NHTSA RESEARCH TO INFORM THE MIDTERM EVALUATION AND MY 2022-2025 CAFE RULEMAKING

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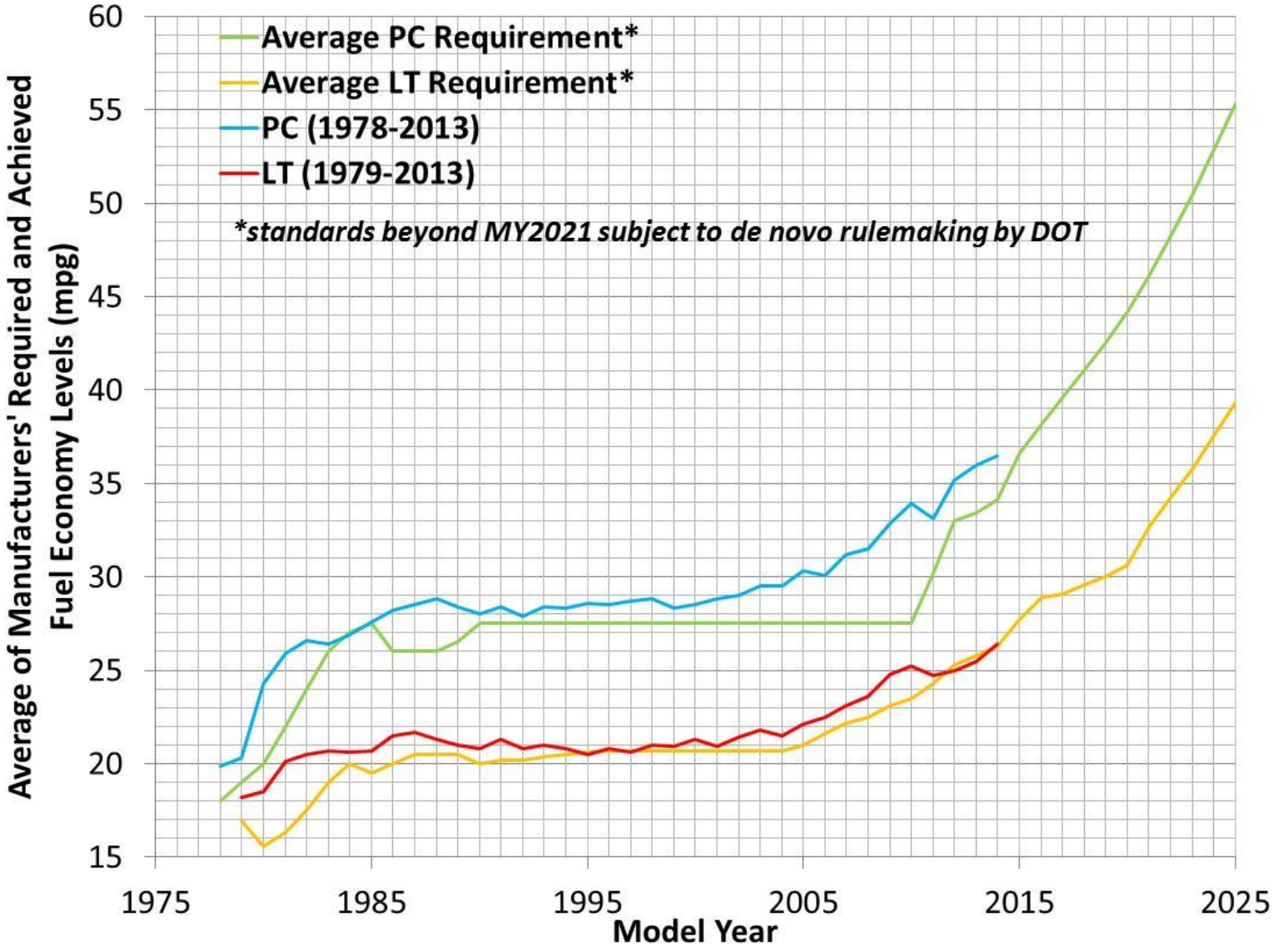
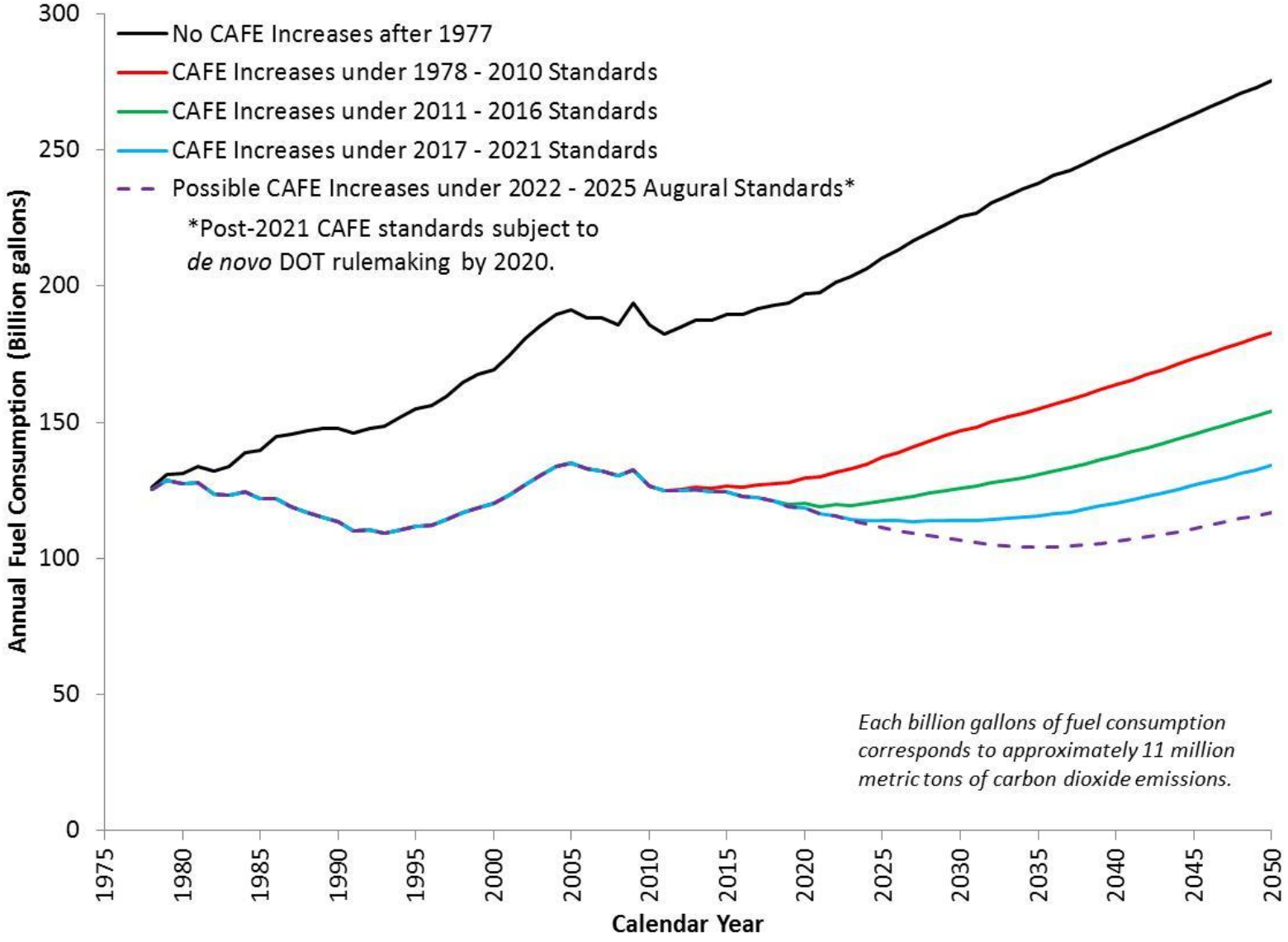
Topics

- Historical Impacts of Corporate Average Fuel Economy (CAFE) Standards
- Mid-Term Evaluation (MTE) Process
- Expansion and Refinement of CAFE Modeling System ("Volpe Model")
- New Approach to Generate Technology Effectiveness Inputs
- Mass Reduction Studies
- Updated Safety Studies

CAFE: Required Fleet Fuel Economy and Actual Fuel Economy



CAFE's Impact on Fuel Consumed by U.S. Passenger Cars and Light Trucks



Mid-Term Evaluation

MY 2017 MY 2025

EPA

Standards final unless changed by rulemaking

NHTSA www.nhtsa.gov

MY 2017-2021 Final

MY 2022-2025 Augural

NHTSA www.nhtsa.gov + EPA + California Air Resources Board

Joint Technical Assessment Report (draft by November 15, 2017)

Expansion and Refinement of CAFE Modeling System ("*Volpe Model*")

Accounting for Technology Impacts

- Technology Effectiveness
  - 2012 rulemaking approach used sequenced decision trees, incremental effectiveness, with "synergy factors" to adjust cases where the effectiveness of combinations of technologies is not mathematically additive ("2 + 2 ≠ 4")
  - **For the next round of rulemaking, DOT is working with Argonne National Lab to use full vehicle simulation results as the technology inputs to the Volpe model** *(more information in later slides)*

- Technology Cost
  - Next round will switch to volume-based learning in lieu of time-based learning
    - Time-based learning may *overestimate* learning under less stringent regulatory alternatives, and may *underestimate* learning under more stringent regulatory alternatives

Accounting for Product Cadence

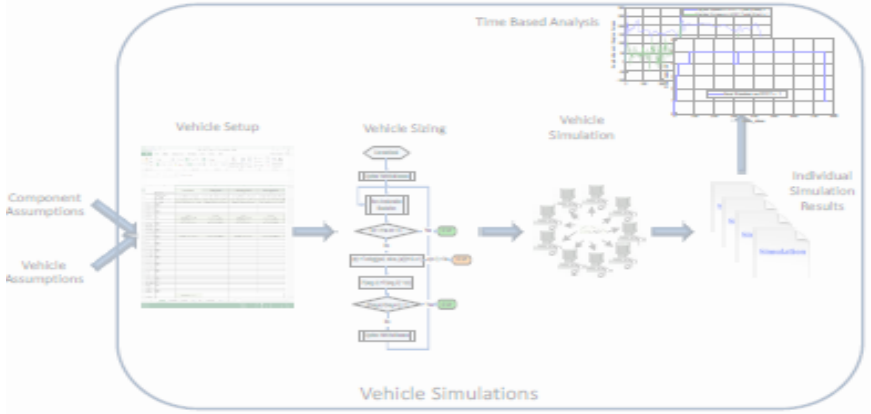
- 2012 Rulemaking approach for Redesign and Refresh
  - Most technologies applied during redesign, then carried forward until next redesign
  - Some technologies applied during freshening, or at any time, then carried forward

- Working to add platform accounting to Volpe model
  - Grouping vehicle models into common platforms
  - Limit “splintering” of engines shared among vehicles with different redesign schedules

Accounting for Impacts of Other Fuel Economy Standards

- CAFE model has been updated to simulate Class 2b-3 fleet compliance with Phase 2 MD/HD Fuel Efficiency standards for pickups and vans

- Modifying CAFE model to account for interactive effects of LD CAFE and MD/HD Fuel Efficiency standards
  - Run LD & MD/HD fleets simultaneously, **accounting for shared platforms, engines, and technologies** across the passenger cars, pickup trucks, and vans in both fleets



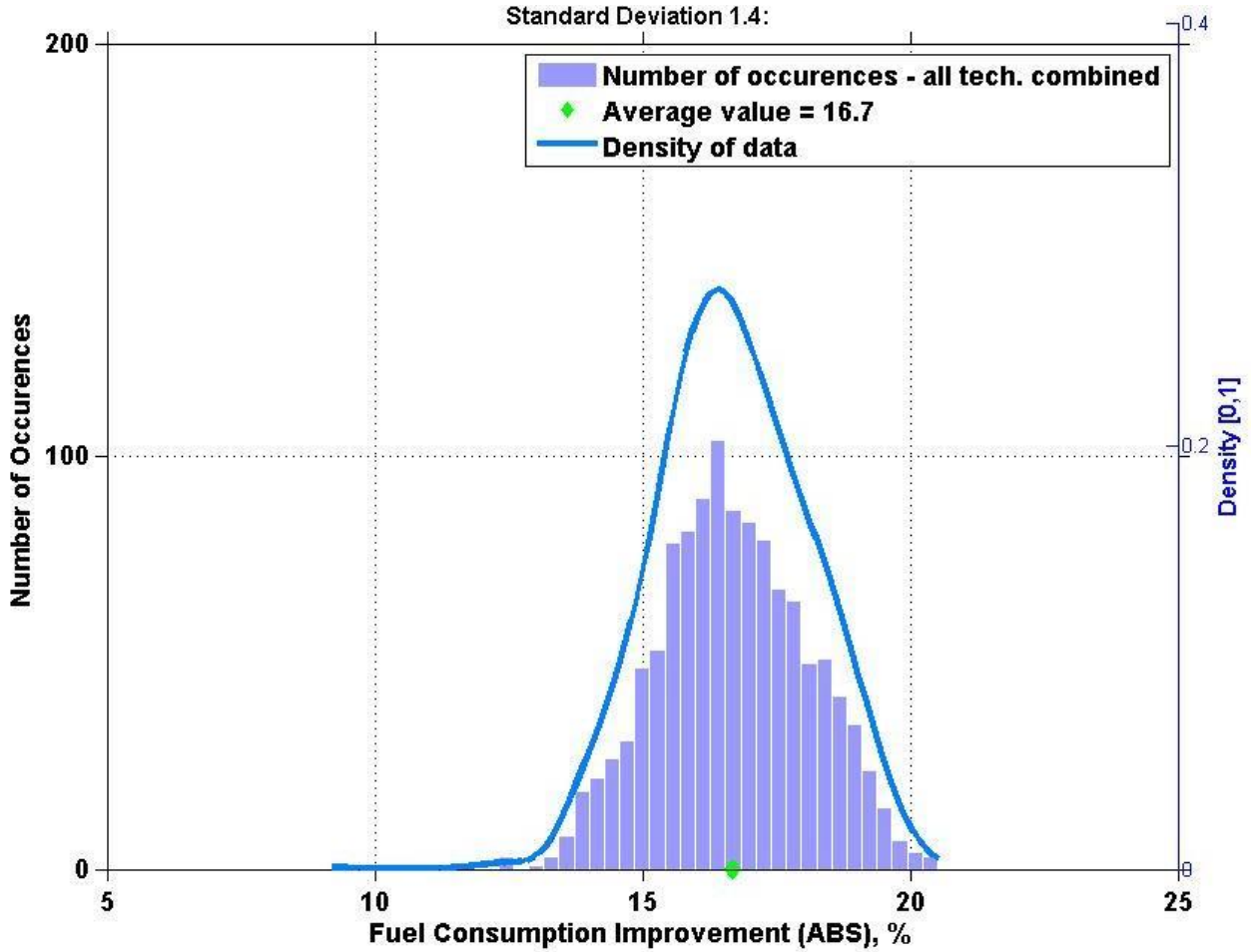
New Simulation Approach to Generate Technology Effectiveness Inputs for CAFE Model

CAFE Model: Light-Duty Simulation

- Using Autonomie simulation model for full vehicle simulations, under the support of Argonne National Labs
- **Conducting large scale simulation of all technology combinations for all vehicle classes**
  - **> 30,000 technology combinations for each vehicle class**
  - Database will be used to populate CAFE model decision tree effectiveness and generate comprehensive set of synergy factors based on individual vehicle simulation results
  - Exploring statistical methods to reduce number of simulations and with automated error checking
  - Working towards discontinuing “synergy factors” or other adjustment factors

Importance of Simulating All Tech Combinations

Example 1 – Benefit of Turbo-downsized engine over baseline engine



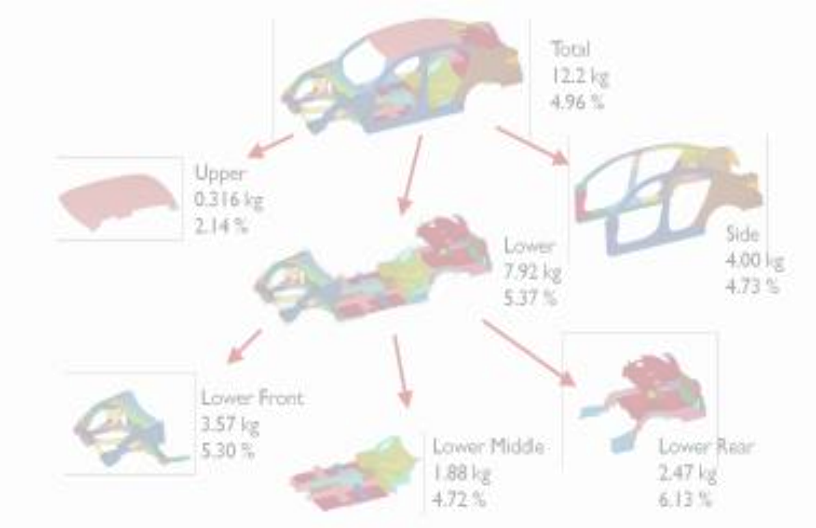
Distribution of fuel consumption improvement (when considering all possible technology combinations) ranges from 13 – 20%.

Why Use Autonomie?

- Autonomie is the lead vehicle simulation tool used by the U.S. DOE to evaluate all future technologies
- PSAT/Autonomie plant and control models have been developed and validated over the past 16 years using detailed test data from Argonne vehicle test facility as well as OEM partnerships for numerous configurations, including conventional, start-stop, HEV, PHEVs and BEVs
- Due to its increasing usage, Autonomie deployment and support now handled by Siemens
- Currently use by industry, academia and government
  - Light duty vehicle manufacturers: GM, Ford, Chrysler, Hyundai, Toyota, PSA Peugeot Citroen…
  - Heavy duty vehicle manufacturers: PACCAR, Cummins, John Deere, Daimler, Navistar…
  - Suppliers: Delphi, Eaton, Siemens, ArvinMeritor, Roush, SK Energy, LG Chem …
  - Research organizations: DOD, DOT, EPA, NREL, ORNL, INL, JRC, CATARC, KATECH …
  - Universities: >20 US Universities (University of Michigan, MIT, Purdue..), Mines Paris, Tsinghua Univ., Beijing Institute of Technology, Seoul National Univ…

Transparency of Approach

- All assumptions and inputs will be clearly documented and releasable to the public
  - All engine maps and transmission calibrations would be releasable to public. Informed by engine maps developed in GT Power by IAV and other data sources
  - Calibrations for transmissions would be compared to OEM production vehicles
  - A tool is being created to help the user review and analyze the result database



Mass Reduction Studies

- Objective is to explore vehicle mass reduction feasibility and cost
  - Mid-Size Passenger Car Small Overlap Study
  - Full-Size Pickup Truck Lightweighting Project

Mid-Size PC Small Overlap Update

- Scope of Work
  - Update the **baseline Honda Accord** finite element model to correlate to IIHS small overlap test
  - Update **lightweighted midsize passenger car design** to achieve good rating in IIHS small overlap test
  - Estimate the amount of vehicle mass and cost change to meet the IIHS small overlap test requirement

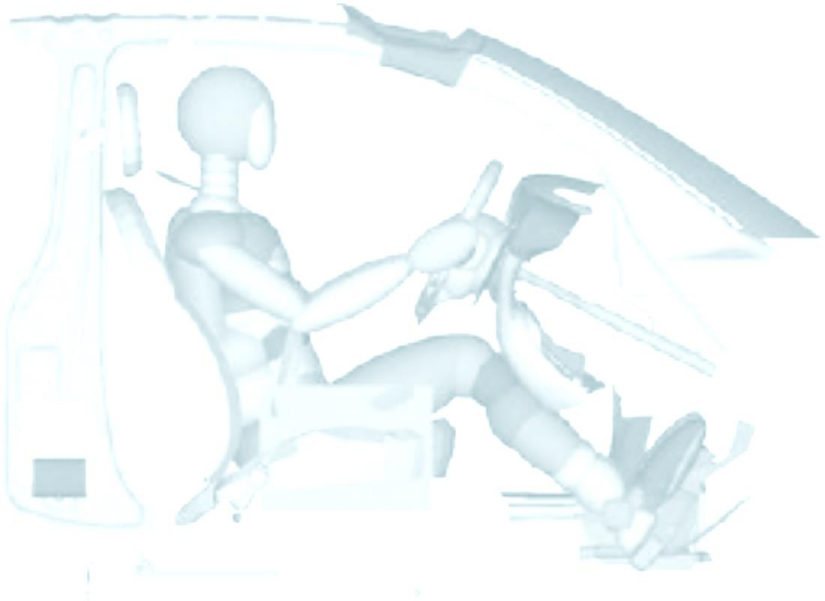
Full Size Pickup Truck Lightweighting Project

- Scope of Work
  - Find the maximum feasible amount of mass reduction for a high volume production body-on-frame light duty pickup truck
  - Technology Selection Boundary:
    - Use advanced design, material and manufacturing process for MY2020-2030
    - At minimum, lightweighted pickup truck should meet the performance of the original baseline vehicle in safety, utility, manufacturability, powertrain performance, durability, NVH, serviceability
  - Cost boundary:
    - Control both direct and indirect cost to maintain affordability, price parity of +/- 10% of baseline vehicle

Full Size Pickup Truck Lightweighting Project

- Scope of Work
  - Phase I: Baseline Vehicle Reverse Engineering
    - Tear down a baseline vehicle
    - Reverse engineer the baseline vehicle and generate finite element analysis (FEA) and cost models
  - Phase II: Design and Optimization of the Lightweighted Pickup Truck
    - Design and optimize the lightweighted pickup truck and develop a FEA model
    - Perform cost analysis for the optimized design.
    - Update the cost analysis for midsize passenger car study.
    - Update the mass reduction estimate for other vehicle classes done in the passenger car lightweighting project
- Contractor: EDAG, Inc.

Safety Studies



- Vehicle Fleet Simulation
- Mass-Size-Safety Statistical Analysis

Vehicle Fleet Simulation

- Objective: Systems modeling to assess the effects of **future lightweight vehicle designs** on overall fleet safety
  - The approach includes estimating the real-world level of safety in a vehicle for its own occupants (self-protection) and for the occupants in vehicles with which it collides (partner protection)
    - Phase I:
      - Report has been peer reviewed and published in the docket (Report No. DOT HS 812 051A)
    - Phase II:
      - Introduce a modern design of CUV into the fleet
      - Perform frontal impact fleet simulations using light-weighted vehicle
      - Update the fleet injury risk

Available on NHTSA website:
http://www.nhtsa.gov/DOT/NHTSA/NVS/Crashworthiness/Vehicle%20Aggressivity%20and%20Fleet%20Compatibility%20Research/812051-FleetModeling.zip

Mass-Size-Safety Statistical Analysis

- Objective: Statistical analysis of **historical crash data** to assess the effects of vehicle mass reduction and size on Fatality Risk
  - Ongoing work by NHTSA
    - Update and publish safety analysis database
    - Use updated safety analysis to inform the midterm review

Questions?

NHTSA MTE Web Page: *CAFE Fuel Economy Standards and Midterm Evaluation for Light-Duty Vehicles, MYs 2022-2025*

http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/ld-cafe-midterm-evaluation-2022-25