CAFE COMPLIANCE CHALLENGES: EVIDENCE FROM MANUFACTURER PRODUCT PLANS

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H-D Systems
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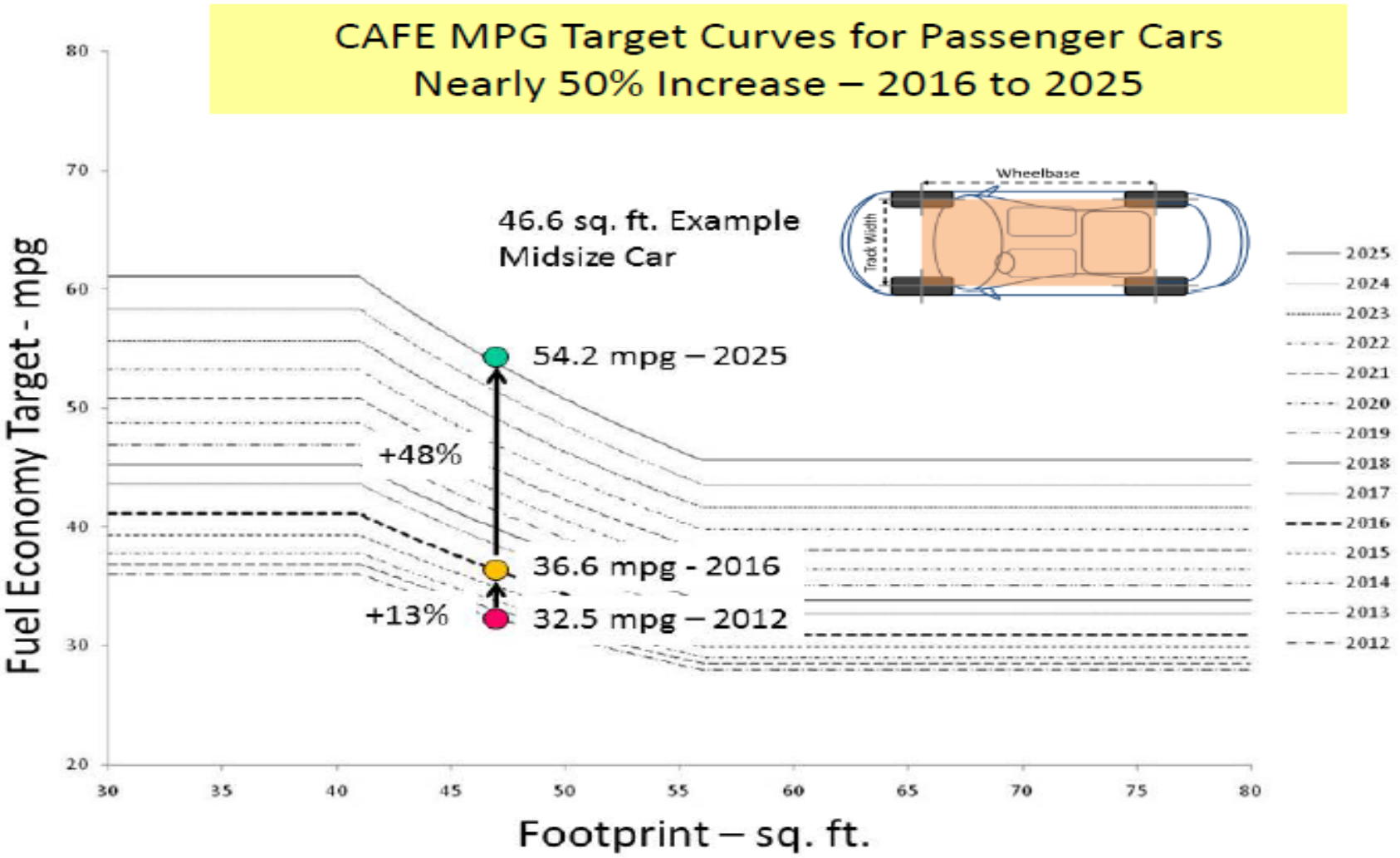
Presentation Overview

- Recent reports from NAS and EPA suggest that compliance with 2025 standards could be possible with minimal hybridization
  - Increased optimism on gasoline engine technology
- Forecasts of compliance to 2020/25 based on manufacturer product plans show a different picture
  - Many vehicle types have significant difficulty with compliance
  - Market moving in direction that makes compliance more difficult
- Factors affecting compliance explored from our detailed forecasts of vehicle technology and fuel economy by model/ engine/ transmission.

Estimates of Actual 2025 Requirements

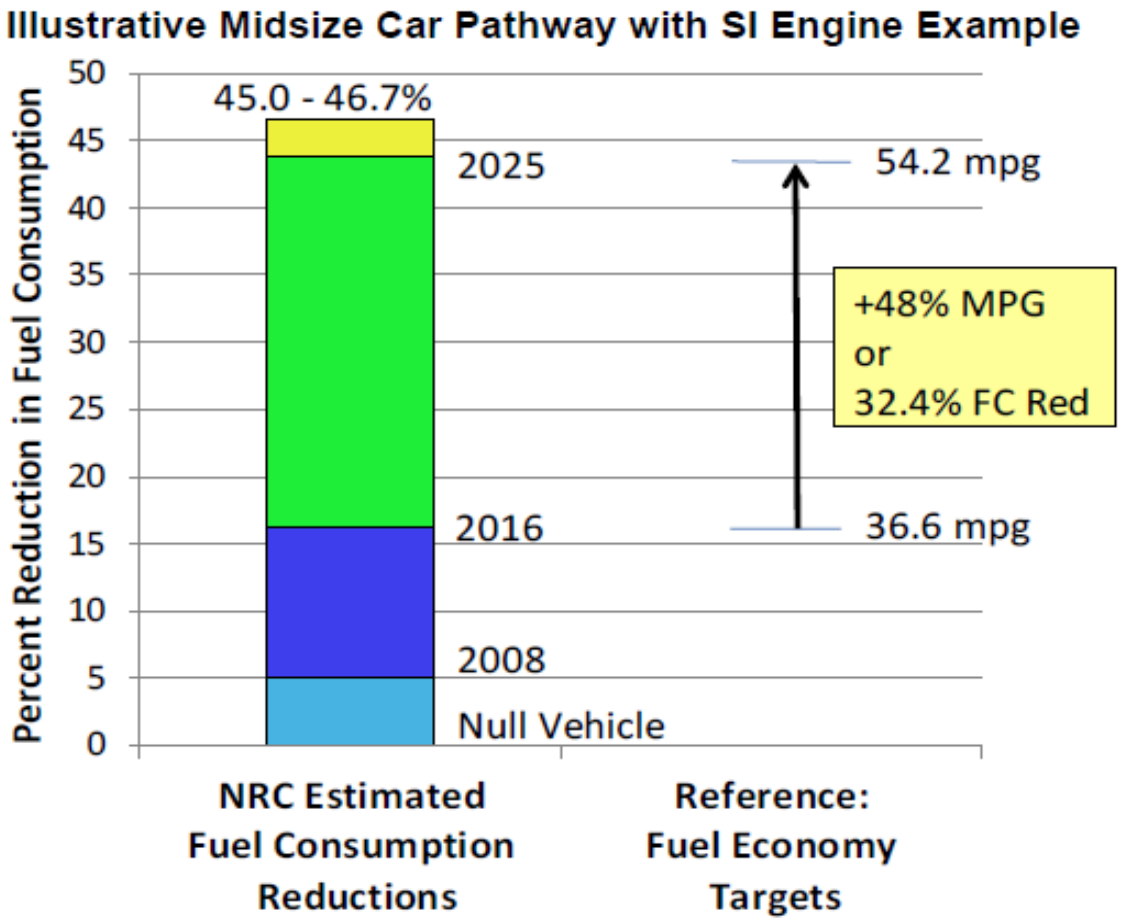
		GHG emissions g/mi
EPA 2025 Standard		163.0 (54.5 mpg)
Air Conditioner Improvements		21.3
Off Cycle Technology Credits (at cap)		10.0
High Efficiency Pickup truck Credit		0.4
EV/PHEV zero g/mi credit at 5% penetration		4.5
Over-estimate of car market share		4.8
Increased wheelbases for all vehicles		4.0 +
Net Total		205+ g/mi (<43.35 mpg)

Midsize Car Example - NAS



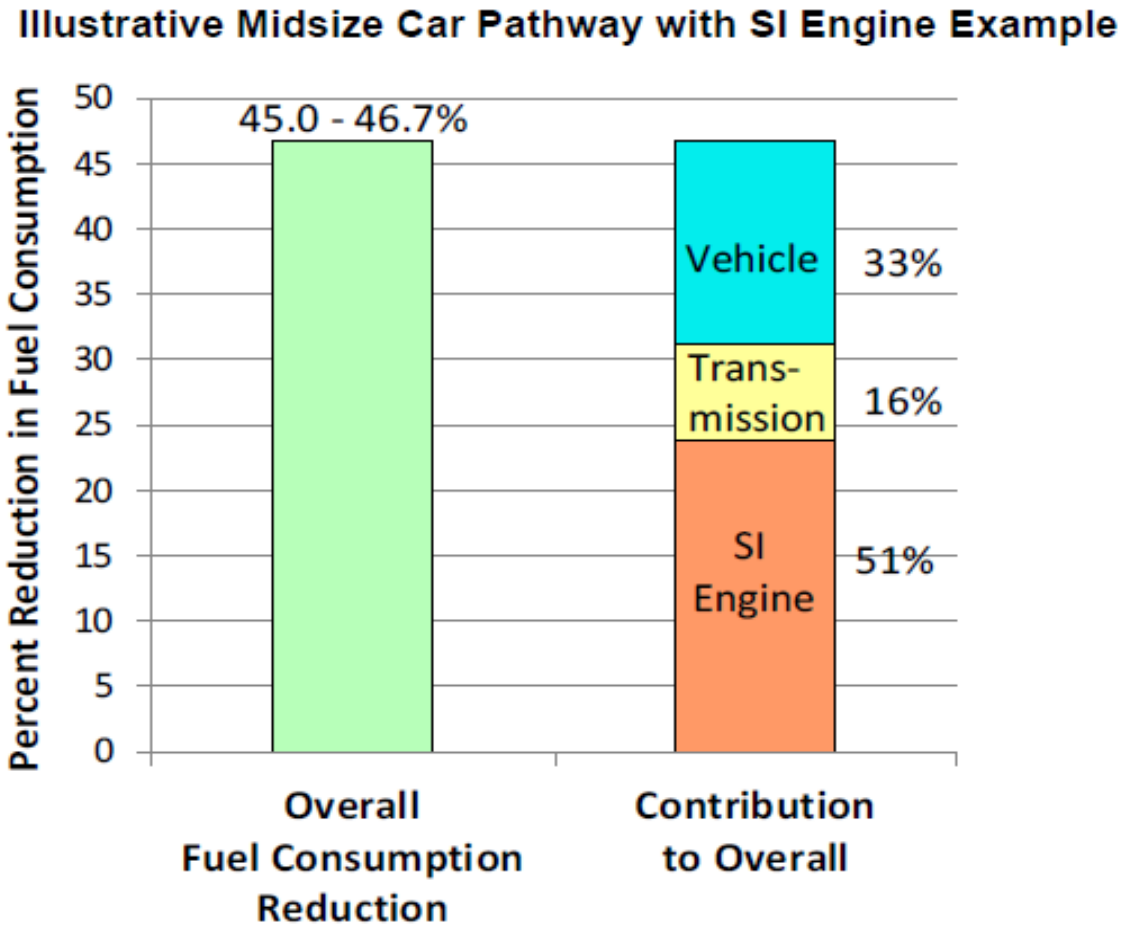
NAS Computation from 2008

NRC Estimated Fuel Consumption Reductions
Compared to CAFE Fuel Economy Targets



NAS Estimates of Tech Pathway

Components of Overall Fuel Consumption Reduction



Overall NAS Pathway

- The NAS pathway for the mid-size car shows compliance is possible without the use of any significant hybridization with 23% FC reduction potential from engine technology alone.
- The most likely cost (not price) of all improvements from 2016 to 2025 is estimated by NAS at about $1190 which is similar to EPA's estimate of $1080.
- Our own analysis of technology potential and cost is quite similar to NAS' estimates with some exceptions, so this is not the driver in compliance issues. However, actual FE results in 2016 suggest some shortfall from benefit estimate.
- Two major issues with compliance calculations
  - The midsize car starts at 36.6 mpg in 2016 and just makes it with all conventional technology by 2025
  - Most other vehicle types except compact cars have a more difficult time.

Midsize Car Fuel Economy

- Many 2016 midsize cars do meet or exceed the 2016 goal of ~36.6 mpg, but this is usually only with the base engine and transmission combination.
- Most midsize cars also offer a "high line" version with higher performance and option content that reduces FE by ~20%. Hence, manufacturers must over-comply with the base model to meet fleet CAFÉ targets
- Since the baseline vehicle "just makes it" in 2025, there are no or minimal offsetting credits available for high line cars. Hence, some form of hybridization is required.
- Luxury car manufacturers have midsize car FE quite similar to those for high-line mass market cars.
- These factors are even more pronounced for sports cars and coupes that have a short wheelbase.
- For most vehicles of this type, preserving high line attributes requires varying degrees of electrification at much higher cost

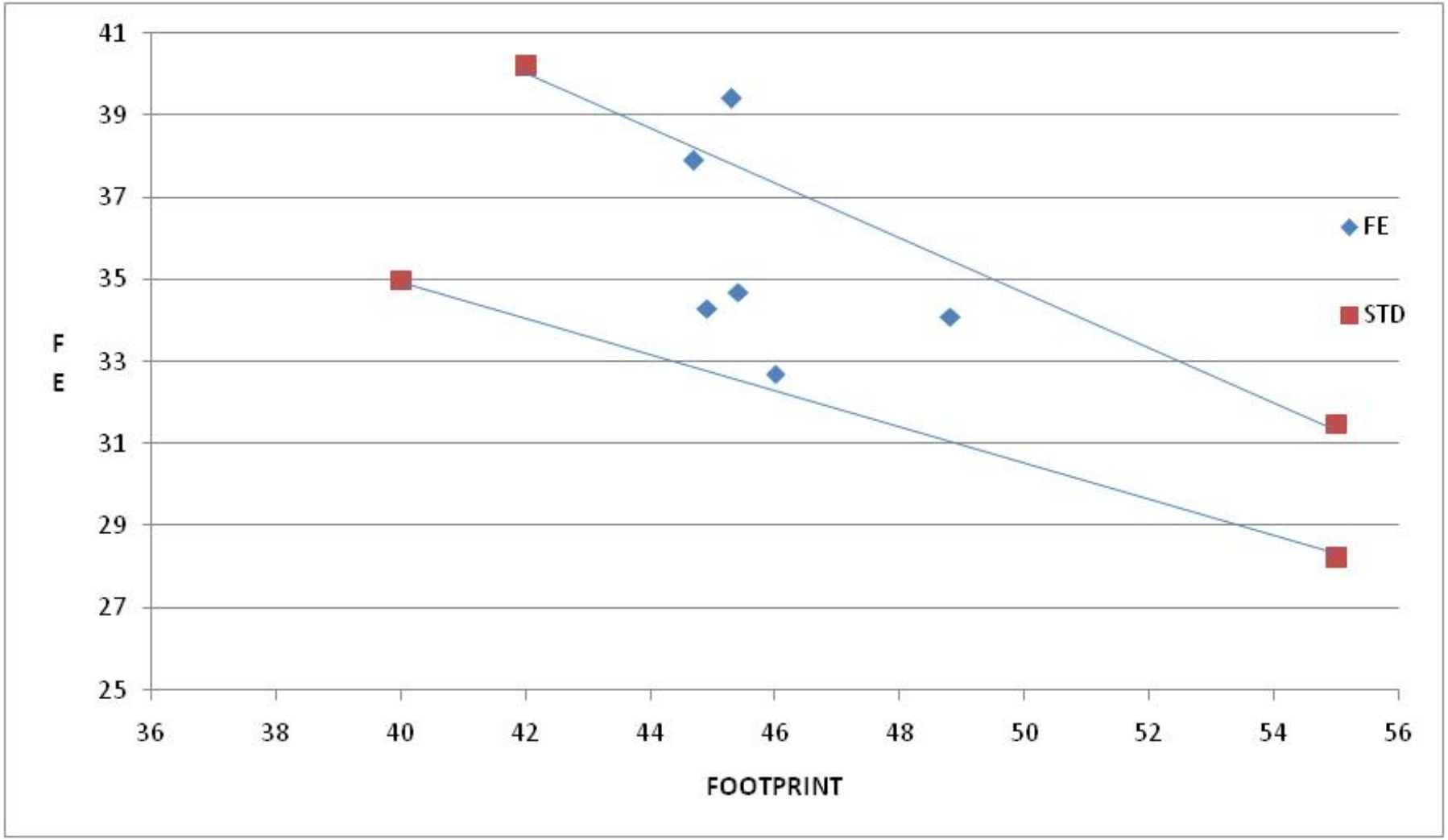
Example 2015 Fuel Economy

		Base Powertrain	Optional Engine
Toyota Camry		38.2	32.6
Honda Accord		39.3	33.8
Ford Fusion		38.9	34.8
Chevy Malibu		39.3	31.4
Nissan Altima		41.7	34.6
BMW 5 series		35.3	31.0
Mercedes E class		30.7	26.9

The SUV Shift

- CAFÉ calculations now shift 2 wheel drive SUV models up to 4000 lb. inertia weight to passenger car category from light truck category.
- At the same footprint size, SUVs are much heavier than passenger cars due to larger and taller body and increased ground clearance both of which increase aerodynamic drag as well. Hence FE at the same footprint is ~15% lower than passenger car.
- Most compact SUV fuel economy in 2015 falls between the light truck and car requirements. The re-classification results in a double shock for manufacturers, lowering LDT FE and lowering passenger car FE.
- The compact SUV class is now the fastest growing class so that market trends are adding to compliance difficulty.

2016 Compact 2WD SUV FE



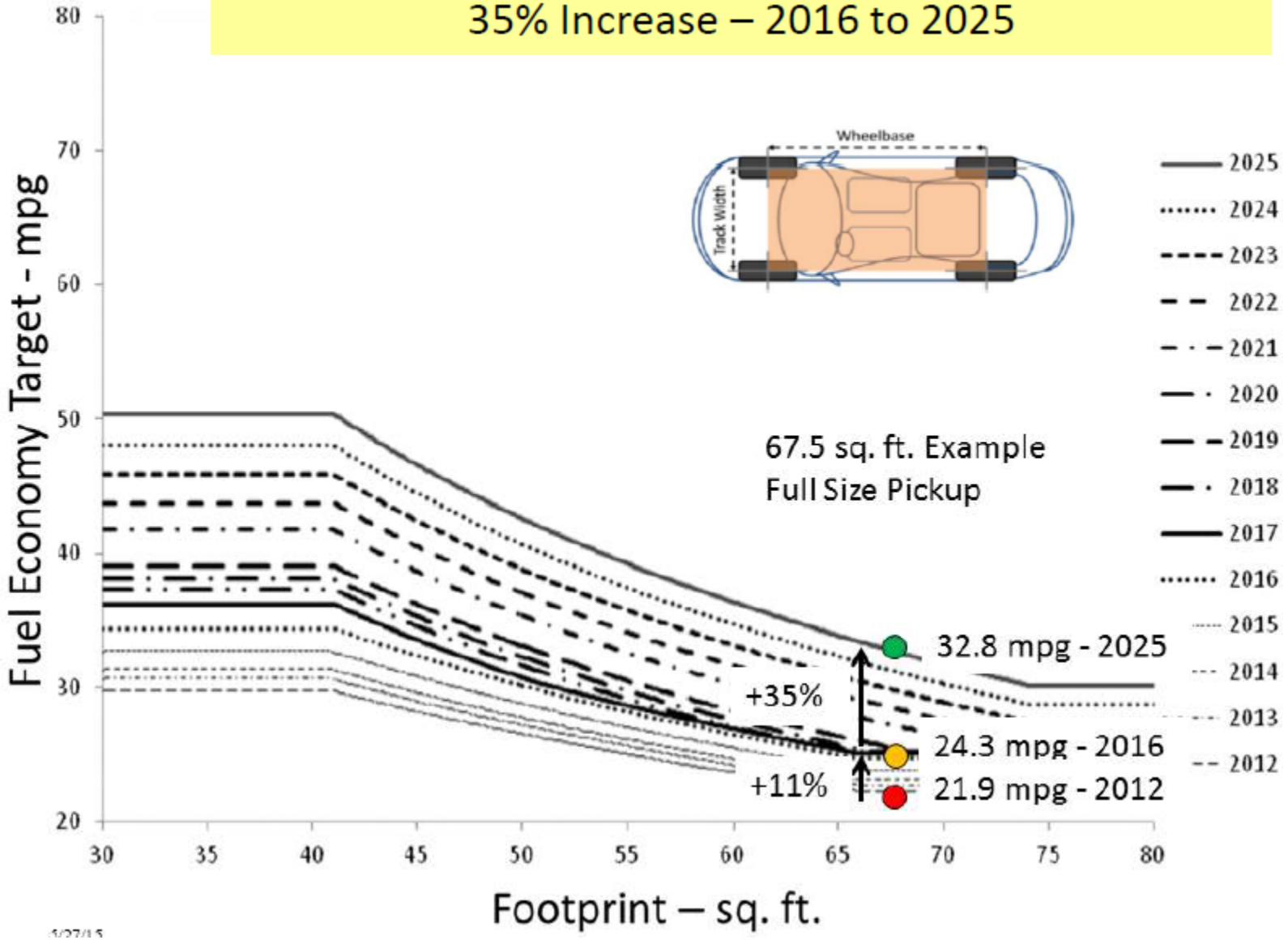
Car CAFE Compliance

- Detailed analysis of product plans by manufacturer highlight difficulty of CAFE compliance even in 2020.
- Example of our analysis of Ford's CAFE shows that only the C-Max and Fusion exceed standards to generate credits and this is because of hybrid sales (all C-Max and about 10% of Fusion sales).
- On the other hand, Mustang, Lincoln models and 2WD Escape generate negative credits which are surprisingly large. The net CAFÉ debit is offset by other special credits to reach compliance.
- While Toyota has significant hybrid sales and Ford and Honda have modest success with hybrids, other manufacturers are struggling to sell hybrids in any volume. Hence compliance issues are larger for many manufacturers.

Ford 2020 Compliance Estimate

MODEL	TARGET	2020FE	CREDIT	VOL	CREDIT*VOL	CAFÉ		TARGET
ECOSPORT 2	49.5	48.1	0.00058	34,000	19.55	706.42		686.87
FIESTA	50.0	48.8	0.00050	60,000	29.84	1229.69		1199.85
ESCAPE 2wd	42.7	38.7	0.00246	149,000	365.92	3852.12		3486.20
CMAX	45.9	68.5	-0.00719	25,000	-179.83	365.10		544.92
FOCUS	45.6	44.5	0.00054	220,000	119.47	4940.46		4820.99
FUSION	41.5	44.2	-0.00144	325,000	-467.00	7357.89		7824.89
MKZ	41.8	39.9	0.00116	40,000	46.39	1003.71		957.32
TAURUS	38.3	34.7	0.00270	70,000	188.93	2017.02		1828.09
MKS	36.2	32.5	0.00318	25,000	79.38	769.30		689.93
LINCOLN	36.2	26.0	0.01082	18,000	194.68	691.42		496.75
MUSTANG	41.7	31.6	0.00768	85,000	652.86	2692.69		2039.83
CAFÉ COMPLIANCE				1,051,000	1050.19	**41.01**	**1.753**	**42.766**

CAFE MPG Target Curves for Trucks
35% Increase – 2016 to 2025



Light Truck CAFE

- The standards impose less of a burden to 2016 and 2020 for light trucks relative to cars, but requirements become more stringent in the 2020-2025 time frame.
- The market shift to crossover SUVs has helped LDT CAFE compliance as they are much lighter and more fuel efficient than traditional body-on-frame SUV models. The moving of compact 2WD SUVs to cars hurts, but our analysis shows most manufacturers exceeding 2020 standards with product plan based improvements.
- The large pickup truck will have difficulty complying even in 2020. For example, Ford's all –aluminum truck 4WD models (x-2.7L) do not comply with 2016 standards even after using most technology in NAS list for 2025.
- Dieselization may be the only option for large pickups to comply in 2025.

Conclusions

- While the standard is known as the 54.5 mpg standard, compliance is likely to be achieved at ~44 mpg due to credits.
- Passenger car (LDV) compliance without hybridization is possible only for the base model compact and mid-size models, but not for high line, sports and luxury models. Hence significant (~20%) hybridization will be required for the LDV fleet by 2025 with costs much higher than the $1200 NAS estimate for a midsize car
- Manufacturer product plans reveal many new hybrid models in the pipeline in-spite of a weak market for such vehicles.
- LDT compliance will be possible through 2020 due to the large shift to crossover vehicles but the re-class of 2WD small SUVs will hurt compliance prospects for both LDV and LDT.
- Large pickup trucks will face compliance problems which are quite difficult by 2025. High level of dieselization may be the only option.