Light-Duty Vehicle Technology: Fuel Consumption and GHG Emissions

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Objectives

1. Review the potential for reducing fuel consumption and GHG emissions through propulsion system and vehicle technology changes.

2. Illustrate potential impact of these changes on U.S. light-duty fleet fuel consumption and GHG out to 2035.

3. Explore feasibility of halving fuel consumption of 2035 new vehicle sales mix.

Technologies That Could Contribute by 2035

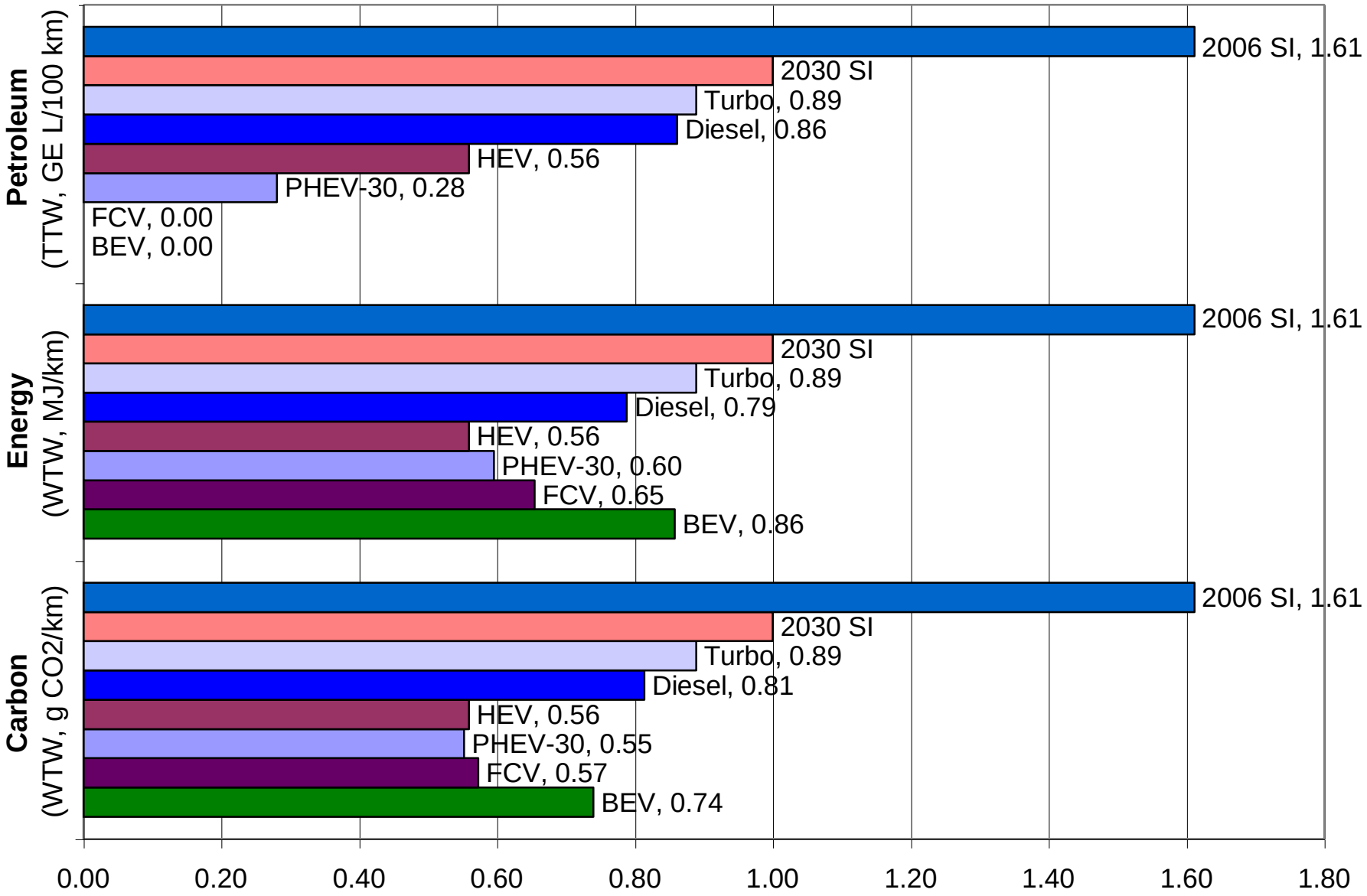
1. Significantly contribute:
   - Improved gasoline spark-ignition engines
   - Turbocharged gasoline spark-ignition engines
   - Gasoline engine electric hybrids (HEV)
   - More efficient transmissions
   - Reduced vehicle weight
   - Reduced vehicle drag and tire resistance

2. Marginally contribute:
   - Fuel cell (hybrids) and hydrogen
   - Plug-in hybrids (PHEV) and electricity

Our MIT Group's Analysis Methodologies

1. Propulsion system and vehicle technology performance analyses (ADVISOR)
2. Light-duty vehicle in-use U.S. fleet model
3. Estimates of growth in fleet size and vehicle km/yr
4. New vehicle fuel consumption and market share assumptions
5. Construct and assess scenarios that would reduce fuel consumption and GHG emissions of the U.S. LD vehicles out to 2035

Relative Petroleum, Energy, and GHG Emissions



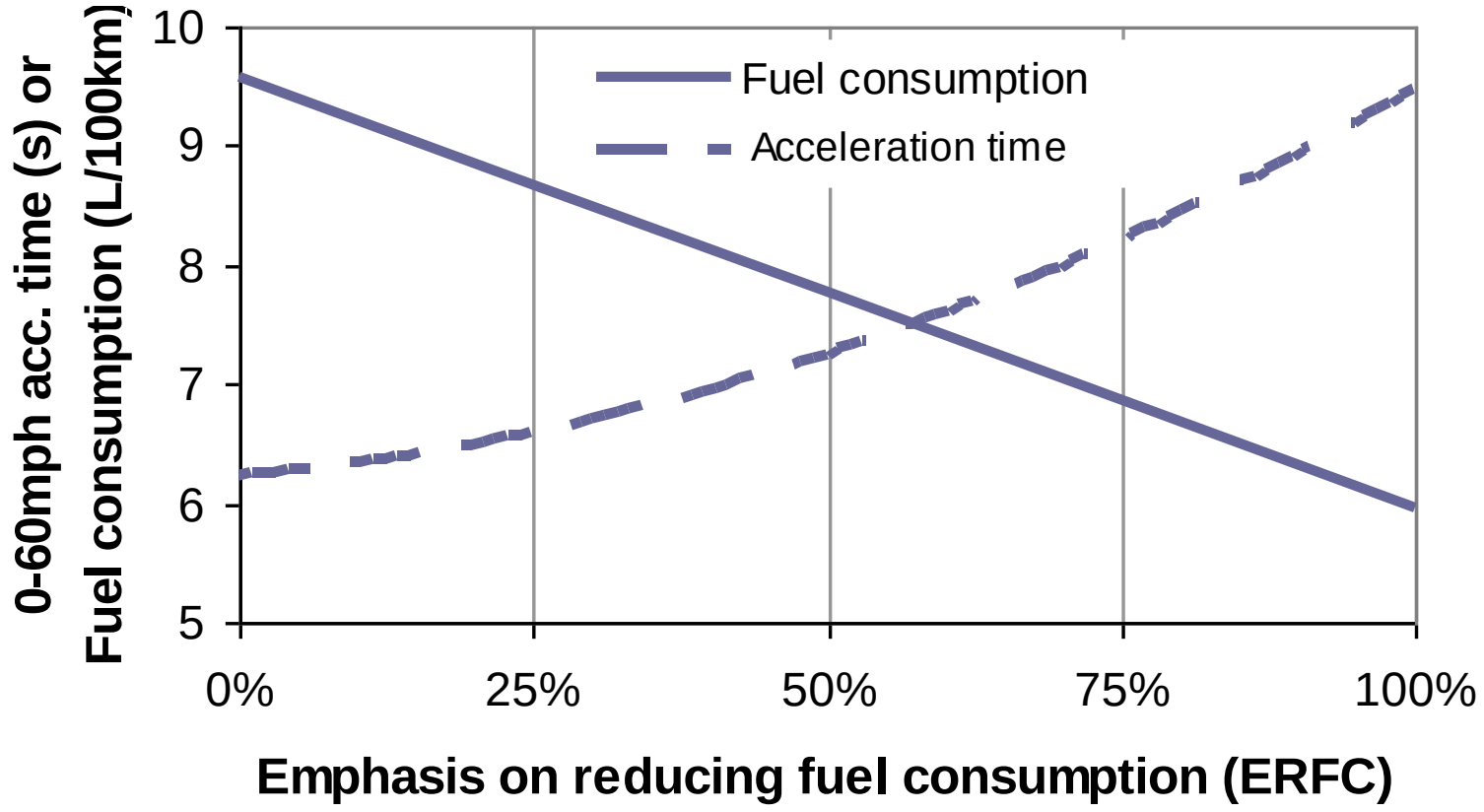
Fuel Consumption/Performance/Size Trade-Off

1. A critical question is the extent to which the benefits of improved efficiency technology go to reduce actual fuel consumption.

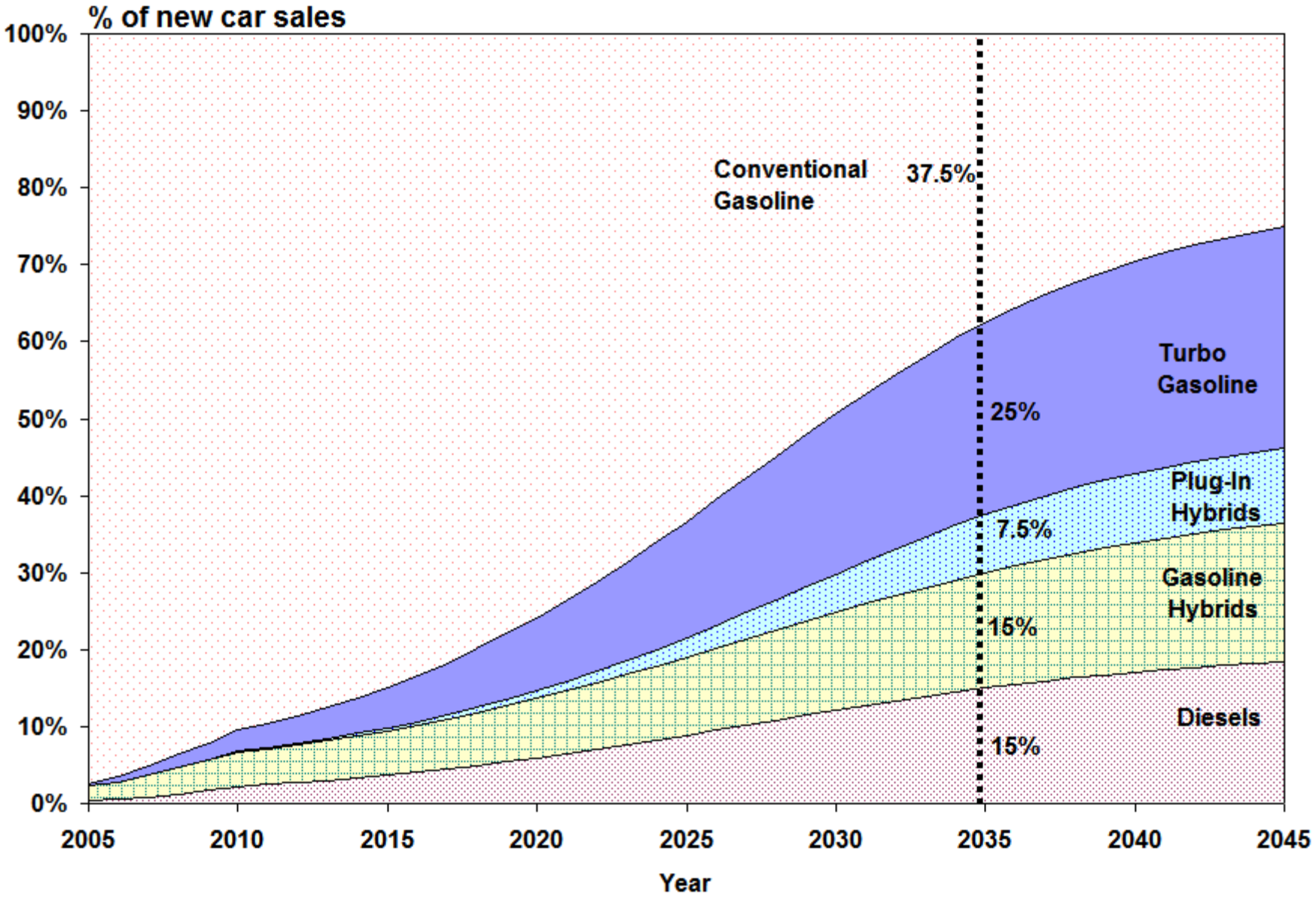
2. Quantify this with a ***degree of emphasis on reducing fuel consumption*** (ERFC).

$$\text{ERFC} = \frac{\text{Fuel consumption (FC) reduction realized}}{\text{FC reduction attainable with constant performance and size}}$$

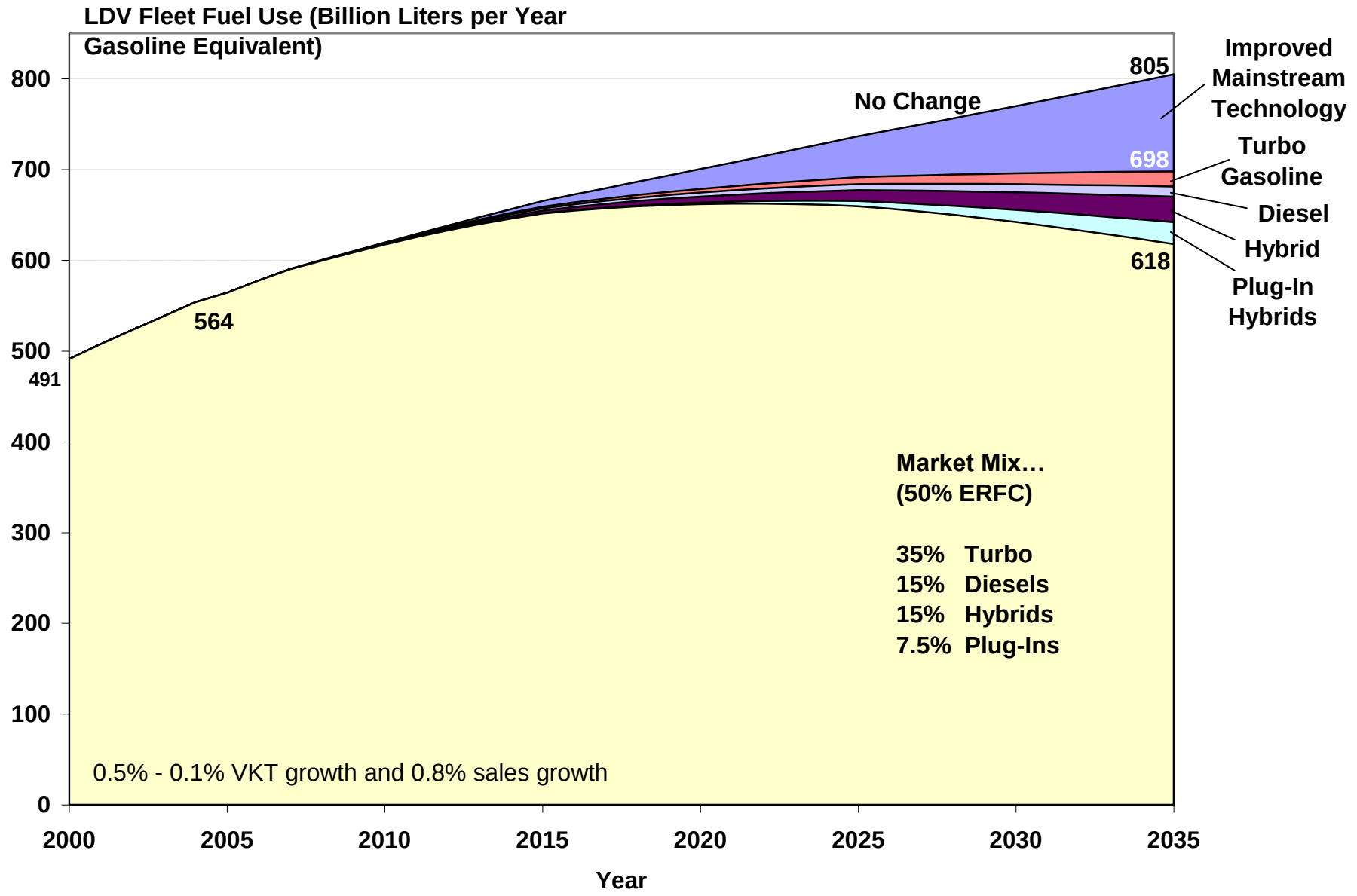
Trade-off between acceleration time and fuel consumption in the 2030 new car



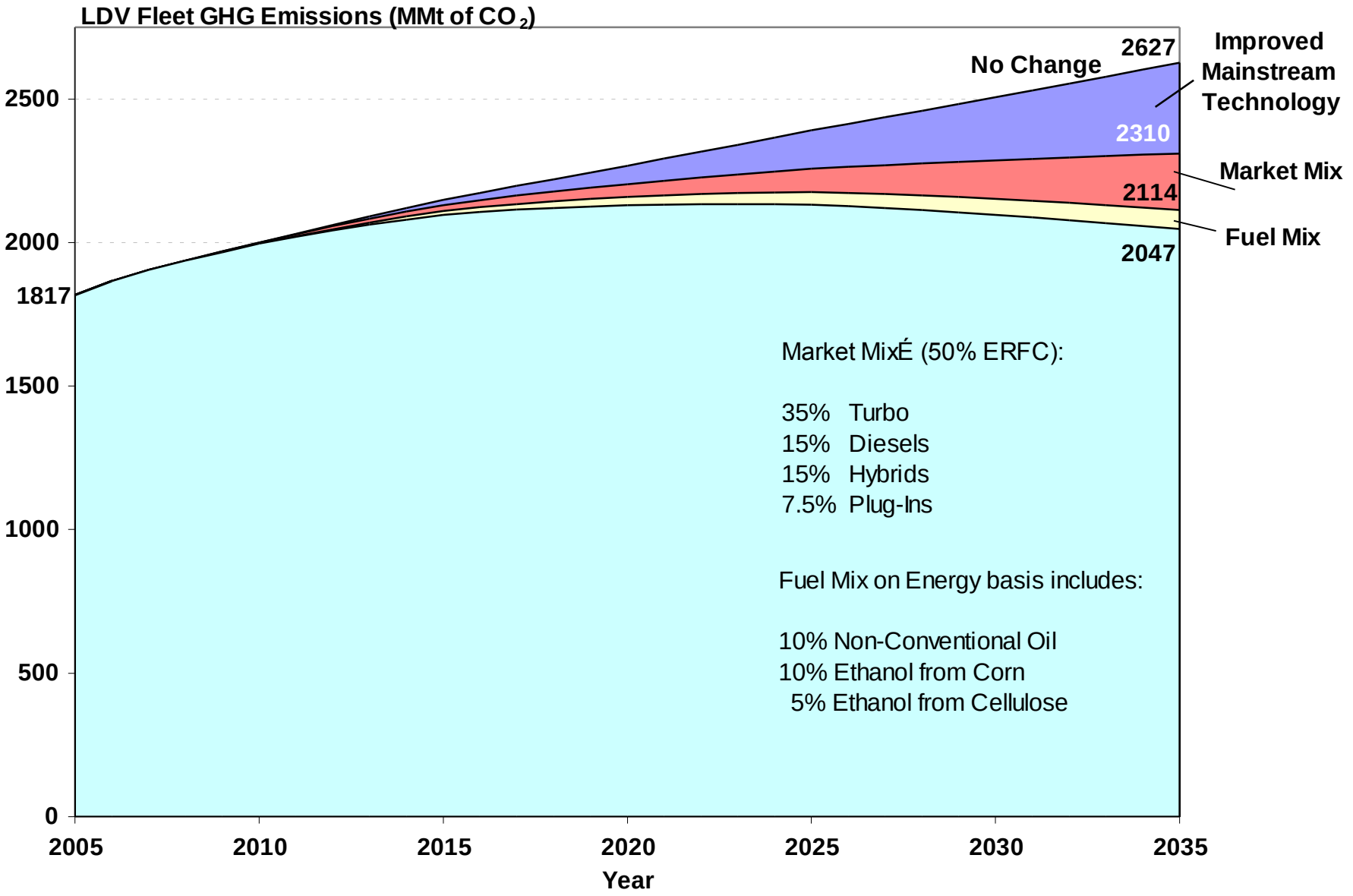
No Clear Winner – Market Mix



U.S. LDV Fleet Fuel Use – Market Mix



U.S. LDV Fleet GHG Emissions – Market Mix



Halving the Fuel Consumption of the 2035 New Light-Duty Vehicles

Vehicle design and marketing options

Scenarios Evaluated

#1. Strong emphasis on reducing fuel consumption and vehicle weight

#2. Strong emphasis on reducing fuel consumption and alternative powertrains

#3. Strong emphasis on alternative powertrains and vehicle weight

#4. Most feasible combination of ERFC, alternative powertrains, and vehicle weight.

Scenarios That Halve Fuel Consumption in 2035

Scenarios	Emphasis on reducing FC, % (avg. car 0-60 acc. time, s)	% weight reduction (avg. car curb weight, kg)	Market share by powertrain, %			
			NA gasoline	Turbo gasoline	Diesel	Hybrid gasoline
2006	-	0% (1,620 kg)	95%	1%	2%	2%
I. Strong emphasis on FC + max. weight reduction	100% (9.5s)	35% (1,050 kg)	72%	**8%**	**8%**	**12%**
II. Strong emphasis on FC + more alternative powertrains	96% (9.2s)	**19% (1,310 kg)**	15%	25%	25%	35%
III. More alternative powertrains + max. weight reduction	**55% (7.4s)**	35% (1,050 kg)	15%	25%	25%	35%
IV. Plausible scenario with aggressive hybrid penetration	75% (8.2s)	20% (1, 300 kg)	17%	15%	15%	54%

2035: Total Extra Cost Comparison

Scenario	Cost of halving fuel consumption (billions, $US)	% of Baseline cost (%)	Undiscounted pay back period (years)	Cost of GHG reduction ($US / ton CO2e)
I	$55	13%	3	$60
II	$57	14%	4	$65
III	$80	20%	6	$90
IV	$65	16%	5	$70

Critical Issues

1. Especially critical is decreasing our emphasis on performance and size.

2. Cost of major GHG reductions is substantial: new vehicle cost increases by some 15%

3. However, total fuel savings more than offset this vehicle cost increase

4. Requires aggressive and large scale changes in vehicle technology and consumer behavior

5. Factor of two by 2035? Maybe, but unlikely!