of Driving (LCOD) Analysis
 - GREET GHG Emissions Model
 - GPRA Program Benefits and Mandatory Reporting
- Publications
 - Market Report
 - Transportation Energy Data Book and Fact-of-the-Week
 - “One million PEVs on the road by 2015” Analysis
- External Support and Coordination
 - Transportation Energy Futures EERE Crosscut Analysis
 - Other *ad hoc* analyses

First developed in 2008 and executed since by David Greene and Zhenhong Lin, ORNL
Additional contributions and execution by Jonathan Ford, Sentech/SRA

- Excel-based multinomial logit (logistical probability) model
 - 1,458 consumer segments
 - Several vehicle technology platforms (e.g., conventional, HEV, PHEV, etc.)
- Lessons Learned
 - Using “**average**” daily VMT can cause a **low-fidelity bias**, in which petroleum use is underestimated by up to 68% and electricity consumption is overestimated up to 48%.
 - With only overnight home charging **PHEV10s can travel 29% of VMT on electricity; PHEV40s, 72%.**
 - **Quantifying range anxiety penalties is difficult**; though, values in excess of \$15 per day of inadequate range significantly inhibit BEV market penetration

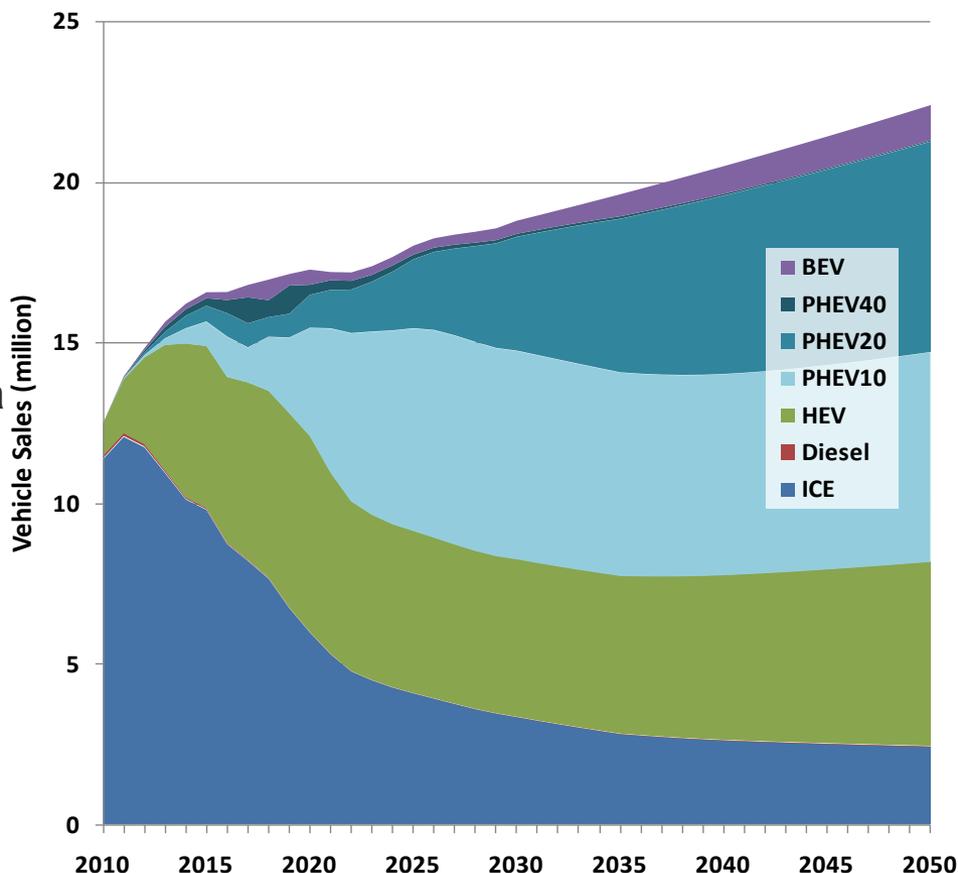


Figure: MA³T results for a theoretical “rapid electrification” scenario assuming VTP and ARPA-E cost goals are met showing high PHEV penetration.

Initiated last year (2010) for EERE management
Executed in-house collaboratively with FCT and OBP analysts

- Uses lifecycle-cost framework to combine dissimilar subprogram goals (e.g., lightweighting or engine efficiency)
 - Captures technology cost reduction and performance (i.e., fuel efficiency)
- Informed by Autonomie output
- Uses standardized external assumptions prescribed by EERE/DOE management

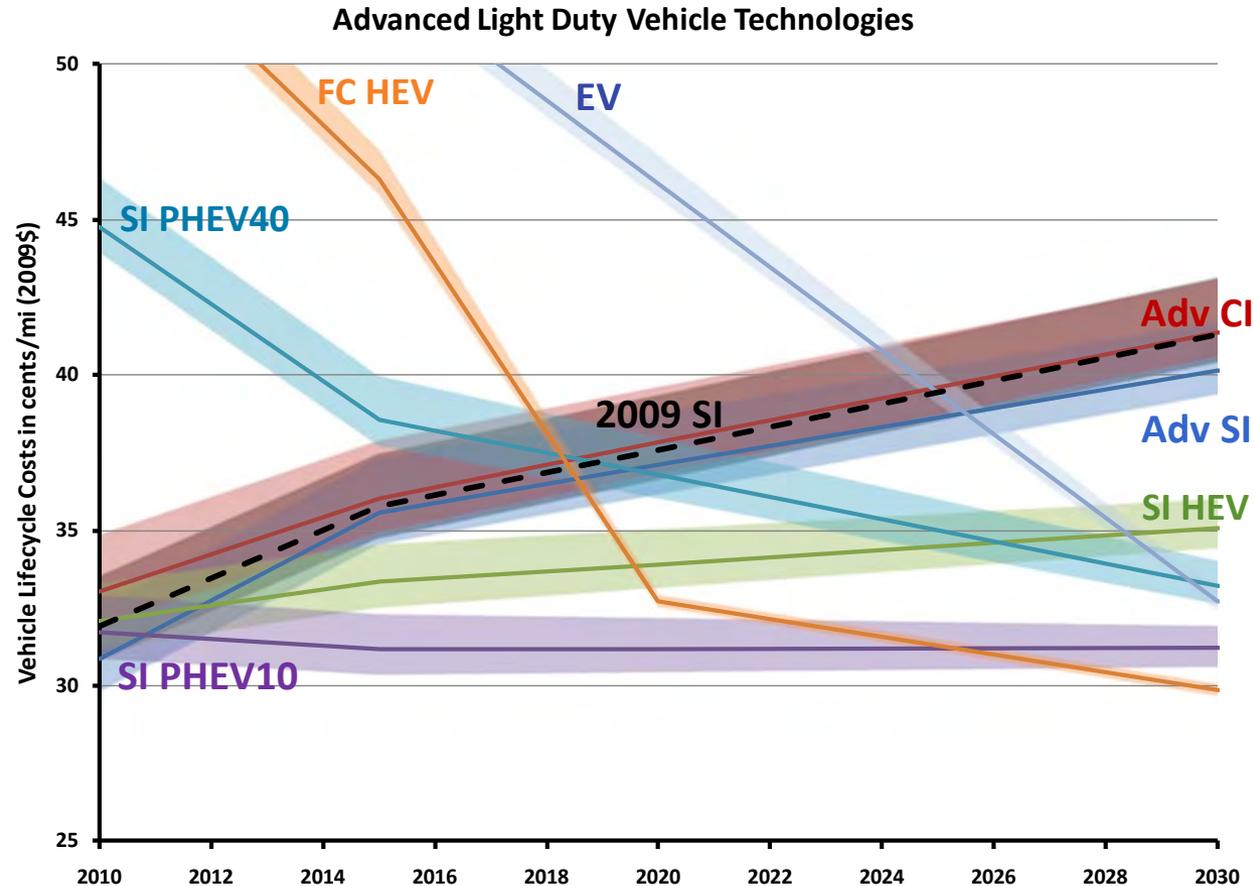


Figure: Results using 2010 “optimistic” inputs show advanced powertrain vehicle lifecycle costs decreasing to levels below those of their conventional counterparts.

REET

Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model

Developed and executed by Michael Wang and Amgad Elgowainy, ANL

Publicly available at: <http://greet.es.anl.gov/main>

- “Well-to-wheel” analysis: GREET identifies both upstream/indirect and vehicle/direct energy use, petroleum use, and emissions
- Includes emissions of GHG and 5 criteria pollutants
- Well vetted, established model (e.g. California GREET version was used in rulemaking)
 - More than 14,000 users worldwide

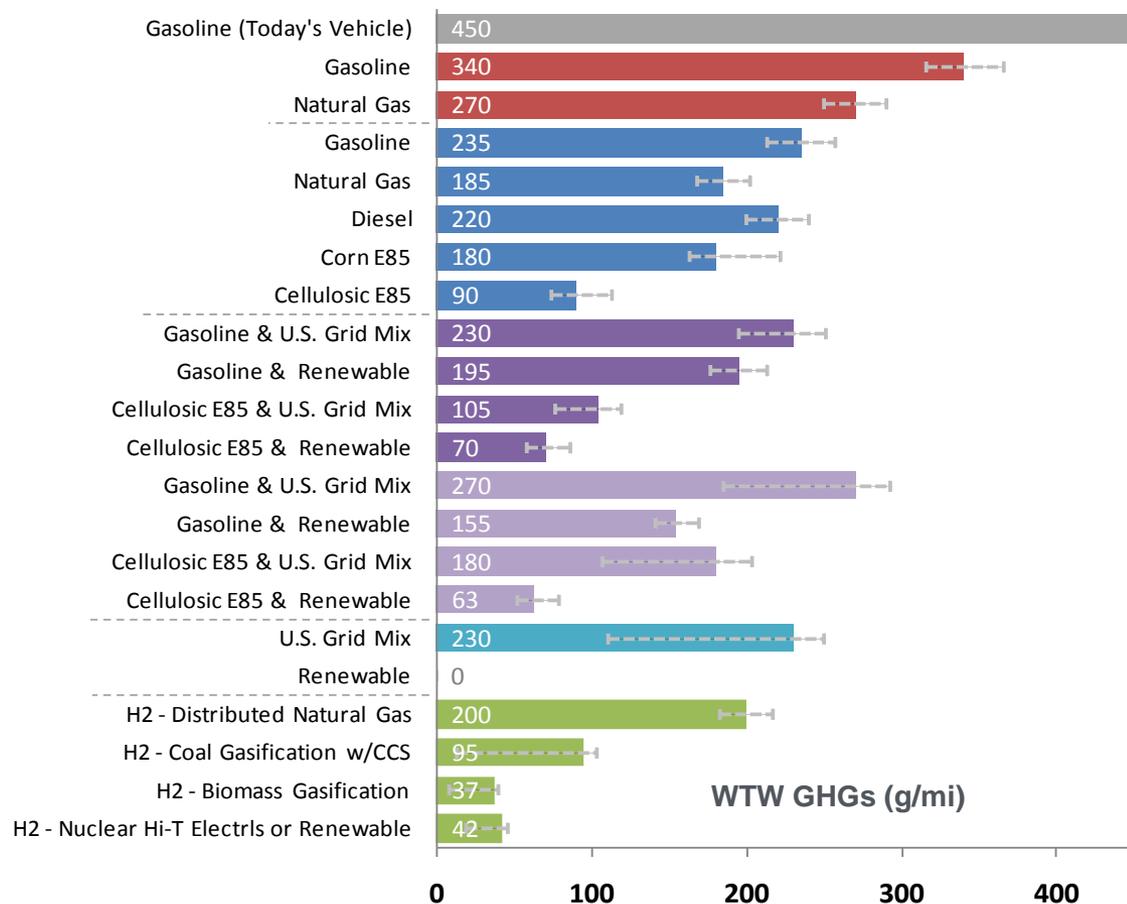


Figure: 2010 WTW estimates (published as the Hydrogen Program Record) show advanced powertrain vehicles can significantly reduce GHG emissions relative to today's baseline.

EE portfolio analysis w/NEMS+MARKAL (Frances Wood, OnLocation, and Chip Friley, BNL) Heavily leverages ANL's Autonomie Tool (historically PSAT with postprocessing)

- ANL's Autonomie generates VTP inputs based on fuel consumption estimates over official EPA drive cycles
- Program offices provide inputs specific to their technology output.
 - VTP gives advanced technology vehicle incremental cost and fuel economy improvement relative to a baseline conventional vehicle
 - (Other Programs give, e.g., levelized cost of renewable electricity)
- Output is macroeconomic in scope and does not easily or directly tie back to inputs.
- GPRA-2010 estimates showed VTP will save 40 billion barrels of oil and abate nearly 20,000 mmt of CO2 through 2050.

Metric	Model	2015	2020	2025	2050
		Energy Security Benefits			
Annual Oil Savings (mbpd)	NEMS-BA	0.05	0.36	0.99	2.00
	MARKAL	0.50	0.90	1.53	2.00
Oil Consumption Reduction, cumulative (Bil bbl)	NEMS-BA	ns	0.41	1.70	2.00
	MARKAL	0.57	1.93	4.26	2.00
Oil Import Reduction, cumulative (Bil bbl)	NEMS-BA	ns	0	2	2.00
	MARKAL	1	2	4	2.00
Environmental Benefits					
CO2 Emissions Reduction, cumulative (million metric tons CO2)	NEMS-BA	ns	153	637	2022
	MARKAL	299	947	2022	2022
CO2 Emissions Reduction, annual (million metric tons CO2/yr)	NEMS-BA	ns	49	138	2022
	MARKAL	98	151	258	2022
Economic Benefits					
Primary Energy Reduction, cumulative (quads)	NEMS-BA	ns	2.6	9.8	2022
	MARKAL	3.6	11.7	25.7	2022
Net Consumer Cost Reduction, NPV (Bil \$)	NEMS-BA	13.0	77.3	272.4	2022
	MARKAL	10.9	136.6	423.7	2022
Reduction in Energy Intensity of US Economy (BTUs of energy/\$GDP)	NEMS-BA	ns	51	113	2022
	MARKAL	83	128	191	2022
Other Key Indicators (not compared to base)					
% Advanced Vehicles Based on Sales, annual	NEMS-BA	23%	51%	69%	2022
	MARKAL	5%	20%	51%	2022

Figure: GPRA-2010 estimates for VTP program benefits from 2015 to 2050 (later years excluded for visibility).

A study to identify near- and long-term transportation energy solutions**VTP provides direct and in-kind support (Tom Stephens, Steve Plotkin, Anant Vyas, ANL)**

- Identify and fill analytical gaps in EE's analytical capacity
 - Focus on four issue areas: light duty vehicles, non-light duty vehicles, fuels (and infrastructure), and transportation demand
- Literature review and original research
- Collaborative approach: DOE, NREL, ANL, subcontractors, and input from a steering committee (industry, non-profits, other agencies, etc.)
- Results will be documented in written reports, analytic tools and a database
 - One new tool will be an expanded version of ANL's VISION, a transportation energy accounting tool (Anant Vyas)

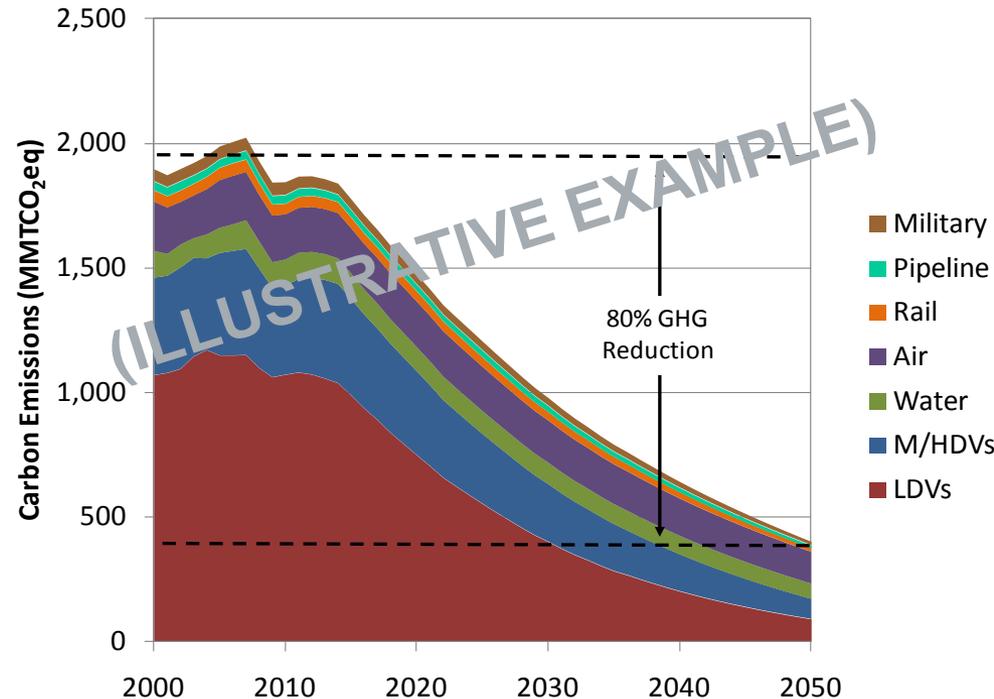


Figure: Example [draft] TEF output showing a portfolio approach to 80% GHG emissions reduction in transportation by 2050.

Developed in 2009 at EERE management's request with Stacy Davis, ORNL
Publicly available at <http://www.nrel.gov/docs/fy09osti/46018.pdf>

- Documents the trends in market drivers, new vehicles, and component suppliers
- Conveys vehicle and heavy truck sales by end manufacturer and supplier, where possible
- Tracks changes in vehicle characteristics (average fuel economy, performance) by manufacturer
- Tracks penetration of VTP-sponsored and other advanced and efficiency technologies, where possible

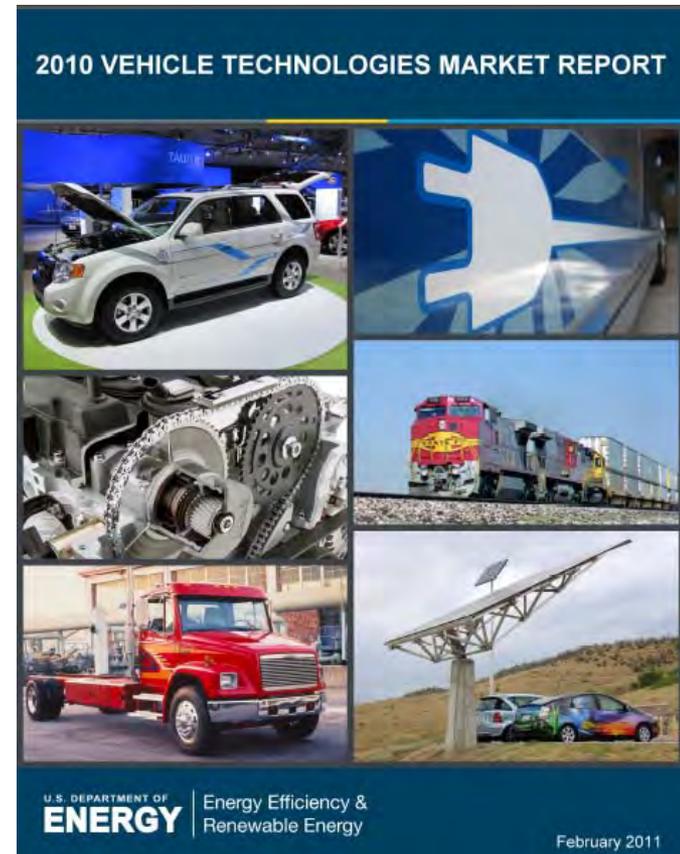


Figure: The 2010 VTP Market Report will be released in May, 2011.

Stacy Davis, ORNL, coordinates both the TEDB (<http://cta.ornl.gov/data/index.shtml>) and FOTW (http://www1.eere.energy.gov/vehiclesandfuels/facts/2011_index.html)

- TEDB pulls together data across transportation modes on, e.g., petroleum and energy balances, the U.S. vehicle fleet, vehicle-miles traveled, etc.
 - Initiated by Phil Patterson in 1976; edition 30 will be released in July
 - In 2010, 1,500 hard copies distributed to 1,000+ regular recipients
- Fact of the Week offers snapshots of interesting transportation data, e.g., time and fuel wasted in traffic, and an explanation of EPA's EV/PHEV fuel economy sticker, advanced vehicle market research surveys, etc.
 - Updated weekly since 1996

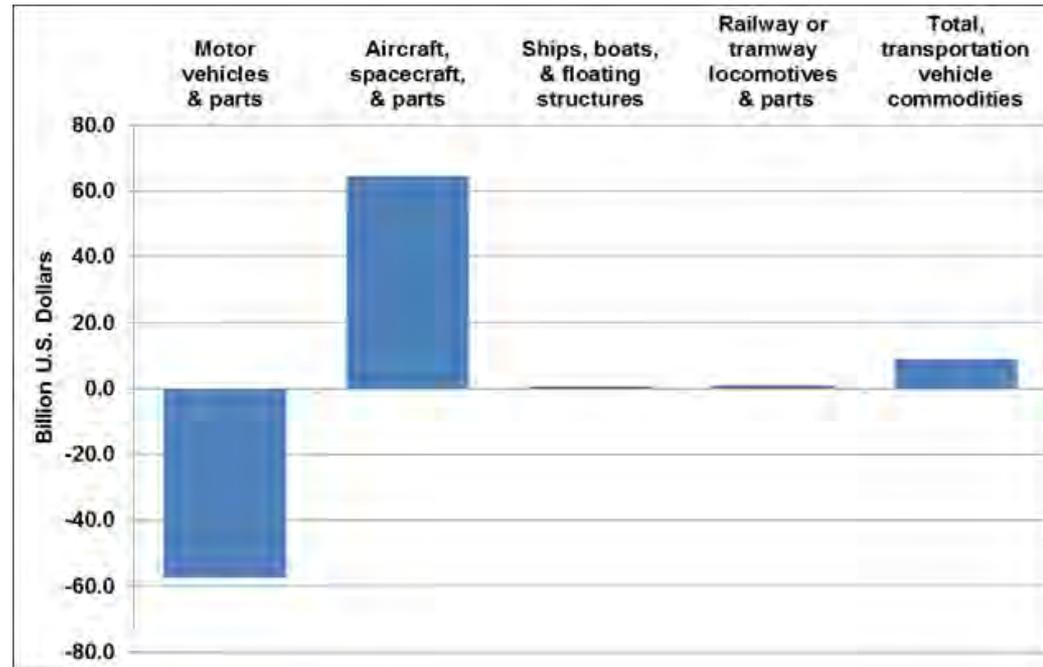


Figure: Fact of the Week #673 (May 2, 2011): U.S. Trade Balance for Transportation Vehicles.

- “One-million PEVs by 2015”
 - Demand-side projections (MA³T, NEMS, etc.)
 - Supply-side literature reviews
- EPA
 - Reviews of DOT/EPA CAFE proposals
 - Technical Assessment Report – Chapter 3: EV Infrastructure
 - Reviews of new proposed EPA Fuel Economy labeling
- NAS and NPC review and support
 - National Academies/National Research Council’s “The Potential for Light-duty Vehicle Technologies, 2010-2050: Costs, Impacts, Barriers and Timing”
 - National Petroleum Council’s Future Transportation Fuels (“with prospects through 2035 and views through 2050”)

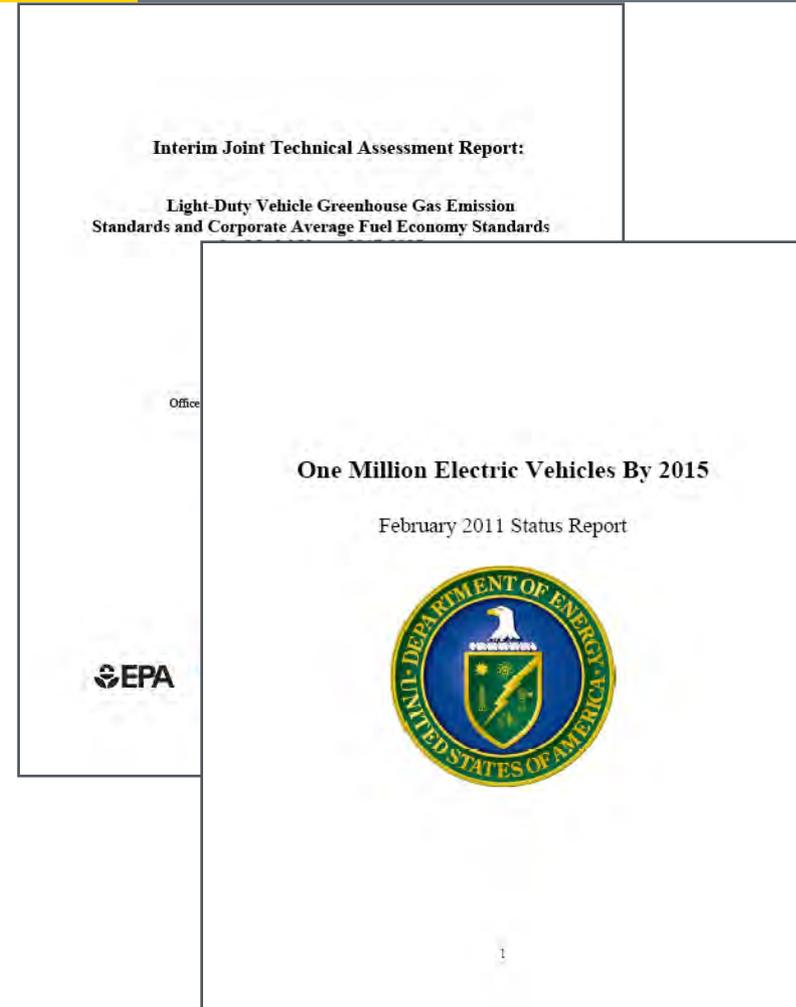


Figure: EPA’s Technical Assessment Report and DOE’s One-Million Electric Vehicles Status Report, to both of which VTP analysis contributed

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