CAFE Beyond 2021

Key questions and challenges

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Office of the Secretary of Transportation
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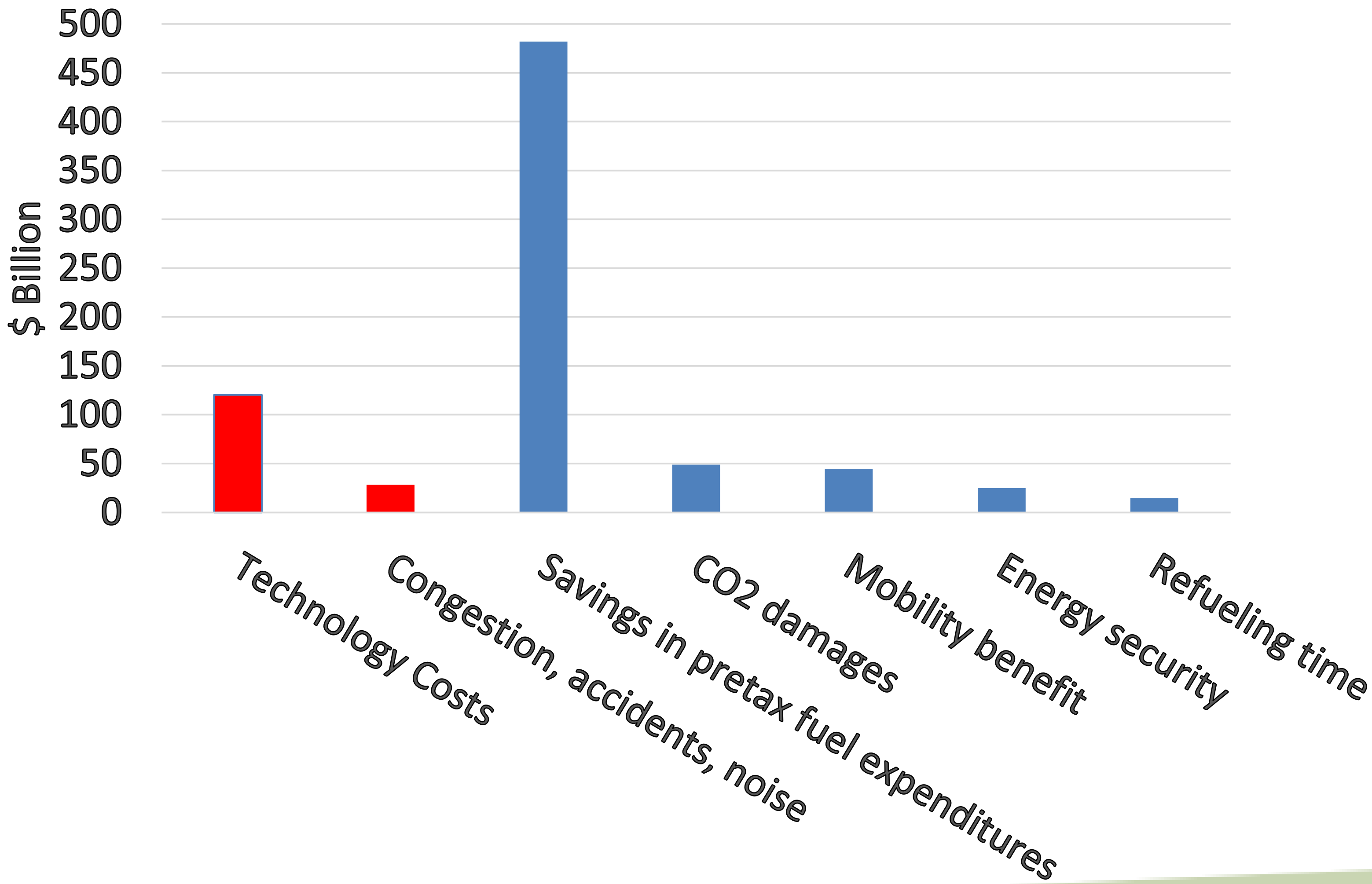
Roadmap

- Impact of MY2017 – 2025 standards on society/consumers
- Background on CAFE program and current status
- Regulatory Analysis
  - Important elements
  - Sources of information
  - The CAFE Compliance and Effects Model (aka “The Volpe model”)
- Simulating manufacturers’ responses to CAFE standards
- Important considerations for next analysis

MY 2017 - 2025 rulemaking creates large benefits to society net of technology costs



Largest benefits are value of fuel savings: "Private perspective" is important

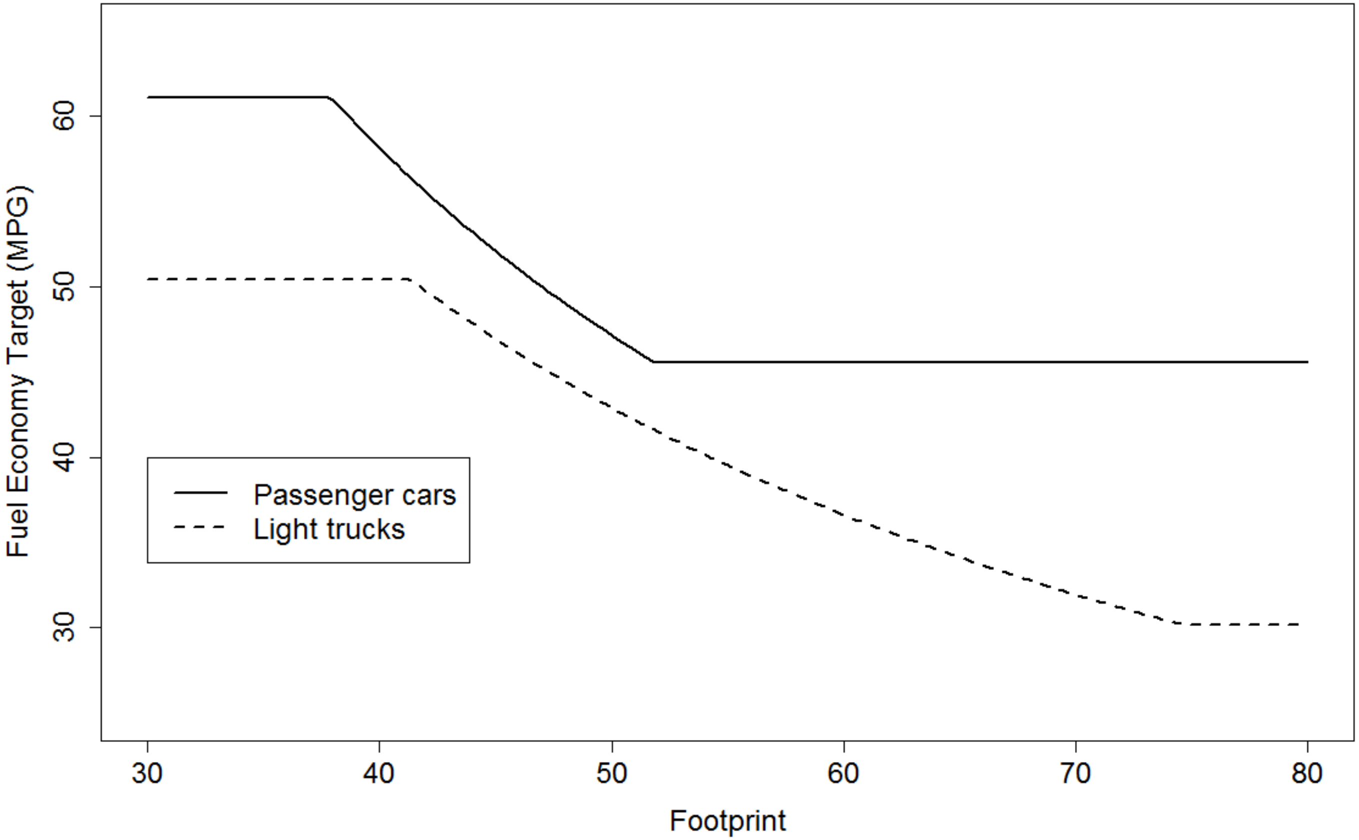
Vehicle	Measure	Value at Alternative Discount Rates		
		New Car Loan Rate (5.16%)	Consumer Rate (7%)	Credit Card Rate (13.8%)
MY 2025 Passenger Car	Fuel Savings	$4,200	$3,800	$2,800
	Price Increase	$1,400	$1,400	$1,400
	Difference	$2,800	$2,400	$1,400
MY 2025 Light Truck	Fuel Savings	$4,900	$4,500	$3,300
	Price Increase	$1,100	$1,100	$1,100
	Difference	$3,800	$3,400	$2,200

Standards Beyond 2021

- Process and requirements subject to statutory requirements
  - APA (notice and comment)
  - EPCA/EISA (structure and stringency of CAFE standards)
- CAFE standards are in place through 2021
- CAFE standards are not in place beyond 2021
- No later than April 2020, DOT/NHTSA must issue a *de novo* rule about stringency for MYs 2022 and beyond
  - Augural standards shown in 2012 notice can be among the range of considered alternatives, but can receive no special consideration
- Per EPCA/EISA, post-2021 standards must be set at the maximum feasible levels separately for each fleet (cars, light trucks) and each model year
- "Mid Term" for Related EPA GHG standards
  - Agencies continue to discuss scope and plan – nothing to announce today
  - Expect continued coordinated approach and harmonized (as practical) standards

What are the standards?

- Headline numbers are generally misleading
  - For example, “54.5” is not the standard in MY 2025 described in latest rule



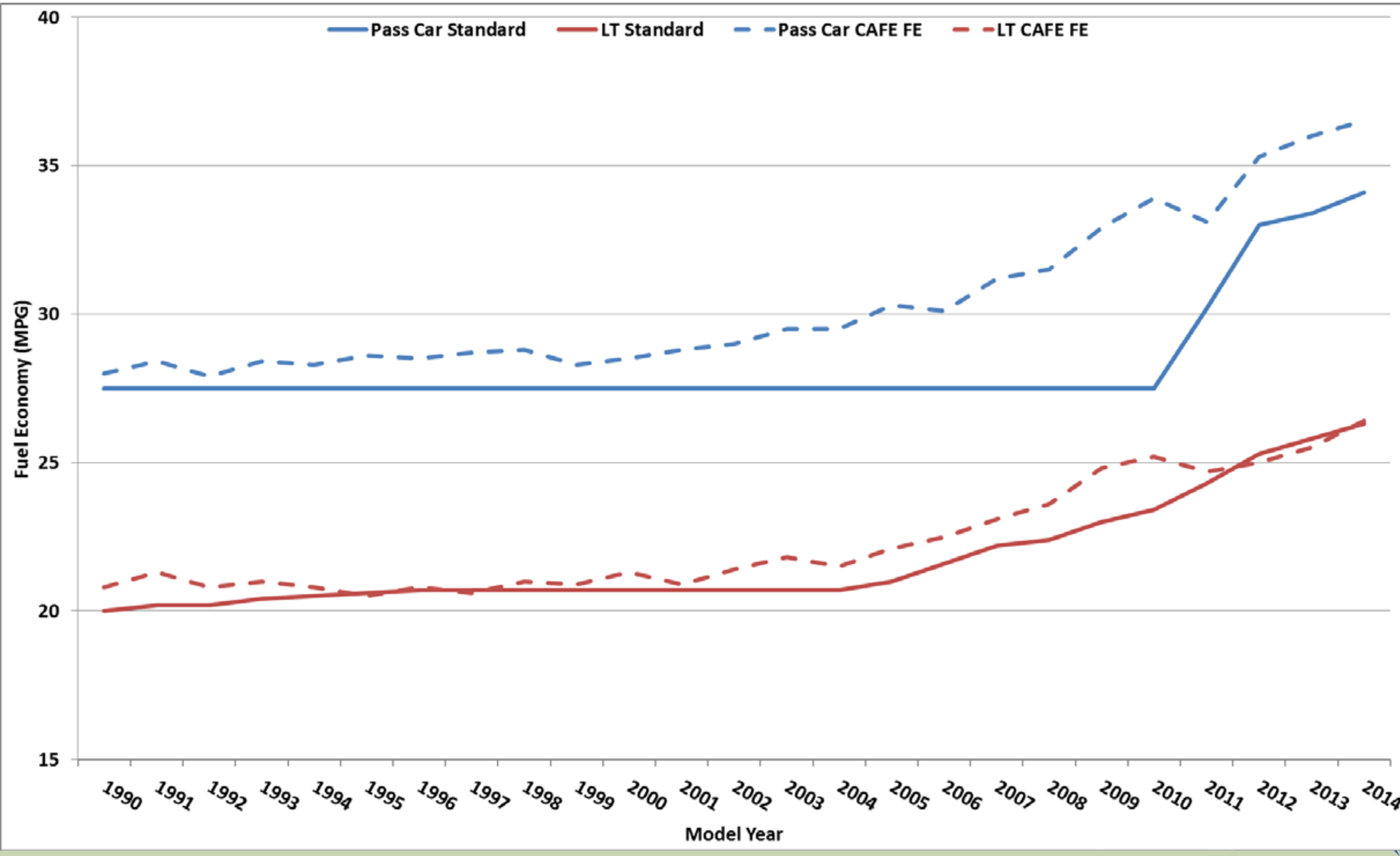
These are.

Corporate Average Fuel Economy

- Specific vehicle models have a “target” not a “standard”
- Compliance is based on fleet-wide average, for each OEM
  - Attribute based standard, differs by class (passenger cars, light trucks)
  - Different fleet compositions change the average required level (LT share, distribution of sales by footprint)
- Standards provide flexibility, as specified in statute:
  - manufacturers can add technology to vehicles or shift product mix
  - bank and borrow credits
  - transfer credits between fleets
  - trade credits
- EPCA/EISA requires that OEMs pay fines for any failure to comply.

So how's it going lately?

- CAFE standards have been steadily increasing since 2005 for LTs and 2011 for PCs



Regulatory action requires choosing among regulatory alternatives and their impacts

- Consider multiple specifications/stringencies
  - Different schedules based on footprint (shapes of curves)
  - Consider different levels of efficiency increase per model year (e.g. 2% per year vs. 6% per year)
  - Different class distinctions (e.g., definition of a "light truck")
- Integrate relationships between standards, changes in technology adoption, exogenous factors, economic assumptions
  - Model manufacturers' decision to address standards (add technology, pay fines, borrow/generate/use credits) over multiple years, simultaneously
  - That decision in context of assumed consumer willingness-to-pay for fuel economy increases and prevailing fuel prices
- Compare standards across variety of metrics
  - (Private) Change in average vehicle cost, benefits to consumers
  - (Social) Total net benefits (to society), total fuel/GHG savings, etc.

Supporting analysis requires information about…

Industry status and outlook

- Vehicles offered, baseline attributes, technology, and fuel economy; product development cadence

Available technology

- Both now and over model years spanned by rule
- Estimated fuel efficiency improvement, costs (both direct and indirect)
- Decision trees, application logic and engineering constraints

Exogenous factors

- Forecasts of fuel prices, fuel properties, new vehicle sales, annual vehicle usage (miles) and survival throughout the vehicle’s useful life

Economic valuations

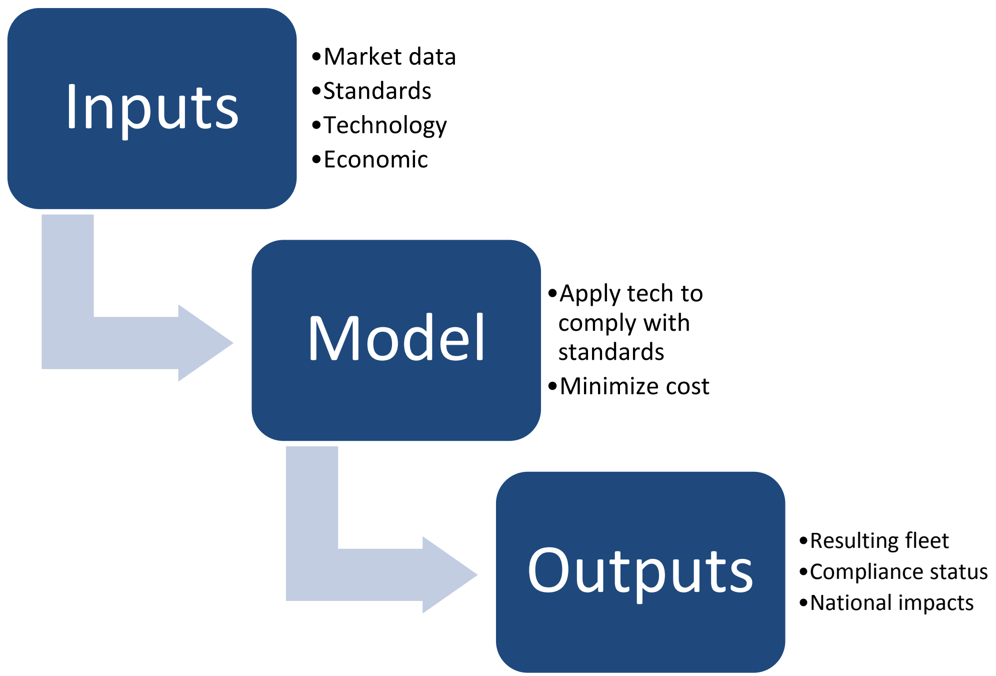
- Social cost of carbon, relevant discount rates, time saved, additional travel, energy security, consumer valuation of fuel economy, pollutant damages

Multiple sources provide critical data

- Technology costs and effectiveness values
  - Agency-sponsored tear-down studies, full vehicle simulation studies, National Academy of Sciences reviews
- Baseline vehicle sales, characteristics, and fuel economy
  - CAFE certification data provided by manufacturers
  - Public sources of vehicle attributes (OEMs, Edmunds, Wards automotive)
  - Future sales from commercial forecasts/Annual Energy Outlook
  - Can also use manufacturer-provided forecasts, but must protect confidentiality of this information
- Vehicle usage data
  - National Household Travel Survey (NHTS)
  - Annual Energy Outlook
  - National vehicle registration data (state DMVs provide to R.L. Polk)
  - Crash data (mass-safety analysis)
- Academic literature informs determination of economic inputs

CAFE Compliance and Effects Modeling System (the "Volpe model") was developed to support CAFE rulemaking activities

- ❑ Continuous development and refinement of model since 2002, informed by extensive and detailed external review
- ❑ Simulates manufacturers' year-by-year and fleet-by fleet responses to new standards
- ❑ Executable file, model documentation, source code, and input and output files from recent regulatory analysis available on NHTSA's website
- ❑ http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/CAFE+Compliance+and+Effects+Modeling+System:+The+Volpe+Model



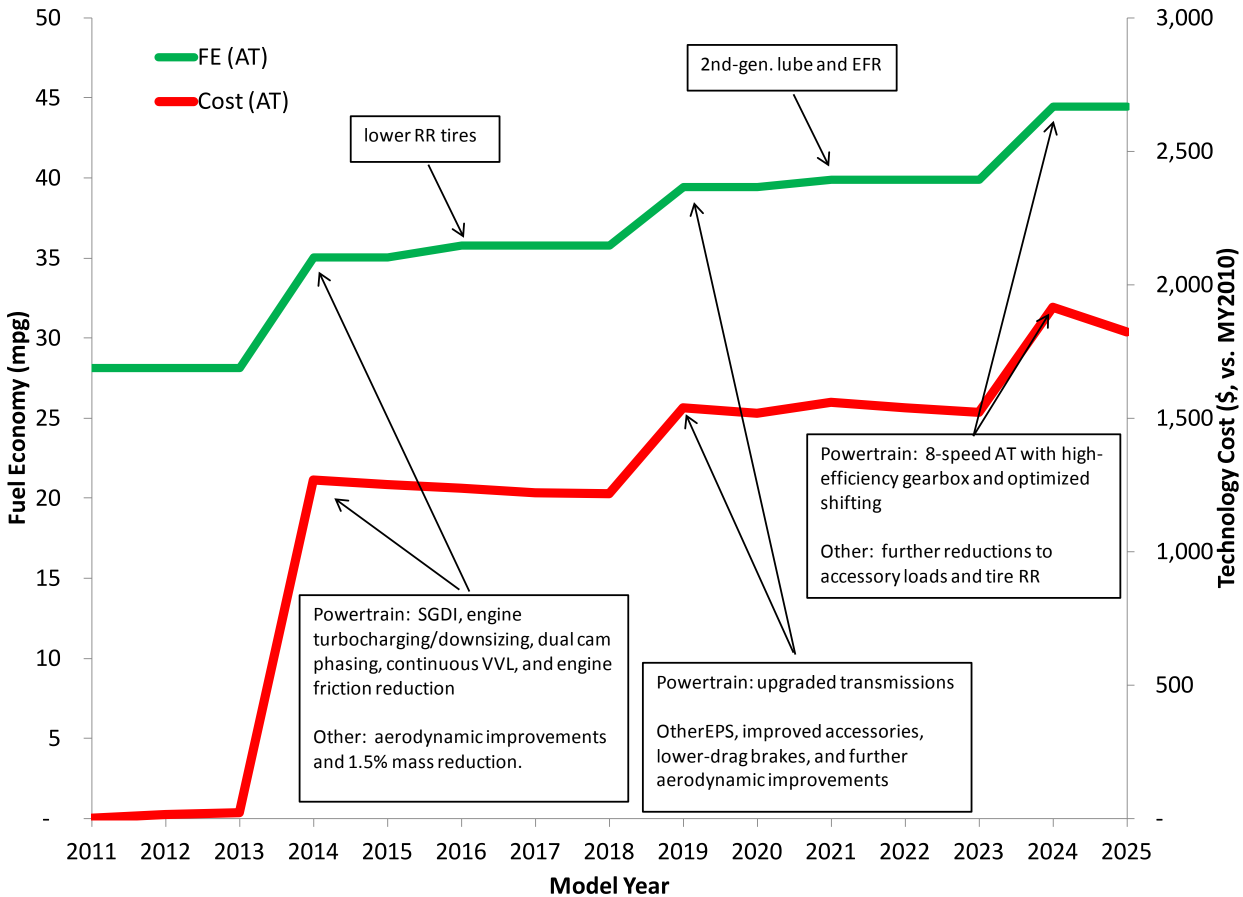
Simulating manufacturers' decisions

- Compliance simulated at manufacturer level
- Some more constrained by standards than others
  - Differences in sales mix, existing fuel economy, credit position
  - Credit/fine payment strategy
- Add technology where possible (product cadence matters)
  - Increase fuel economy in a performance neutral manner
  - Planning for multiple years at each decision point
  - Limited number of engines across larger number of models
  - Engines redesigned less frequently than (most) models
  - Vehicle models inherit new engines at redesign (refresh?)
  - Other technologies platform-specific or model-specific
  - Technology carried between redesign/refresh model years
- Pay fines
- Generate/apply credits

Accounting for Technology Impacts

- Fuel consumption impacts
  - Current approach uses sequenced decision trees, incremental impacts, with "synergy factors" to adjust for "2 + 2 ≠ 4" situations.
  - Not clear this approach is problematic in terms of biasing fleet-level results, but some observers have recommended more simulation-centric approach.
  - DOT working with Argonne to develop database of simulation results, and examining potential to modify CAFE model to use these results.
- Cost impacts
  - Still considering how to handle cost accounting (currently also incremental) if database is used for fuel consumption impacts.
  - Also considering implementing explicit volume-based learning in lieu of recent time-based learning as proxy. Volume-independent time-based learning probably overestimates learning under less stringent regulatory alternatives, and probably underestimates learning under more stringent regulatory alternatives.

Toyota Tacoma example



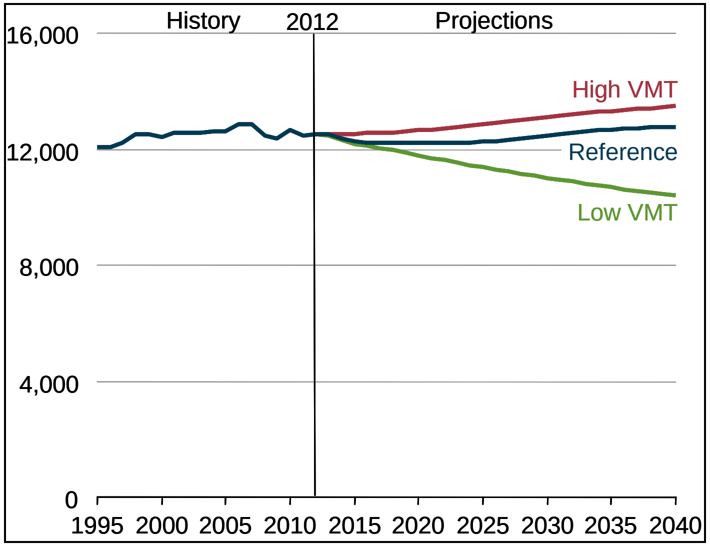
Model Year	Redesign	Refresh
2011		
2012		
2013		
2014	X	
2015		
2016		X
2017		
2018		
2019	X	
2020		
2021		X
2022		
2023		
2024	X	
2025		

Unintended impacts of standards could affect manufacturers' ability to comply

- Will standards affect product cadence?
  - Big technology application is limited to redesigns
  - Currently frequent enough to meet pace of increasing CAFE standards?
  - How will those changes impact global platform development cycles, technology availability, allocation of engineering resources, stranded capital, etc?
  - Impact on suppliers?
- How will the new vehicle market respond to increases in prices?
  - Shifting distribution of fuel economy/costs among models and classes may change fleet mix (e.g., PC/LT ratio) for constrained OEMs
  - Price increase large enough to increase length of ownership, or impact used car market?
  - Alternative fuel technology adoption rates?

Key challenges for next phase analysis

- Estimate likely impact of future standards many years in advance
- Represent availability of technology with fidelity
- Incorporate accurate information about changing system
  - Per-capita VMT and demographic shifts
  - Evolution of preferences for vehicle attributes
  - Volatility in energy market
- Combined impact of CAFE standards
  - PC, LT, MD regulations all in place for some years
  - Technology migration across fleets



Source: Vehicle use by all drivers in three cases, 1995-2040: History: U.S. Department of Transportation, Federal Highway Administration, *National Household Travel Survey*, http://nhts.ornl.gov/download.shtml. Projections: AEO2014 National Energy Modeling System, runs REF2014.D102413A, LOWVMT.D020314B, and HIGHVMT.D020314D.

Thanks