Benefits Analysis for VTP

Presentation at the Vehicle Technologies Program (VTP) Merit Review

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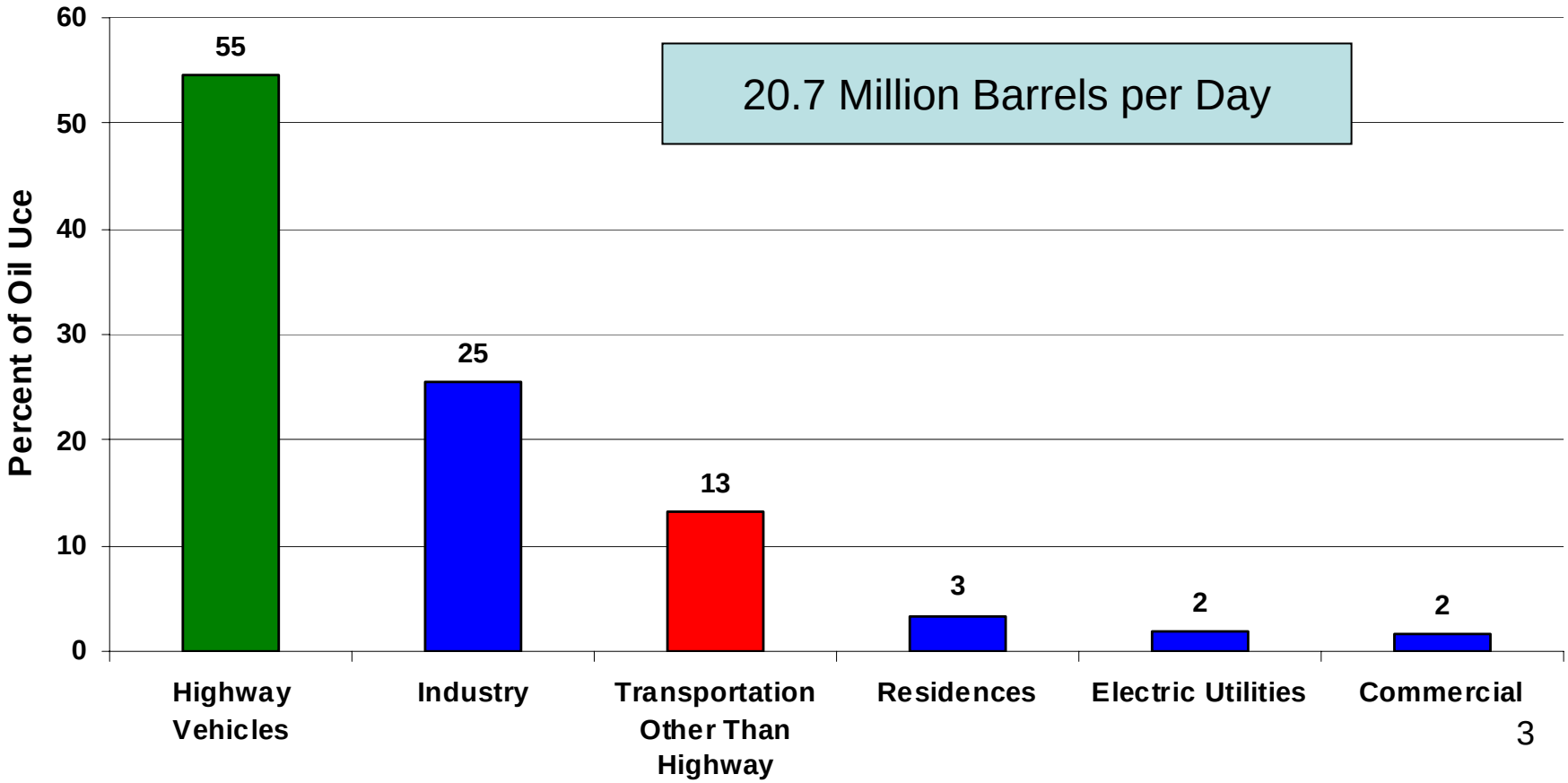
Major Reasons for Benefits Analysis

- Estimate **oil savings** potential of VTP technologies
- Estimate **GHG emission reductions** potential of VTP technologies
- Contribute to R&D **portfolio decision making** by helping to understand the potential value of different technology paths

VTP R&D is focused on reducing the oil use represented by the green bar in this graph (55% of all oil use). Highway vehicles are comprised of light vehicles and heavy vehicles.

U.S. Oil Use: 2007

EERE has no specific program to reduce oil use via efficiency improvements or substitution from activities that account for 45% of U.S. oil use.



VTP Oil Savings and GHG Reductions

- Official estimates used in the VTP annual budget come from the **Portfolio Decision Support** (PDS) (formerly GPRA (Government Performance and Results Act)) system.
- Ad hoc estimates are made using the **VISION** model.
- Scenario estimates are being made in the **Multi-Path Study.**
- A **PHEV Choice Model** is being developed that will estimate market shares (as is done with the other vehicle technologies) which lead to oil and GHG savings.

For PDS, VTP supplies inputs on its technologies and EERE uses two models to estimate the impacts

- VTP Inputs for **Light Vehicles (Passenger Vehicles)**:
  - MPGs are derived from ANL's **PSAT** (Powertrain Systems Analysis Toolkit) model (Aymeric Rousseau, ANL)
  - Incremental vehicle costs are derived from literature reviews, program goals, and **ORNL cost model** (Sujit Das, ORNL and Steve Plotkin, ANL)
  - These inputs are then put into the form the EERE models need: **12 car and light truck classes** (Margaret Singh, ANL)
- VTP Inputs for **Heavy Vehicles (Commercial Vehicles):**
  - Provided by the TRUCK Model (Jim Moore, TA Engineering)
- **Oil and GHG Benefits** Estimated by EERE's Planning, Budget and Analysis Office:
  - The EERE version of the **NEMS (National Energy Modeling System) model** makes impact estimates out to 2030 (Frances Wood, OnLocation Inc).
  - The **MARKAL (MARKet ALlocation) model** makes impact estimates that are used for the 2030 to 2050 period (Chip Friley, BNL).

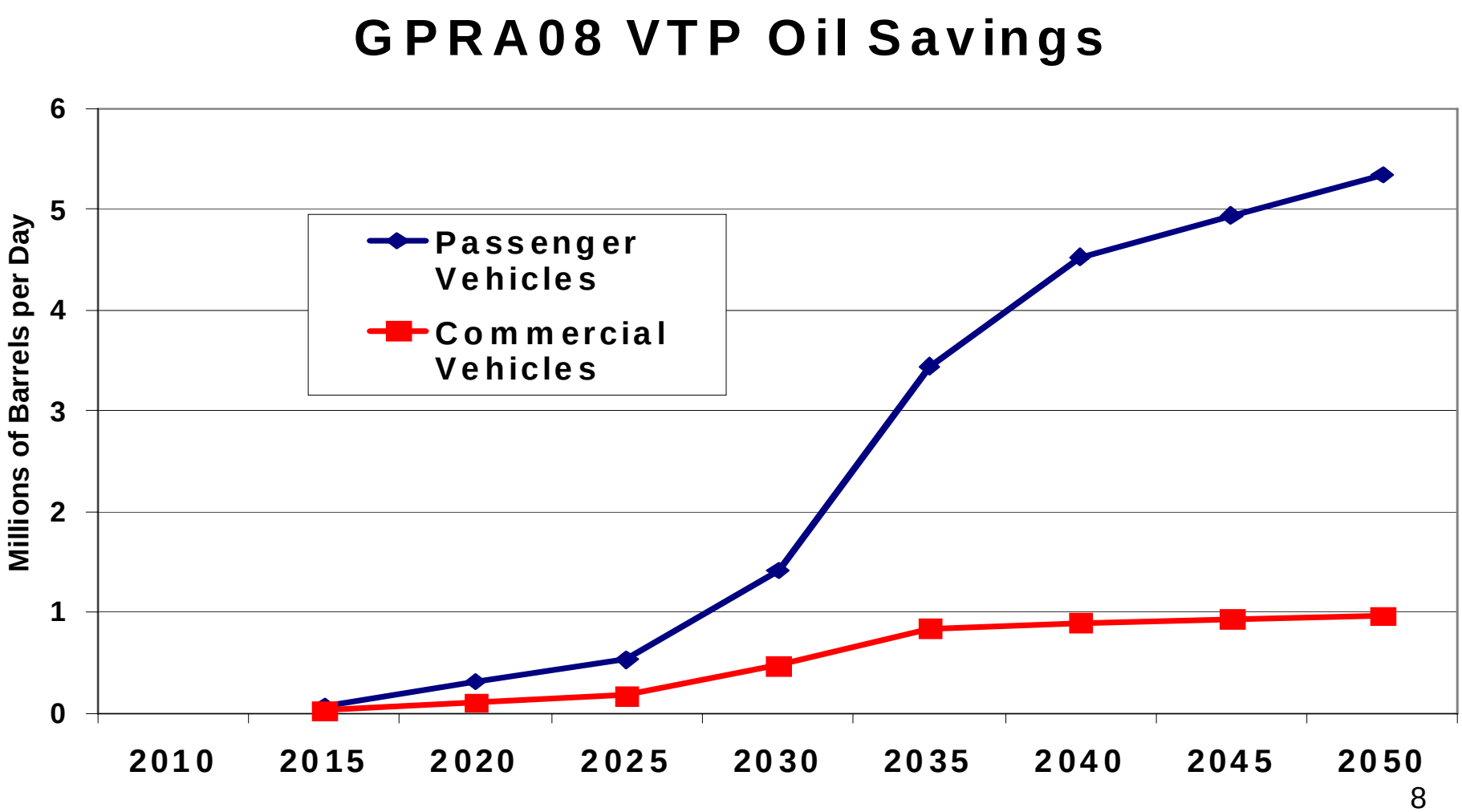
EIA (Energy Information Administration) Assumptions

- For GPRA09 gasoline price was **$2.15 per gallon** in 2030.
- For PDS10 gasoline price will be about **$2.50 per gallon**. [Still to be determined in EIA's 2008 Annual Energy Outlook (AEO).]
- In the NEMS model, fleets are not able to purchase diesels, HEVs, or PHEVs (fleets account for **20% of new car sales and 13% of light truck sales**). PDS10 will override this assumption by reducing the fleet sales to 0.1% for cars and light trucks.
- NEMS uses a **20% rebound effect**, even though the latest literature says the rebound is under 10% and declining over time.

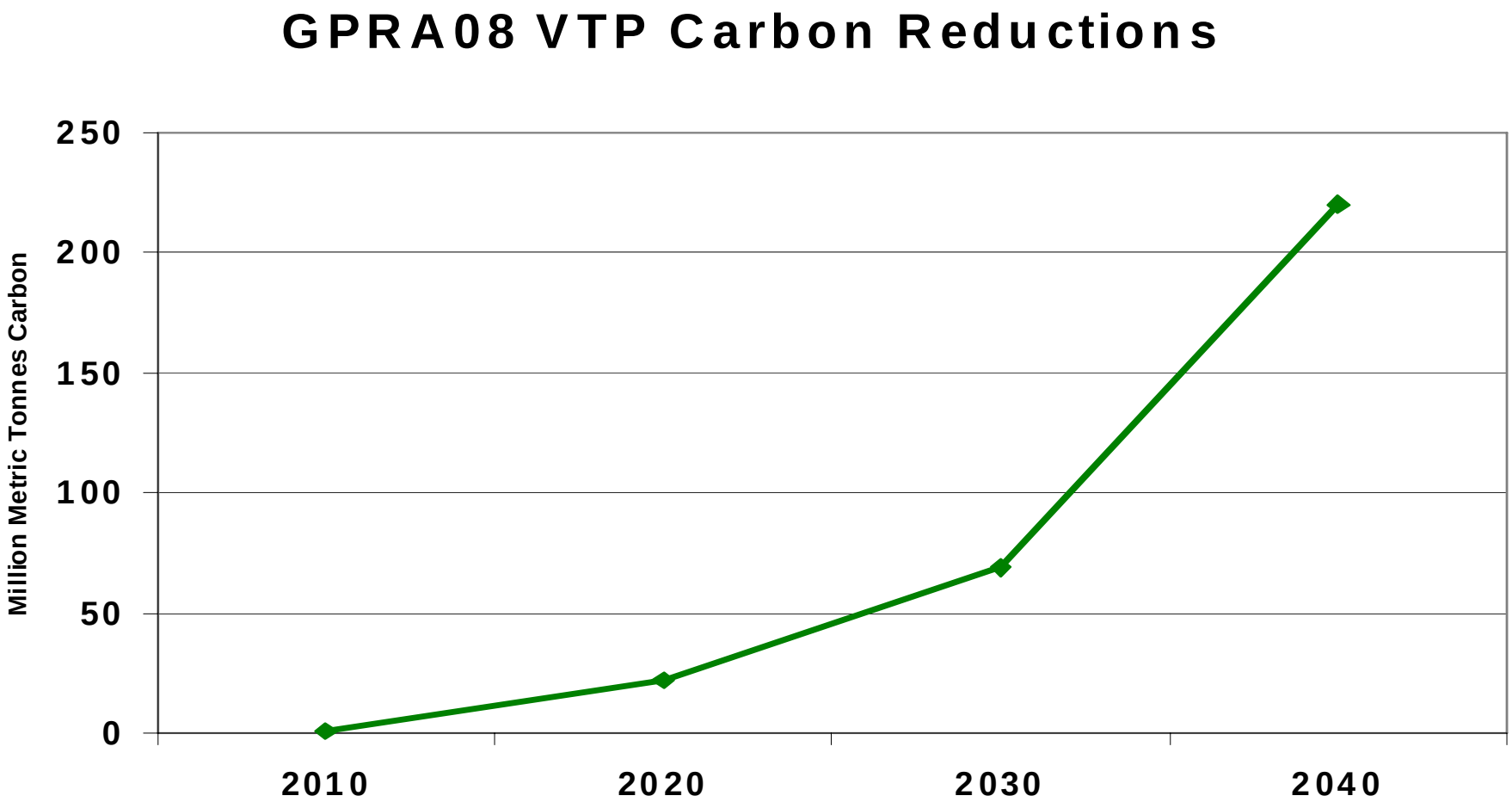
Meaning of the Rebound Effect

- A 20% rebound means that if 100 units of fuel are saved by switching to a vehicle with a higher MPG, 20 of those units saved will be expended in additional travel brought forth by vehicle users who experience a lower cost to travel a mile.
- Therefore, VTP oil savings from efficiency improvements are about 20% less than what one would expect.
- This relationship in the NEMS model is not easy to change.

The GPRA08 Oil Savings for VTP was about 6.3 mbpd in 2050 (31% the projected highway oil use) of which 85% came from passenger vehicles and 15% came from commercial vehicles.



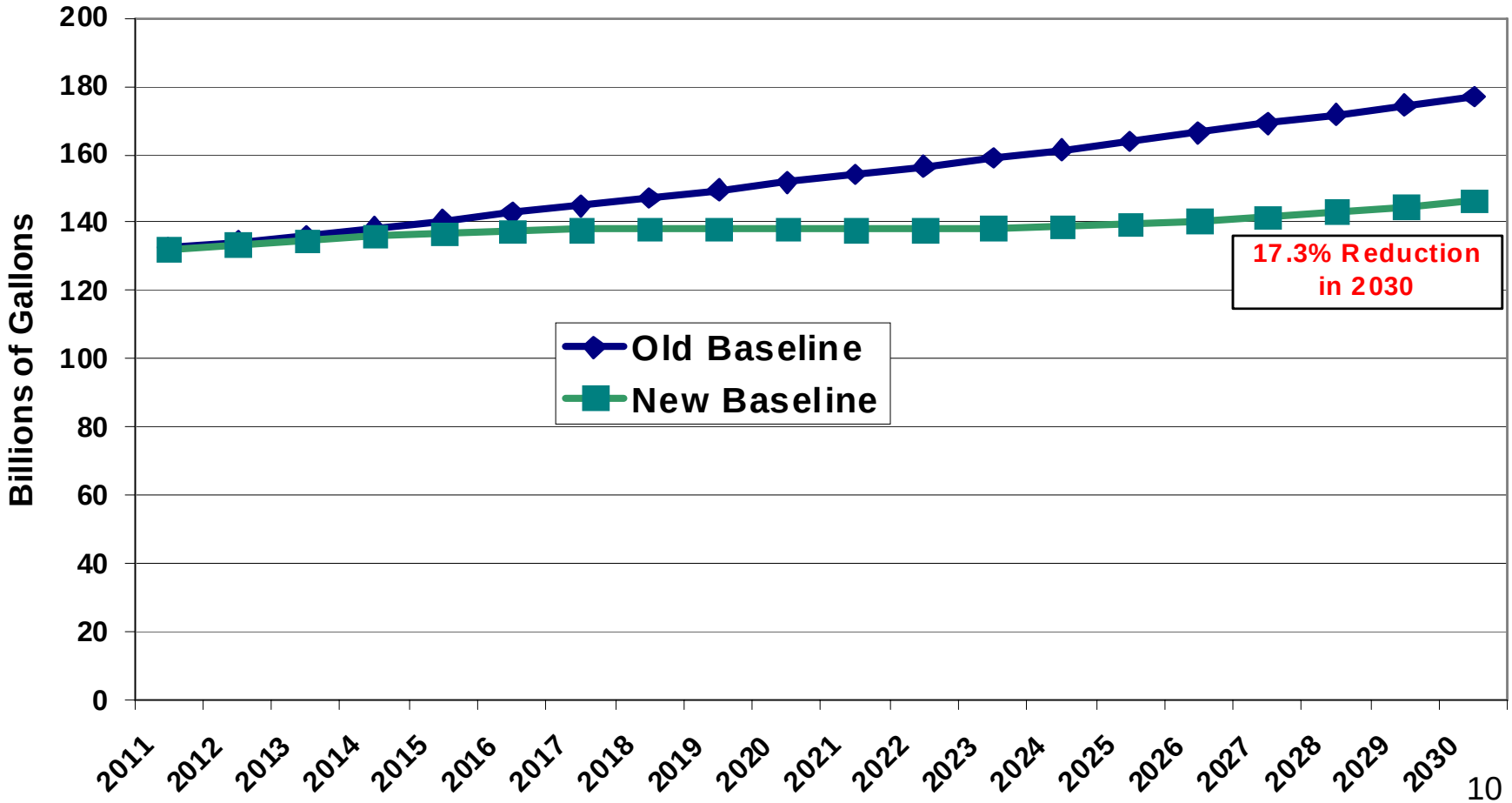
The carbon reduction in 2040 are about 25% of highway carbon emissions.



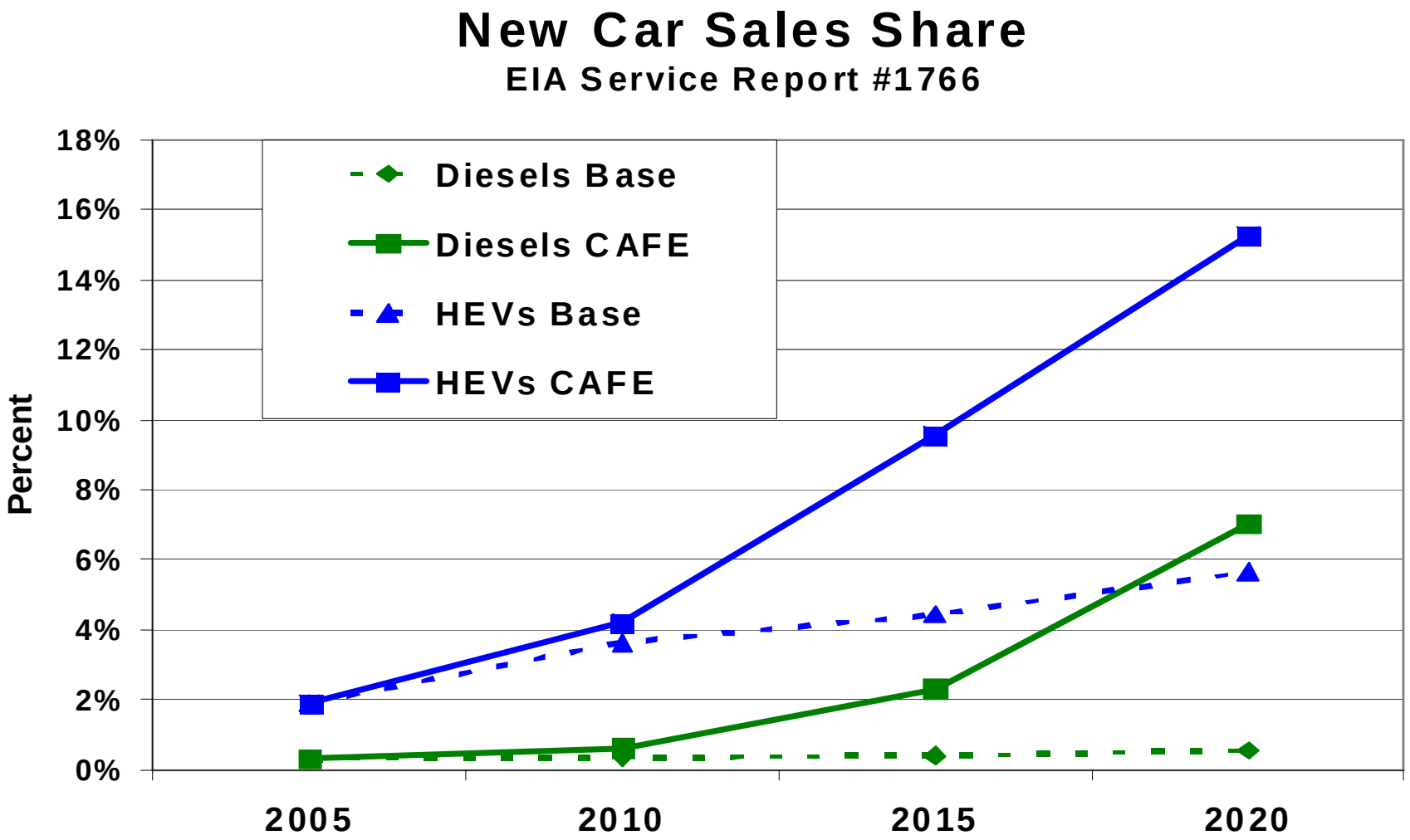
The new CAFE standards will make VTP oil savings for PDS10 from light vehicles smaller than in the past.

Projected Baseline Light Vehicle Fuel Use

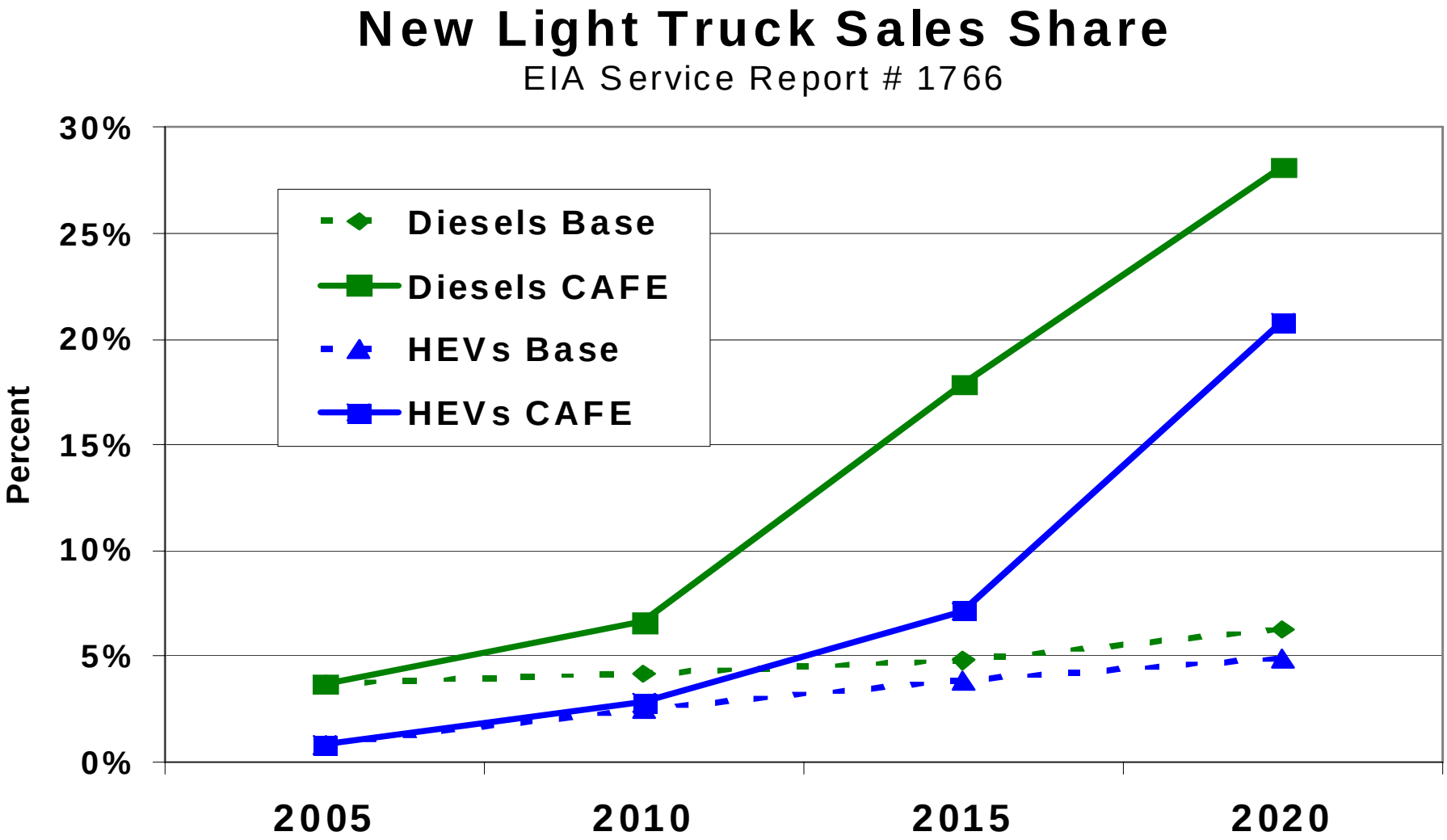
The new CAFE regulations reduce the amount of oil that VTP technologies can save in the future.



But, EIA achieved the 35 mpg standard in 2020 partly by using VTP technologies, such as more diesels and HEVs than in the base case.



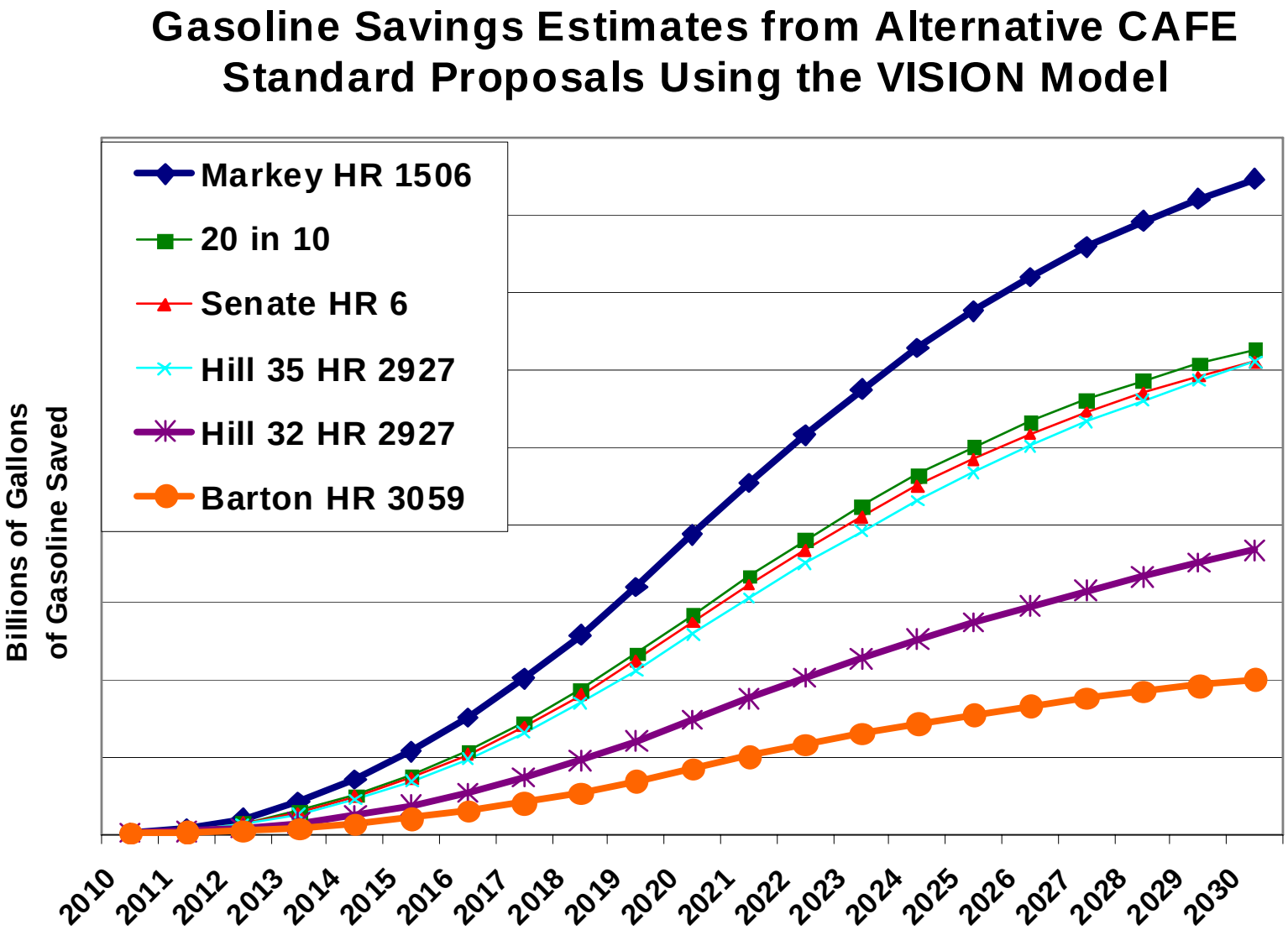
EIA used even more diesels and HEVs in light trucks. The diesel share is 28% in 2020 for light trucks and only 7% for cars for the CAFE case.



The VISION Model

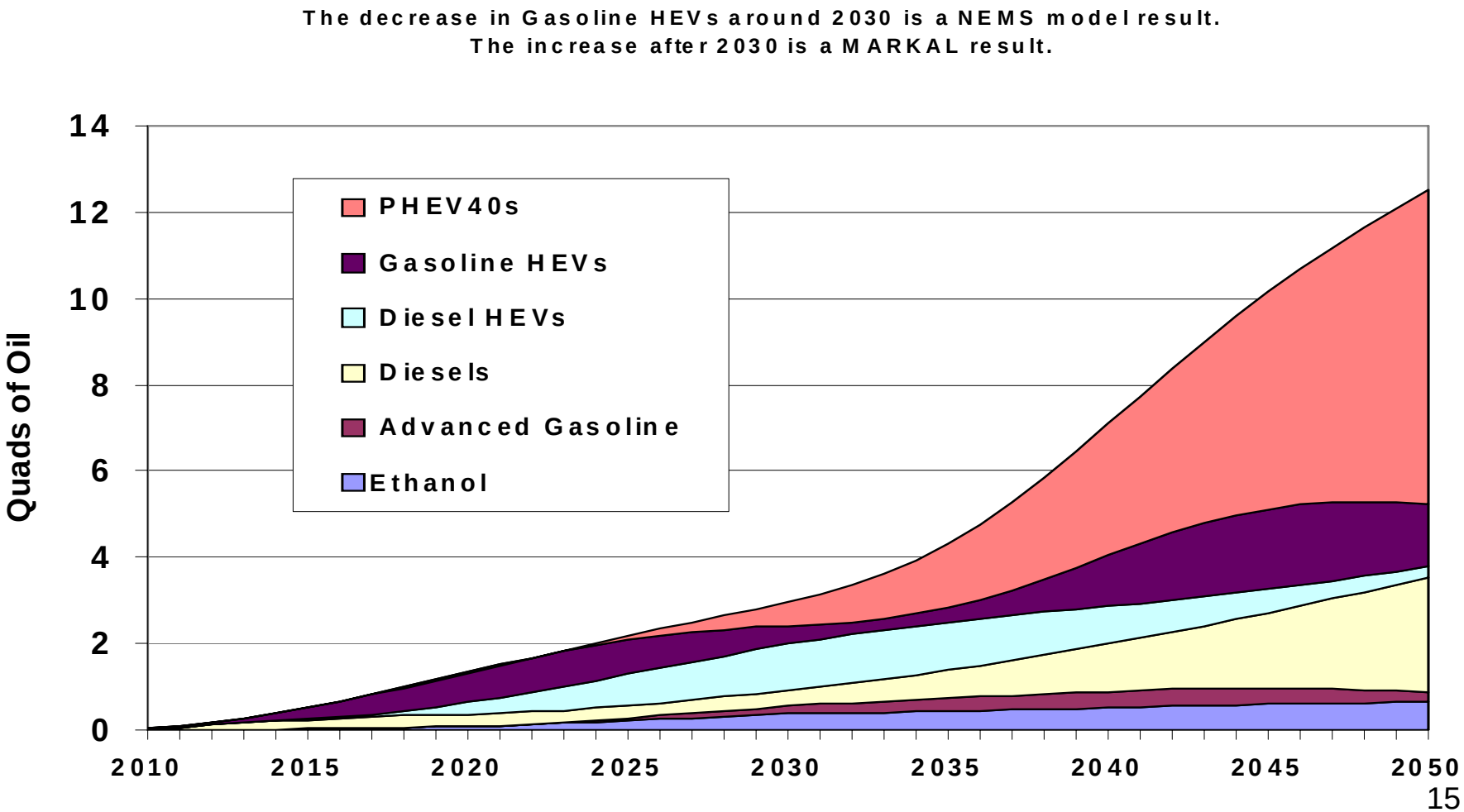
- VISION is a **vehicle stock model** which allows users to estimate the oil savings and GHG emission reductions associated with the market penetration of advanced vehicle technologies.
  - Based on EIA's AEO to 2030 and extended to 2050
  - Includes light and heavy vehicles
- Runs are made for **many clients**.
  - Used to estimate alternate CAFE proposals
  - Disaggregates GPRA08 fuel savings by vehicle technology
- Used by others: **490 downloads** of the model. California has built their own version. VISION is being used in New Mexico and in New England.
- Available for downloading at: http://www.transportation.anl.gov/software/VISION/index.html

A sample of a set of VISION Model runs made in the summer of 2007



GPRA08 Oil Savings by Technology as Estimated by VISION

[The NEMS and MARKAL models do not provide the savings by technology.]



Multi-Path Study Purpose

- Responds to a **EERE Senior Management request for** an integrated analysis of EERE's vehicle-and-fuel-related technologies
- Also responds to a **National Academy of Sciences** call for an assessment of pathways other than hydrogen that can yield similar outcomes (low oil use and low GHG emissions)
- Study **compares alternative ways** to achieve significant reductions in oil use and GHG emissions in **light vehicles** from now to 2050

The Multi-Path Study

- Phase 1: 2006 Fiscal Year
  - Developed **pathways and scenarios**
  - Used **assumptions** to project market penetrations in order to estimate oil savings and GHG reductions using the VISION model
  - Phase 1 results available at: http://www1.eere.energy.gov/ba/pba/multi_path.html
- Phase 2: 2007-08 Fiscal Years
  - Using the NEMS **integrated energy model** to estimate oil savings and GHG reductions

Workers and Funders for Phase 2 of Multi-Path

Phil Patterson, DOE
Margaret Singh, ANL
Steve Plotkin, ANL
Jim Moore, TAE
Grant Miller, TAE

Frances Wood and Niko Kydes, OnLocation, for NEMS Model

ANL PSAT Team
Aymeric Rousseau, Phil Sharer, and Sylvain Pagerit

David Greene, ORNL, Energy Security Benefits

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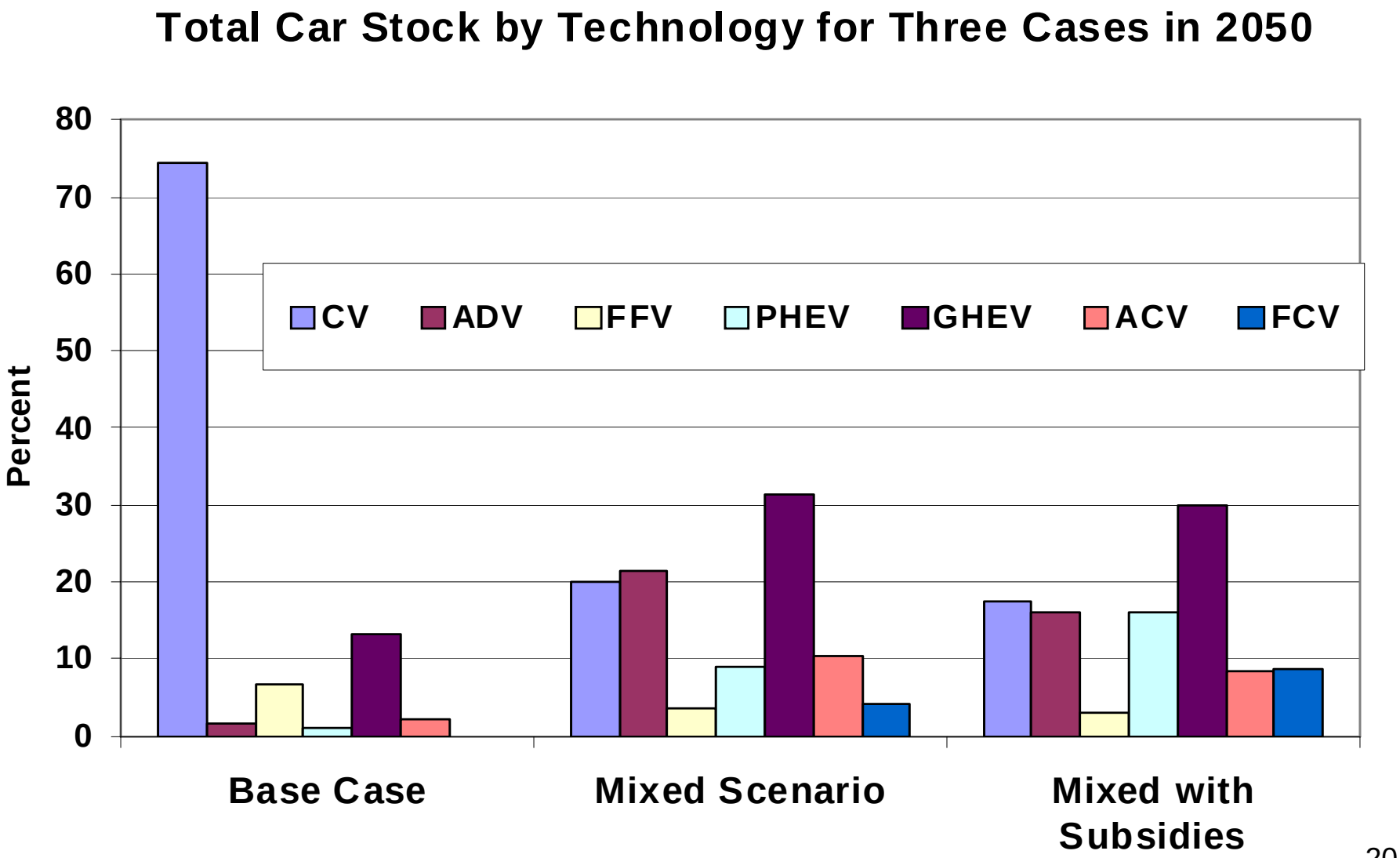
Planning, Analysis and Evaluation
Vehicle Technologies Program
Hydrogen, Fuel Cells and Infrastructure Technologies Program

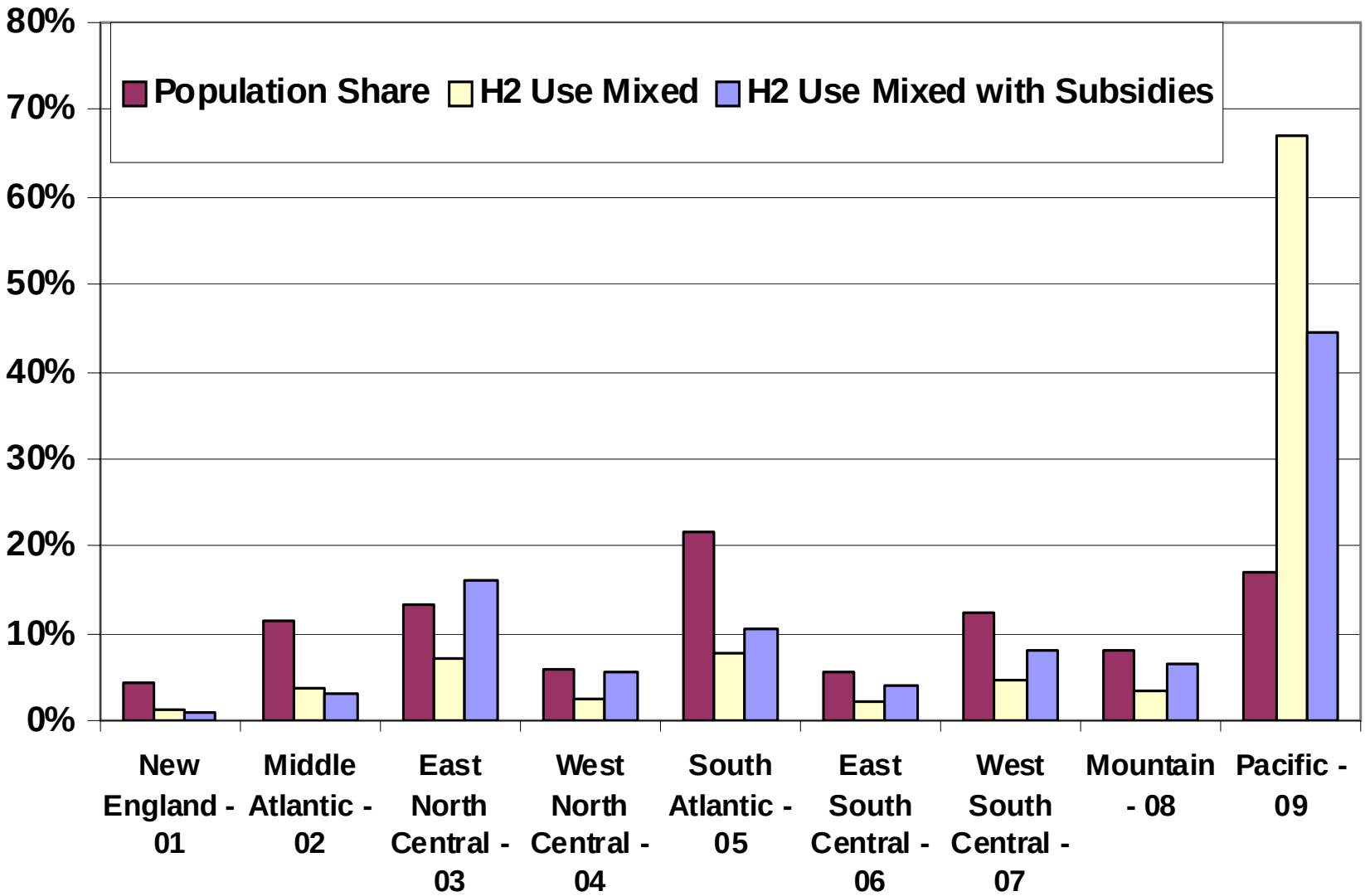
Scenarios in Phase 2 of the Multi-Path Study

- **1. Mixed Scenario** (**MS**): Government avoids picking a winning technology and vehicle technology has advanced along a broad front with no particular technology dominating the field.
- **2. Hydrogen Success Scenario**: The hydrogen program is a complete success. The Government makes a decision to promote fuel cell vehicles (FCVs) and hydrogen.
- **3. (P)HEV and Ethanol Scenario**: Strong pressure from farm States and cellulosic R&D success coupled with battery successes make flex-fuel HEVs and PHEVs very popular.
- **4. Fossil Fuel Focus Scenario**: Domestic coal and oil shale resources are fully exploited and a lot of liquid fuels (much like today's gasoline and diesel fuel) are produced.

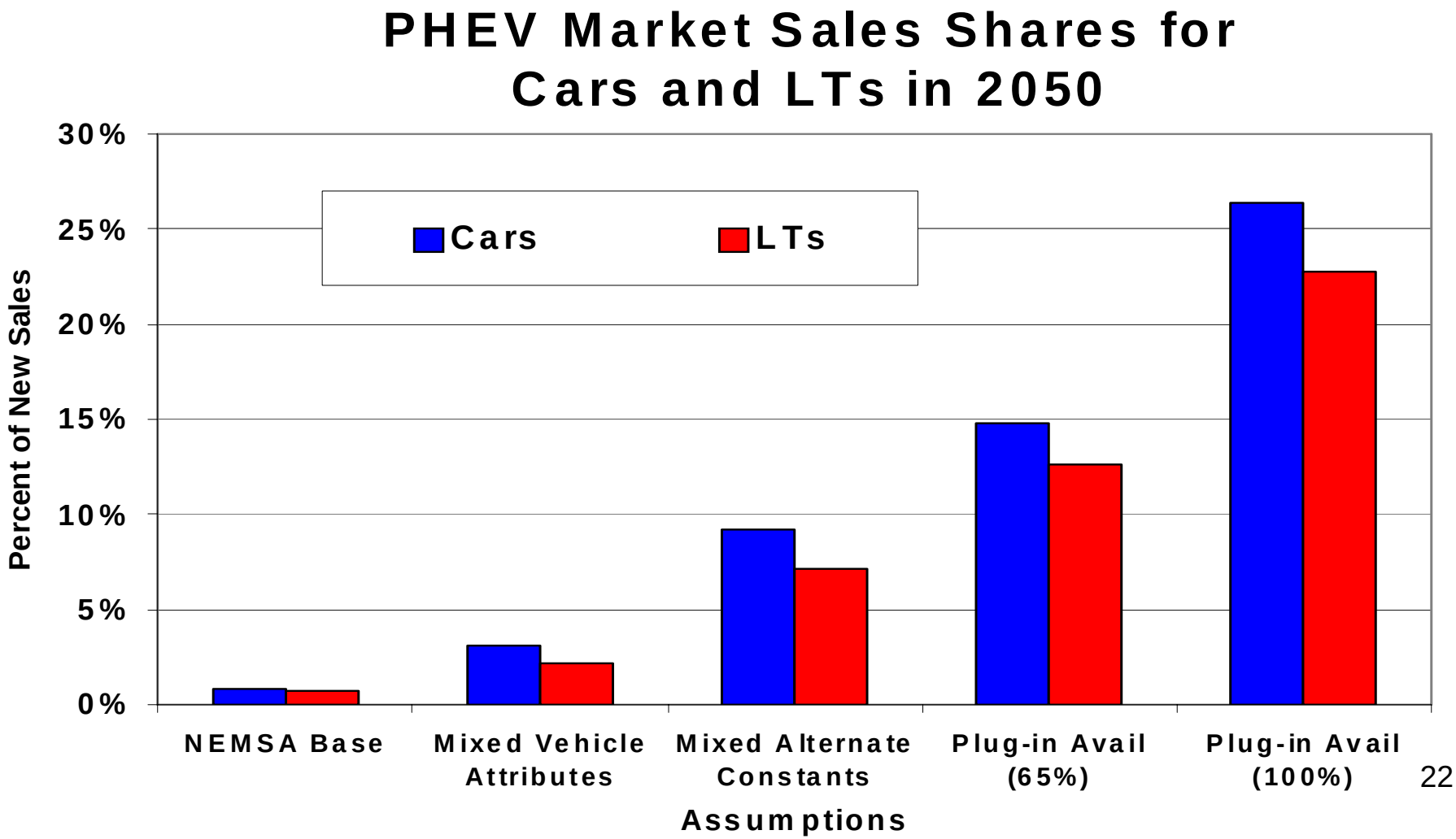
Preliminary Phase 2 results in 2050 for the Mixed Scenario and the Mixed Scenario with Subsidies



Share of H2 Use and Population Share by Region for the Mixed Scenario and the Mixed with Subsidies Case in 2050



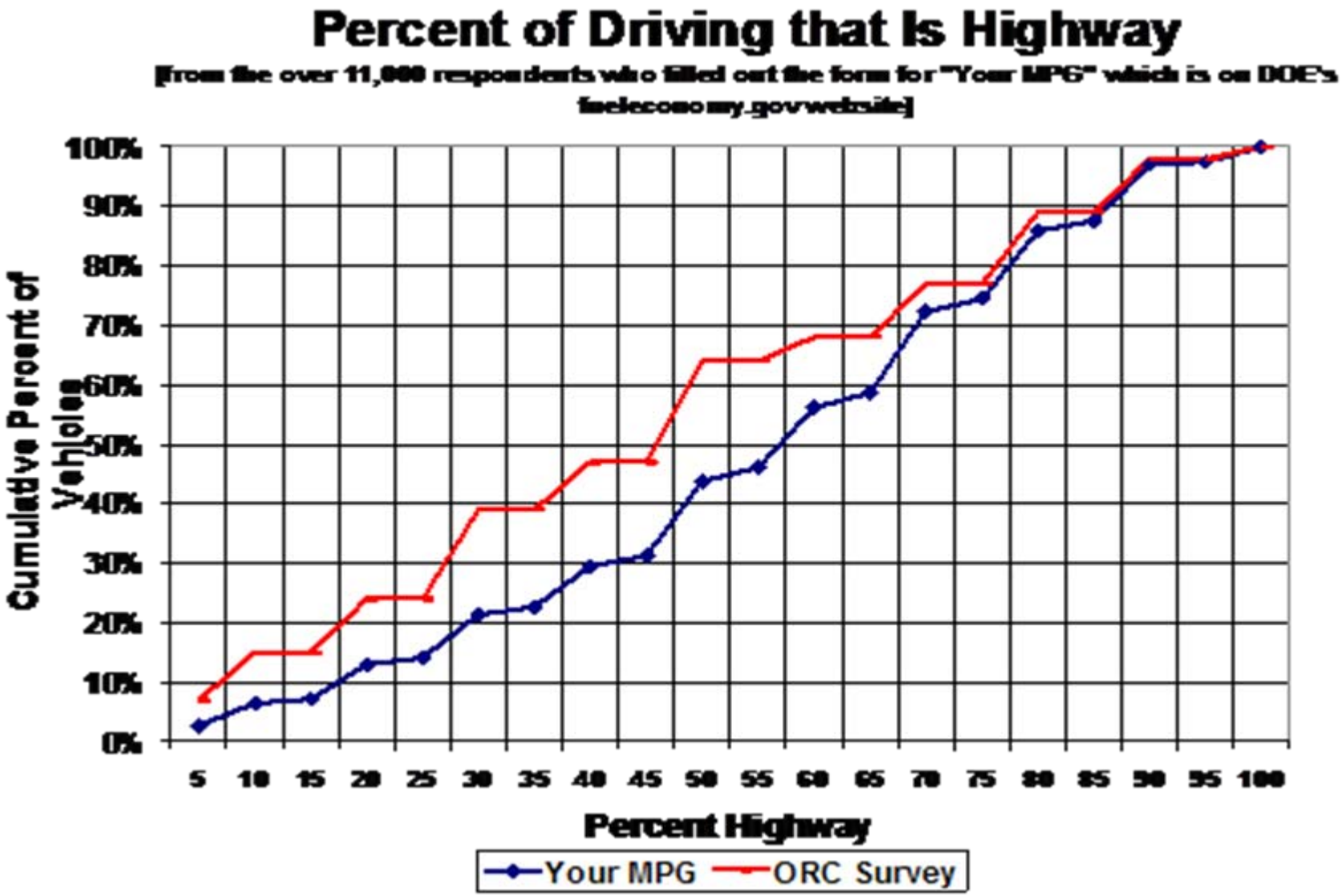
Using the NEMS Vehicle choice model we conducted sensitivities on the PHEV market share. For the first three cases, 50% of the households could buy PHEVs. But we found this vehicle choice model to be inadequate for PHEV analysis.



New PHEV Vehicle Choice Model

- The need:
  - **Compete PHEVs** with differing EV range against one another and against competitors such as diesels, HEVs, and FCVs.
  - **Analyze the effect of different** housing types, parking availability, charging availability, electricity prices, housing location (city, suburb, and rural), and early adopters.
  - Evaluate various **policy options**
- Funded by VTP
- Being built by David Greene (ORNL) and Dan Santini (ANL)
- Phase 1 model available in May 2008.
- Phase 2 model available in September 2009.

Diesels may be the best for the mostly “highway” driving, and HEVs may be best for the mostly “city” driving.



Conclusions

- The official oil saving and GHG reduction estimates for VTP that appear in the annual budget are not adequate for many of the program's needs.
- It is necessary to make other benefit estimates to satisfy VTP needs.
  - "What if ?" estimates
  - Comparison of alternative pathways under different assumptions about fuel prices, policies, and consumer desires
- Additional modeling tools (such as the PHEV choice model) need to be developed to make these benefit estimates more realistic and useful.