



*TAFV*

Analyzing the Transition to  
Alternative Fuel Vehicles.

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Oak Ridge National Laboratory  
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Society of Automotive Engineers  
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TAFV



# TAFV Project Team

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- Paul McArdle (U.S. DOE, OTT)

# Why Study *Transition* to Alt Fuel Vehicles?

- Dual National Concerns:
  - Energy Security
  - Pollution (GHGs & Criteria)
- Limitations of Long-run Equilibrium Analysis
- Examine Policies for Technology Transitions
  - Will we meet EPACT fuel substitution goals?
  - Effects of Fleet Mandates?
  - Other policies to get there?

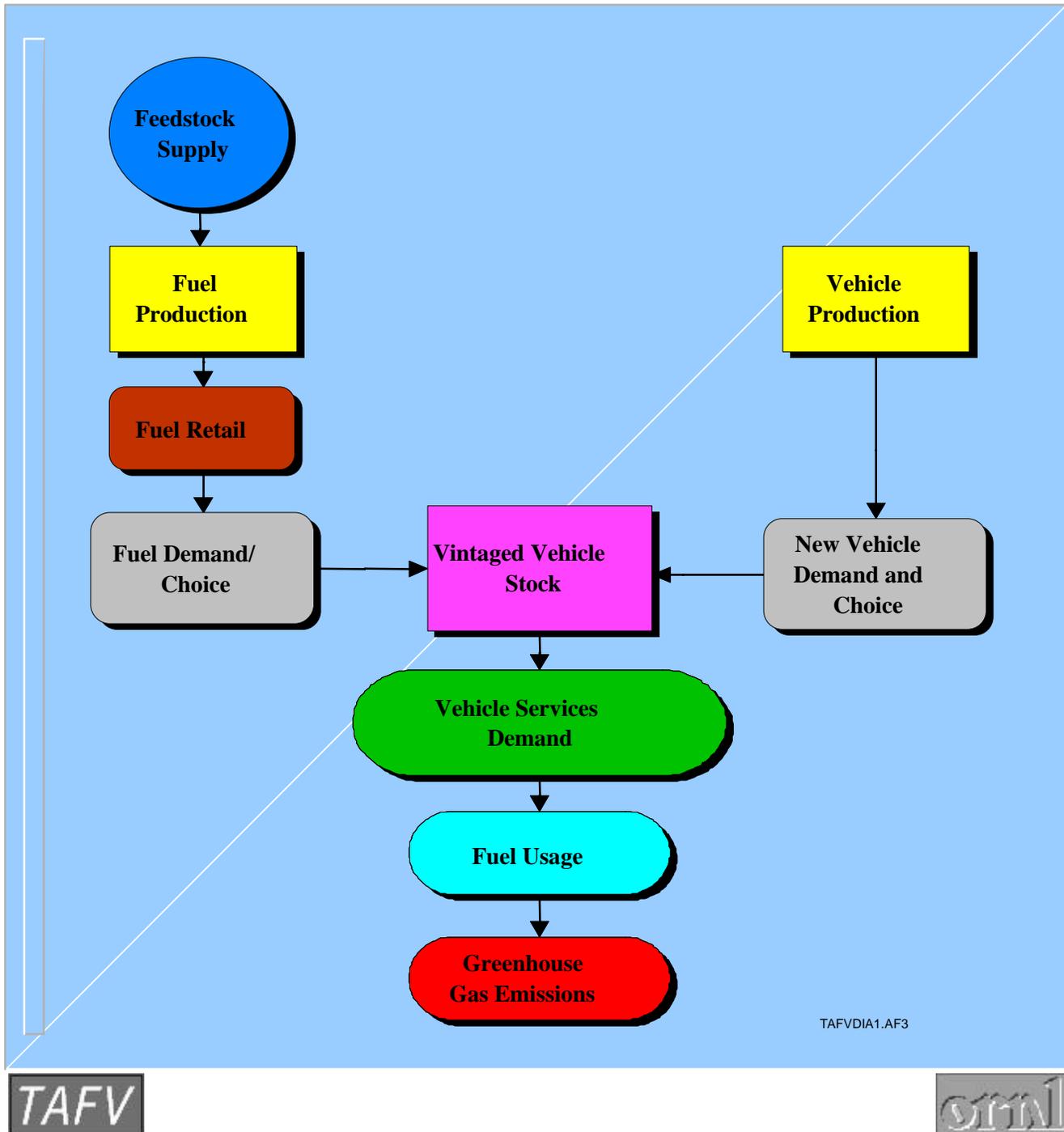
# Principle Objectives of the Transition Analysis

- Explicitly model transitional fuel and vehicle time paths
- Model sunk investments in vehicle and fuel infrastructure
- Integrate consumer and producer behavior
- Feed-back effects from early purchases decisions
- Assess range of federal AFV incentives

# Key Transitional Phenomena

- Capital stock turnover
  - vintaged vehicles
  - durable production plants
- Costs to consumers of limited retail fuel availability
- Production scale economies
- Limited vehicle model diversity
  - Costs to producers
  - Value to consumers

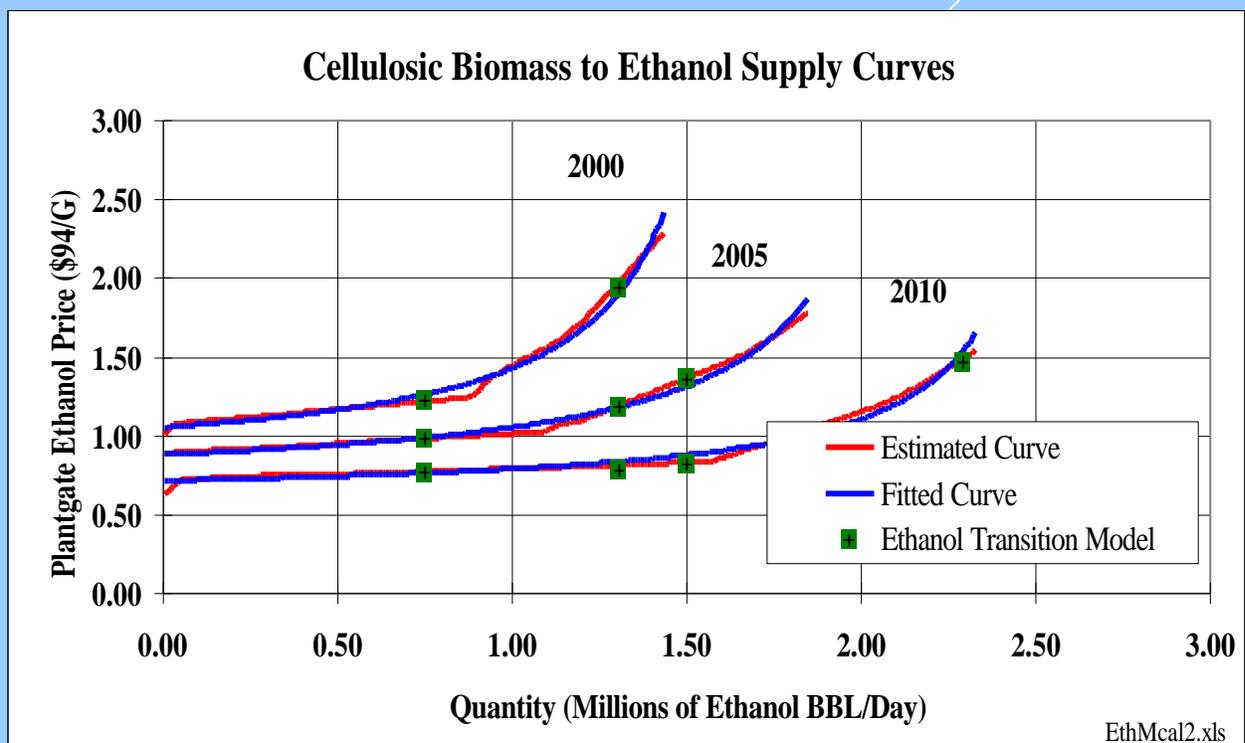
# Conceptual Diagram of TAFV Model



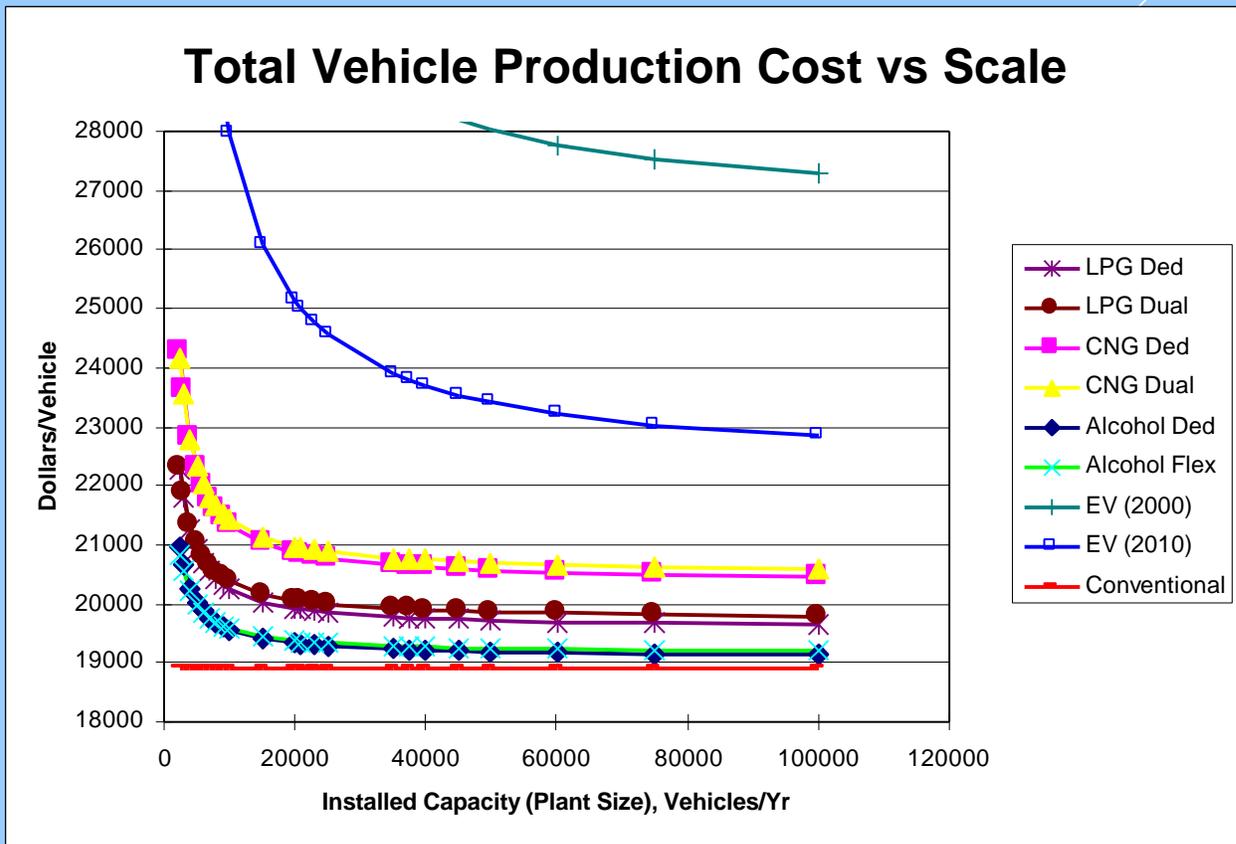
# Important Inputs

- Fuel supply curves
- Vehicle production cost curves
- Cost of limited fuel availability
- Vehicle and fuel choice attributes

# Cellulosic Ethanol Supply

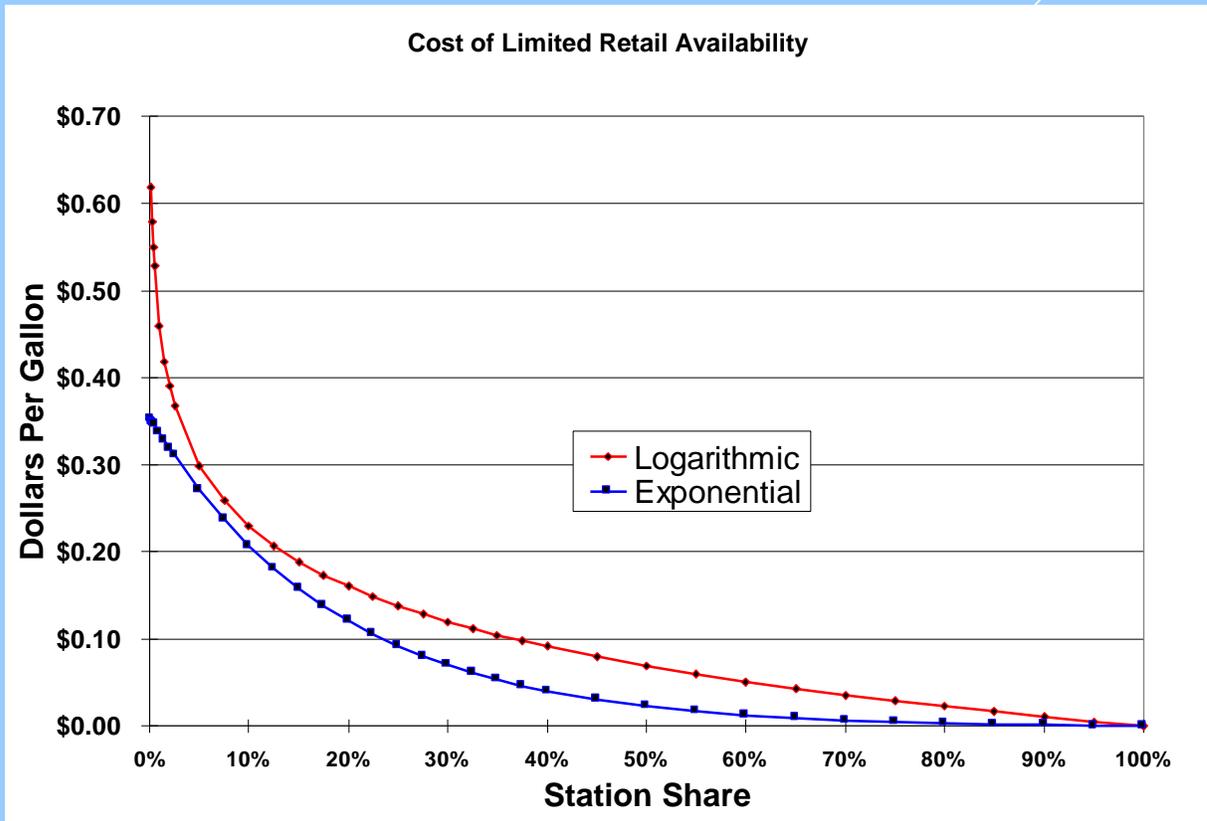


# Cost Data for Vehicle Production



VehPCst6, 6/20/97

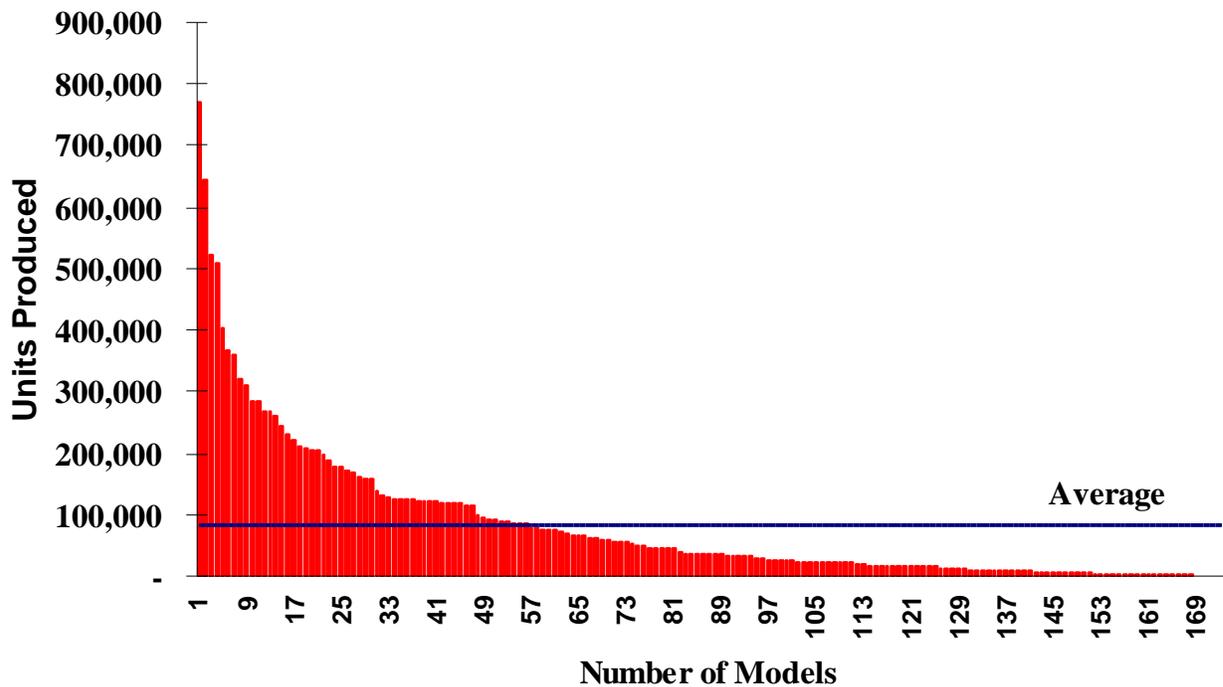
# Cost of Limited Retail Availability for Fuels



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# Wide Variation in Vehicle Model Sales

## Domestic Sales of Light Duty Vehicles for 1994



Domestic sales less than 1000 units not included.  
Source: Automotive News Market Data Book 1995

vehicle0.xls

# Effective Cost of Limited Vehicle-Model Diversity

- Producer's costs based on plant-level fixed costs, scale effects
- Consumer valuation based on nested multinomial logit
  - \$0/vehicle cost if diversity matches conventional vehicles
  - \$770/vehicle if fuel tech offered only on most popular model
  - \$2080/vehicle if fuel technology offered on one random vehicle
- Above jointly determine model diversity

# Vehicle and Fuel Choice

<b>Factors Influencing Fuel and Vehicle Choice</b>		
<b>Factors considered in Fuel Choice</b>	<b>Endogenous</b>	<b>Exogenous</b>
Fuel Price	X	
Fuel Availability (fraction stations offering fuel)	X	
Refueling Frequency (based on range)		X
Refueling Time Cost		X
Performance Using Fuel (HP: weight ratio changes)		X
<b>Factors Considered in Vehicle Choice</b>	<b>Endogenous</b>	<b>Exogenous</b>
Vehicle Price	X	
Fuel Cost (incl. effective cost of non-price fuel attributes)	X	
Performance (changes in HP-to-weight ratios)		X
Cargo Space (loss due to space required for fuel storage)		X
Vehicle Diversity ( number of models offering AFV technology)	X	

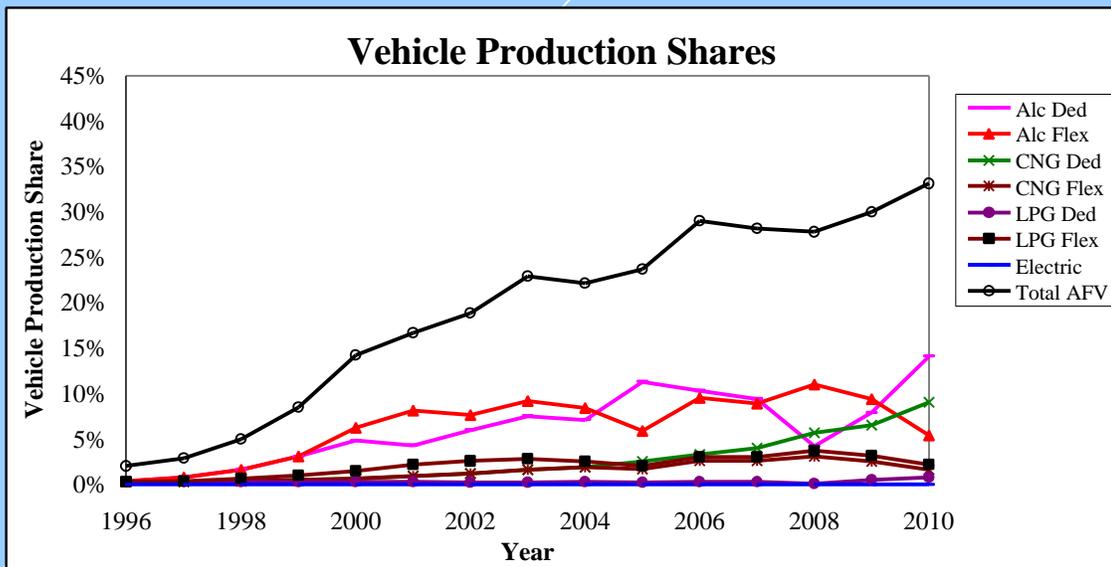
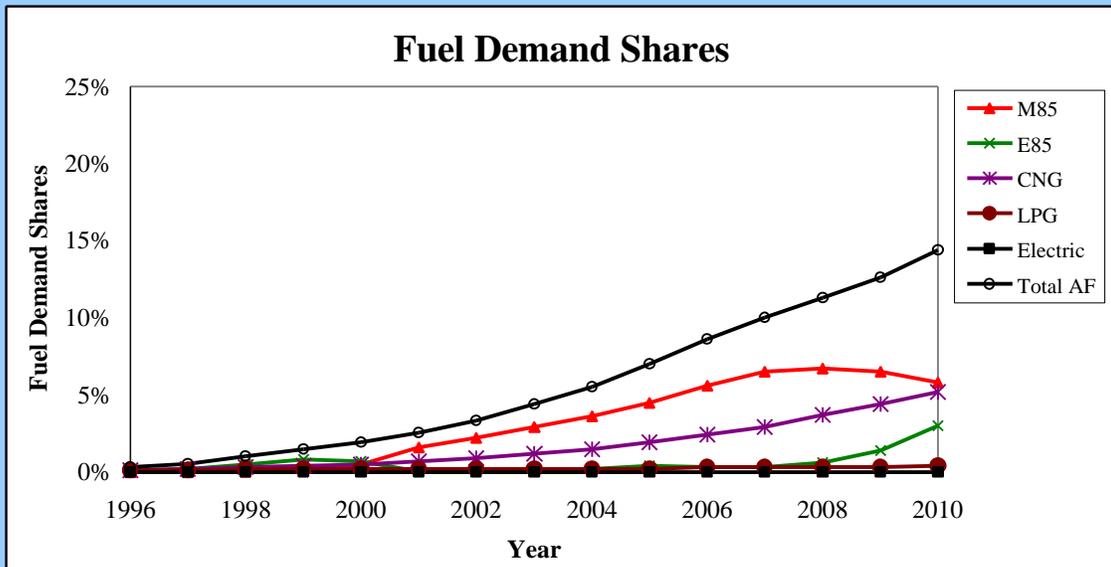
# Equal-Price Shares

<b>Market Choice Shares</b> <b>Given Equal Prices, Fuel Availability and Vehicle Diversity</b>			
<b>Vehicle</b>	<b>Fuels</b>	<b>Fuel Share</b>	<b>Vehicle Share</b>
Conventional	Conventional Gasoline		16.9%
Flex-Fuel	Conventional Gasoline	19.0%	
Flex-Fuel	M85	40.20%	
Flex-Fuel	E85	40.20%	16.8%
CNG Bifuel	Conventional Gasoline	90.8%	
CNG Bifuel	CNG	9.2%	7.1%
LPG Bifuel	Conventional Gasoline	76.0%	
LPG Bifuel	LPG	24.0%	13.8%
CNG Dedicated	CNG		9.7%
LPG Dedicated	LPG		15.6%
Alcohol Dedicated.	M85	50.0%	
Alcohol Dedicated	E85	50.0%	19.4%
Electric	Battery EV	0.0%	0.6%
<b>Total</b>			<b>100.0%</b>

# Cases Examined

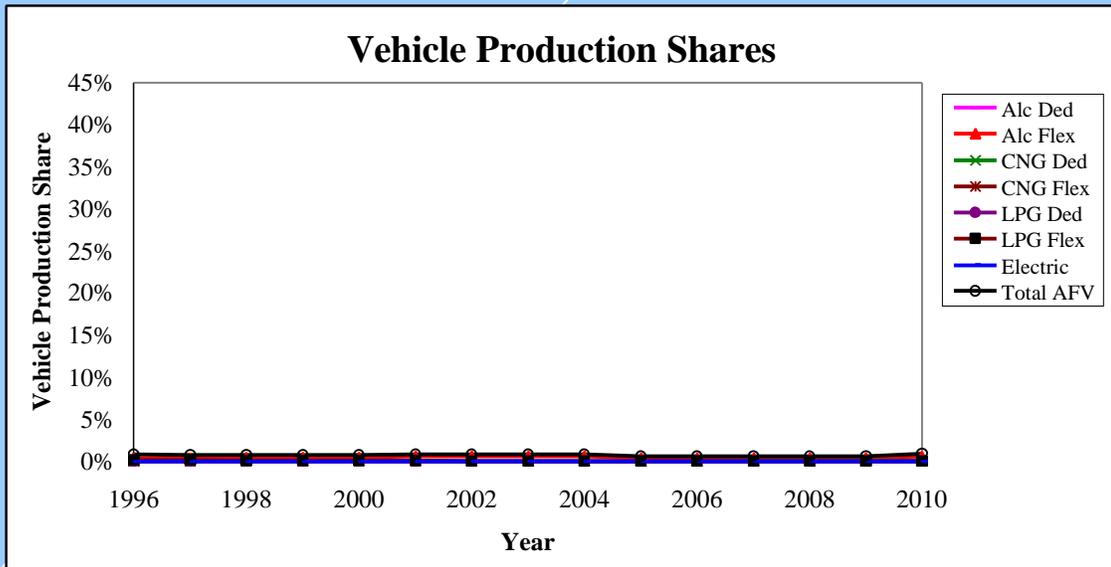
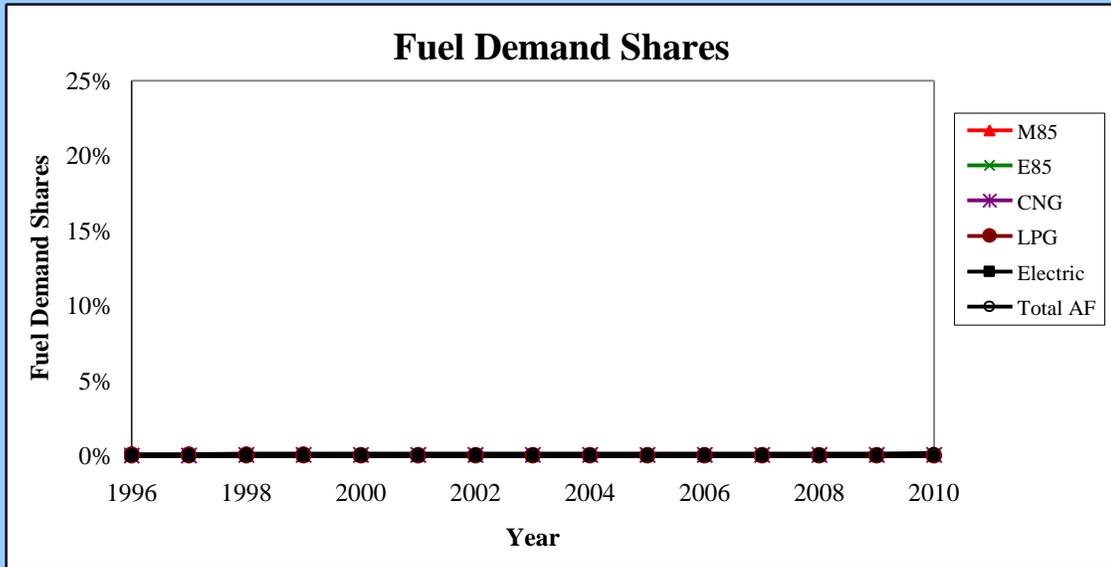
- No Transitional Barriers
- Base
  - Current EPACT
  - CAFE credits
- EPACT late rule making
  - Private and gov't fleets
- EPACT late rule *plus* 50% alt fuel use mandate
- Tax credits for low GHG fuels
- Continued renewable tax credit for ethanol

# No Transitional Barriers



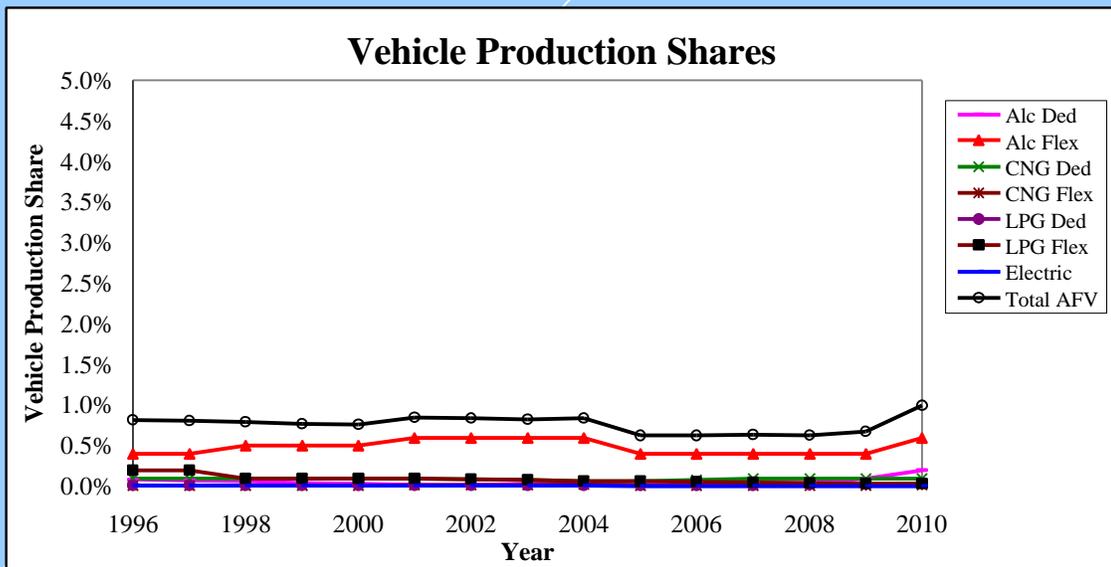
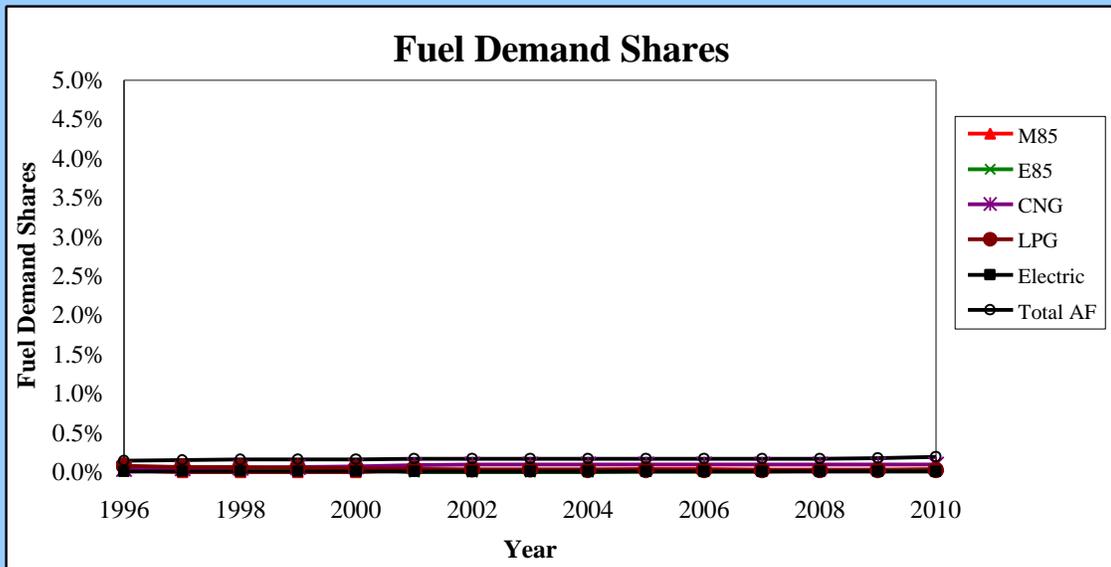
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Higher LPG Costs

# Base



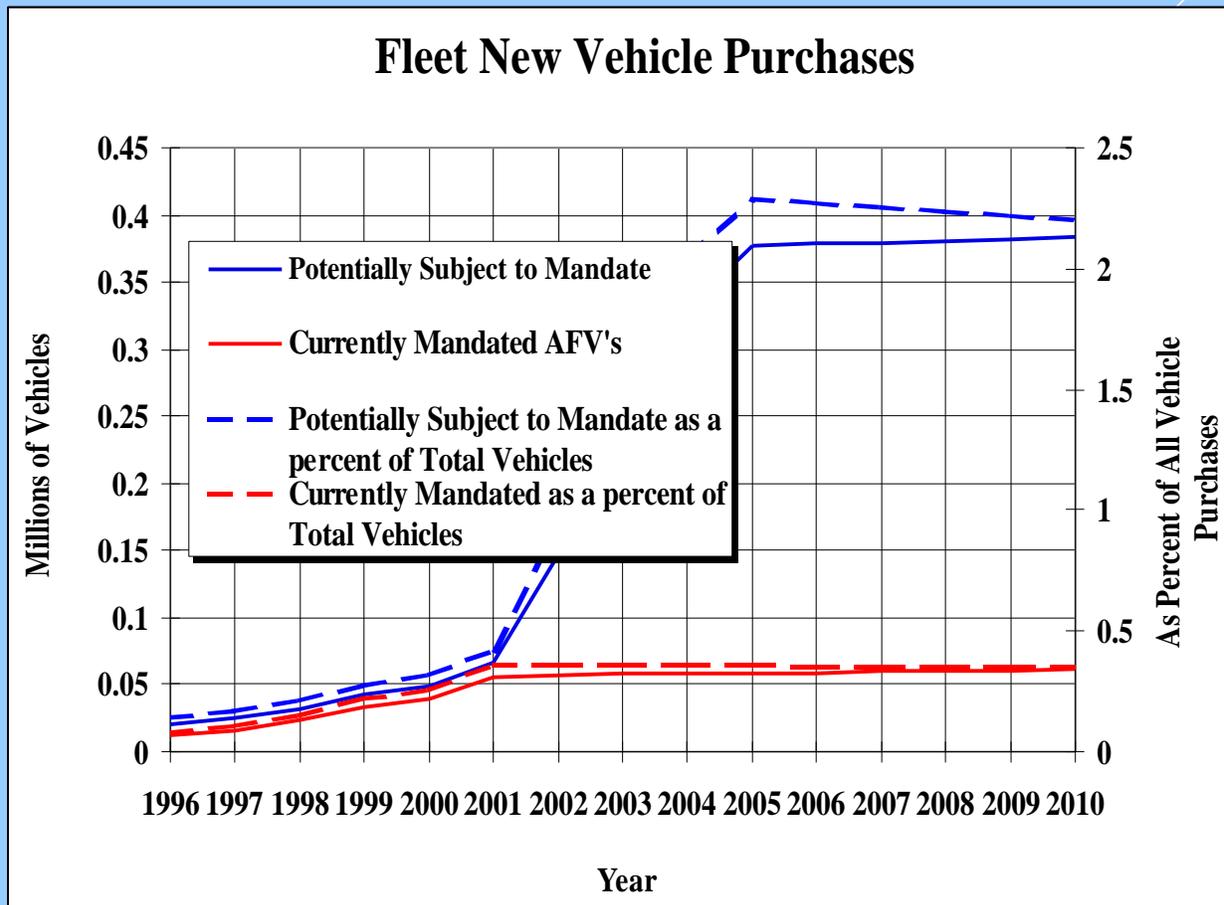
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Higher LPG Costs

# Base (Enlarged Scale)



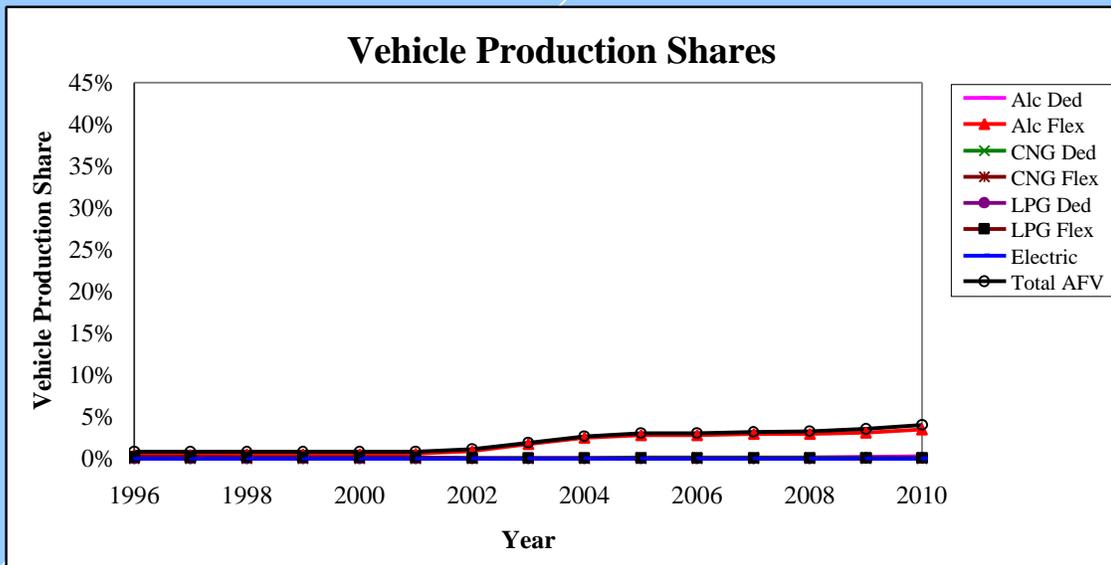
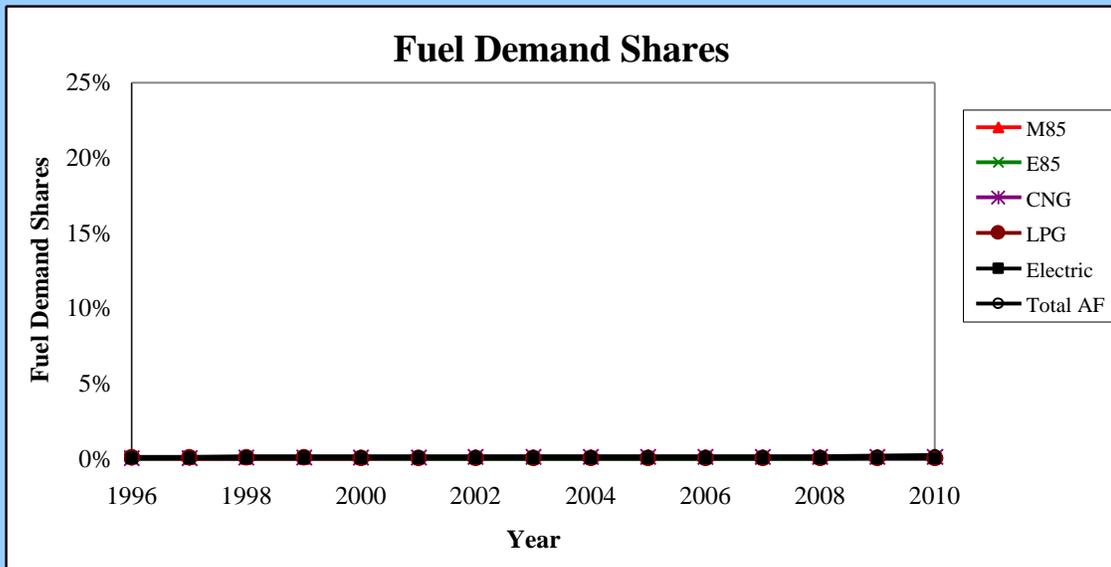
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# EPACT AFV Mandates: Current and Late Rule



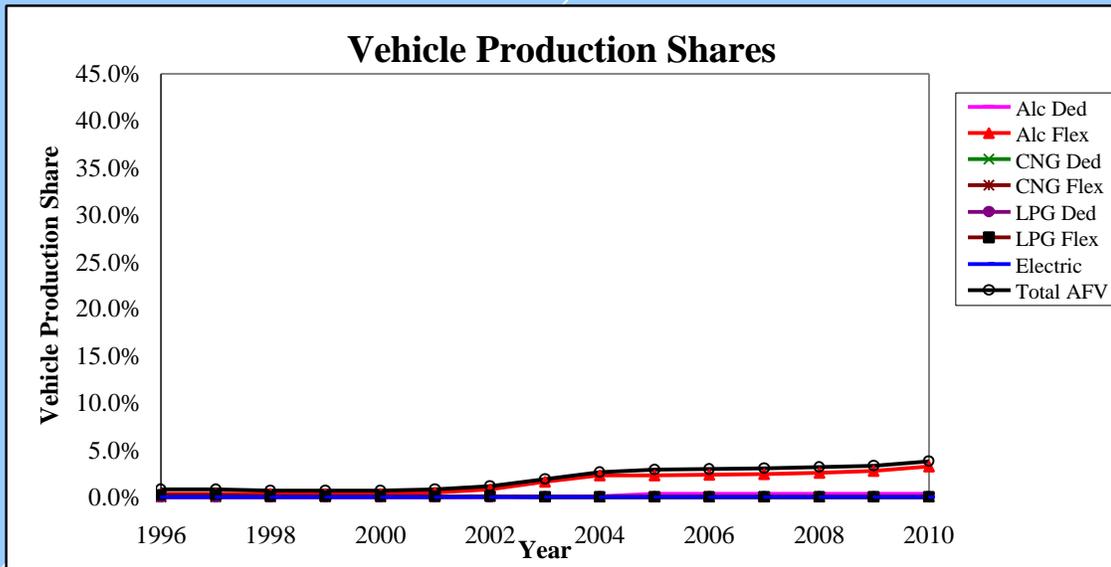
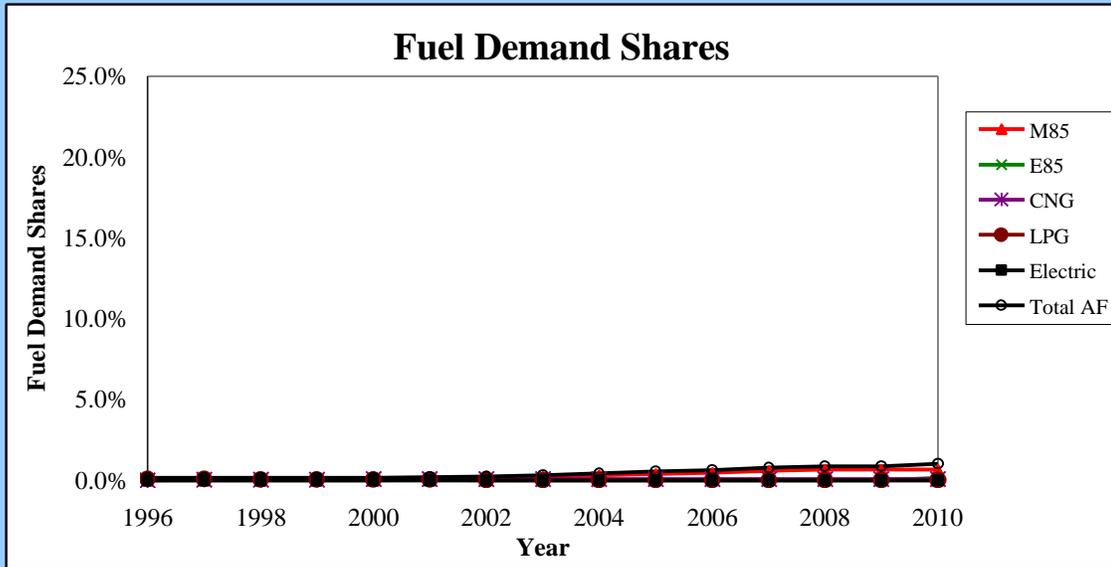
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# EPACT Late Rule Making



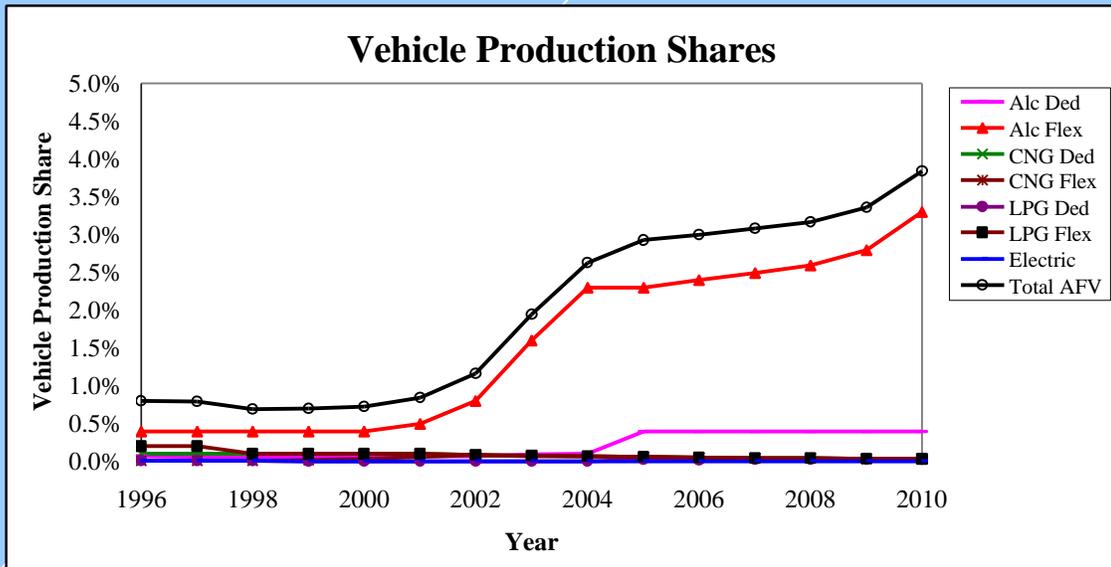
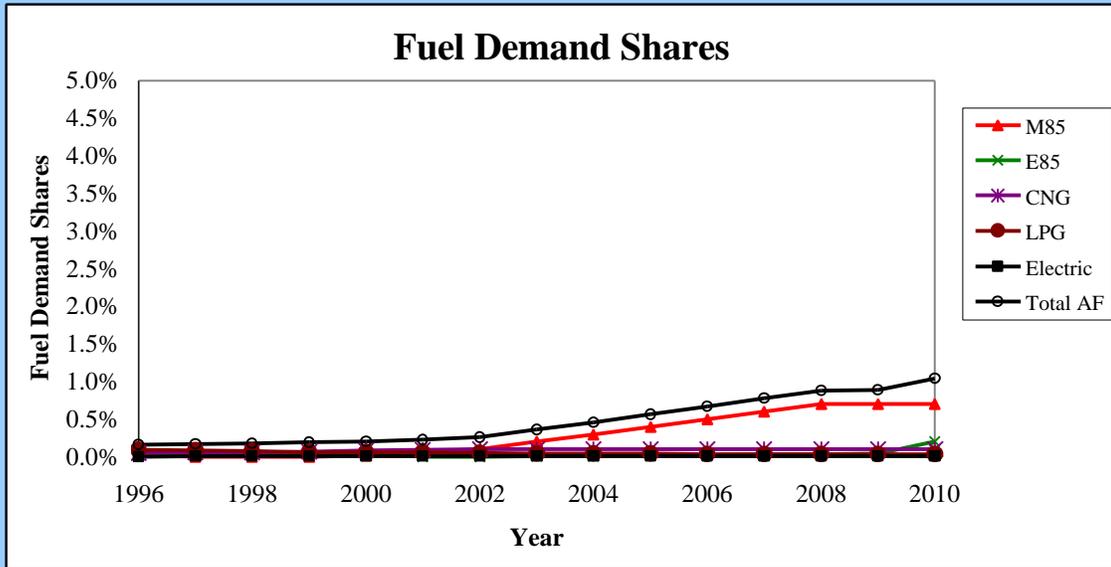
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# EPACT Late Rule Making Plus 50% Alt Fuel Use Mandate



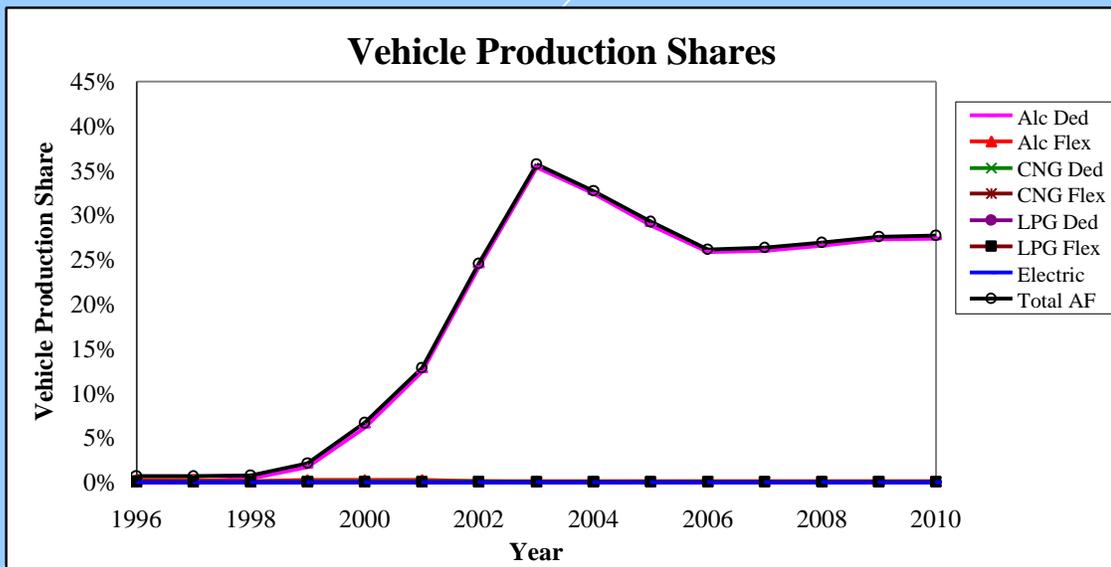
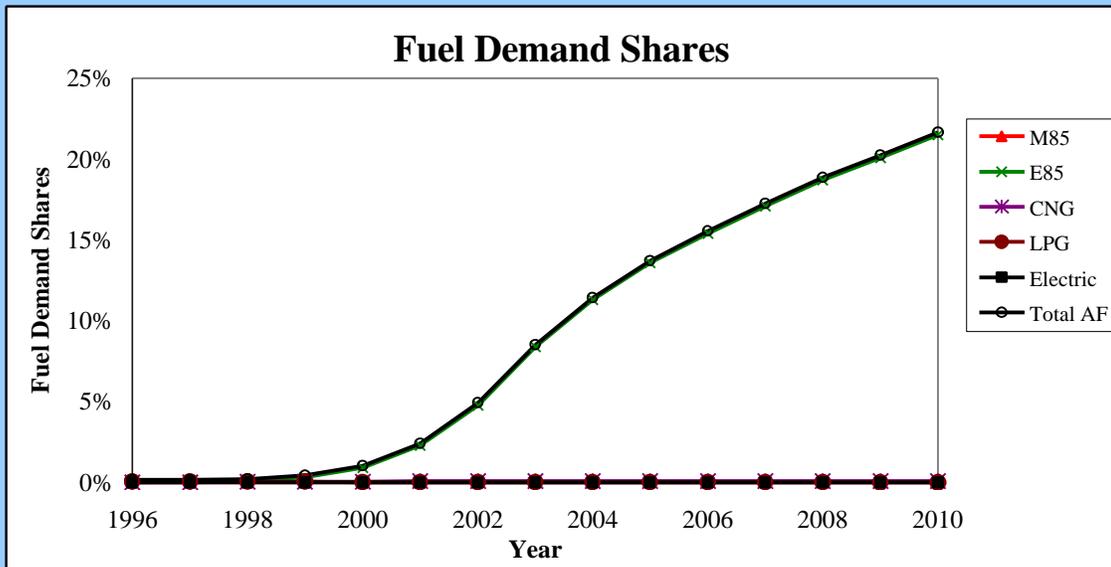
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# EPACT Late Rule Making Plus 50% Alt Fuel Use Mandate



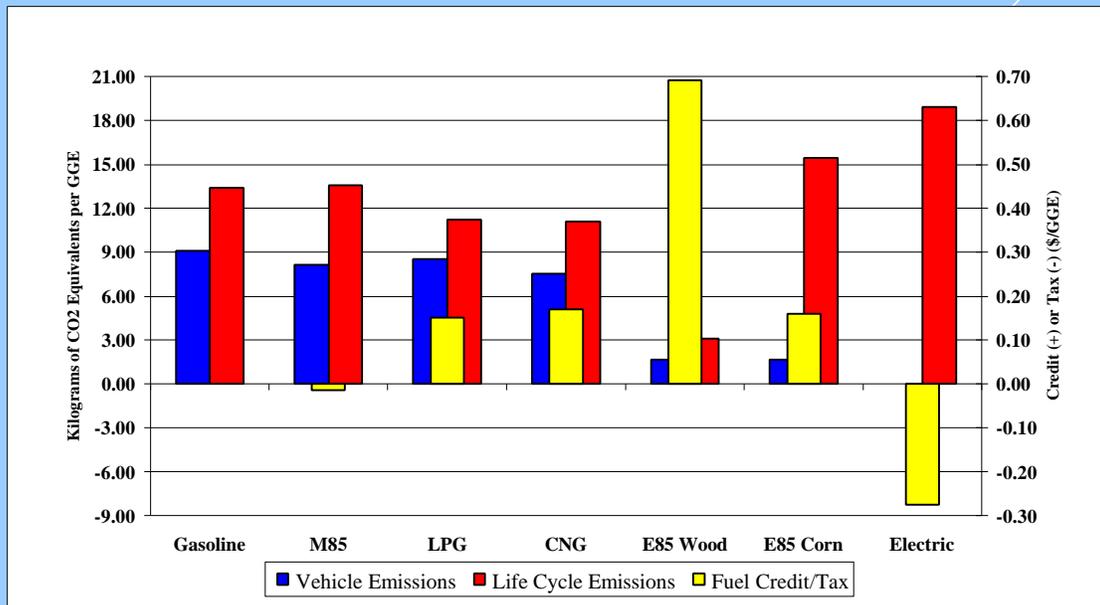
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Higher LPG Costs

# Tax Credits for Low GHG Fuels

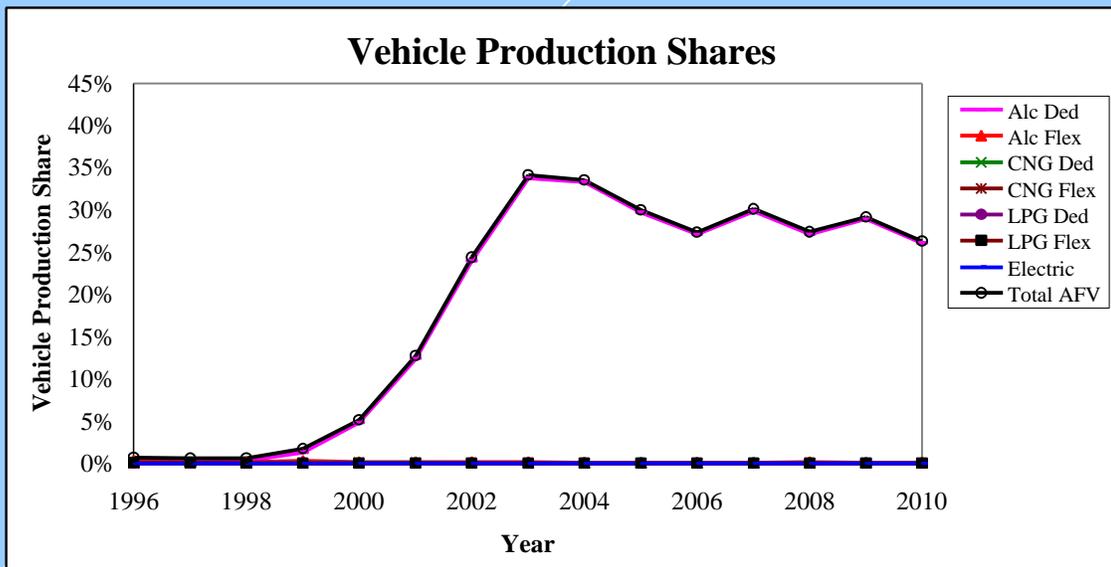
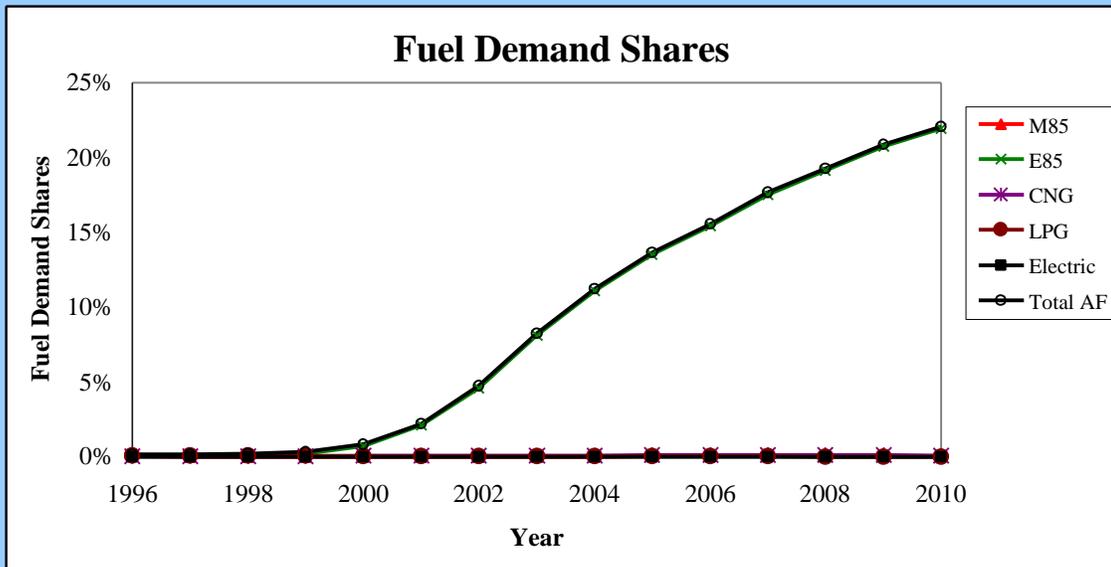


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Higher LPG Costs

# GHG Emissions and Credits or Taxes

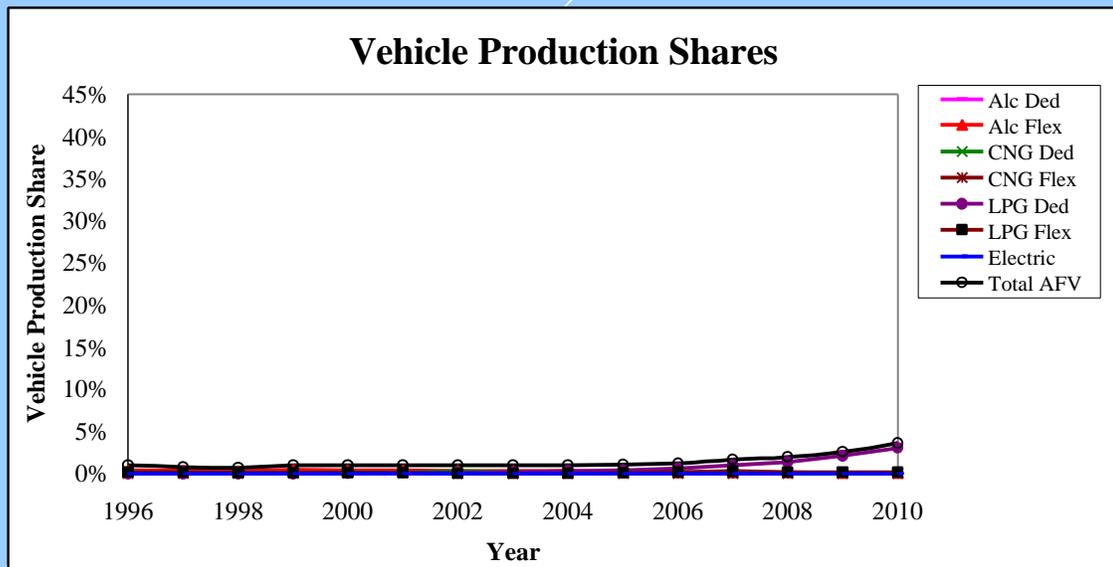
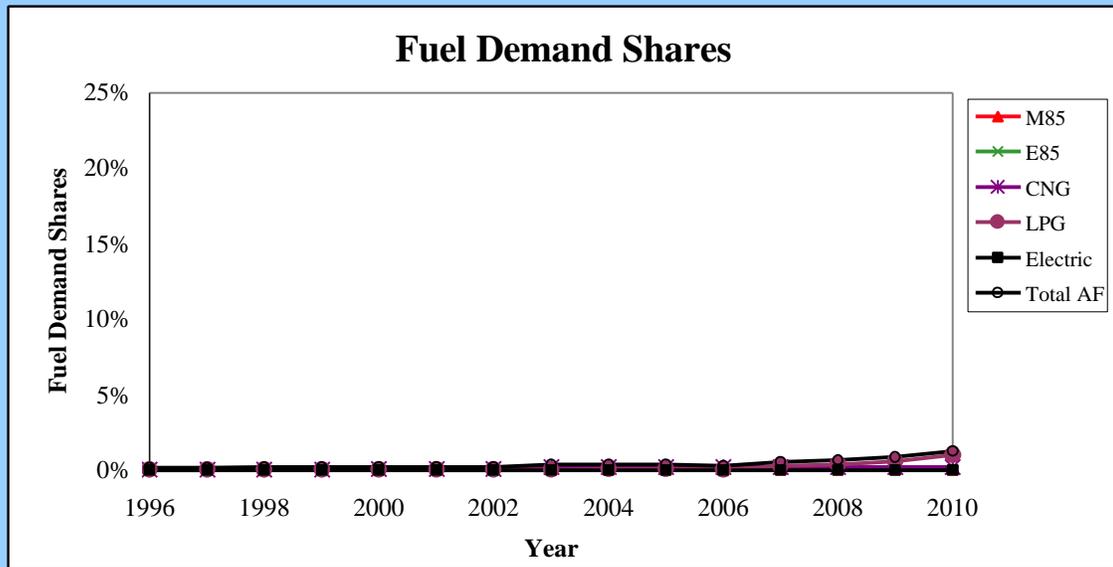


# Continued Renewable Tax Credit for Ethanol



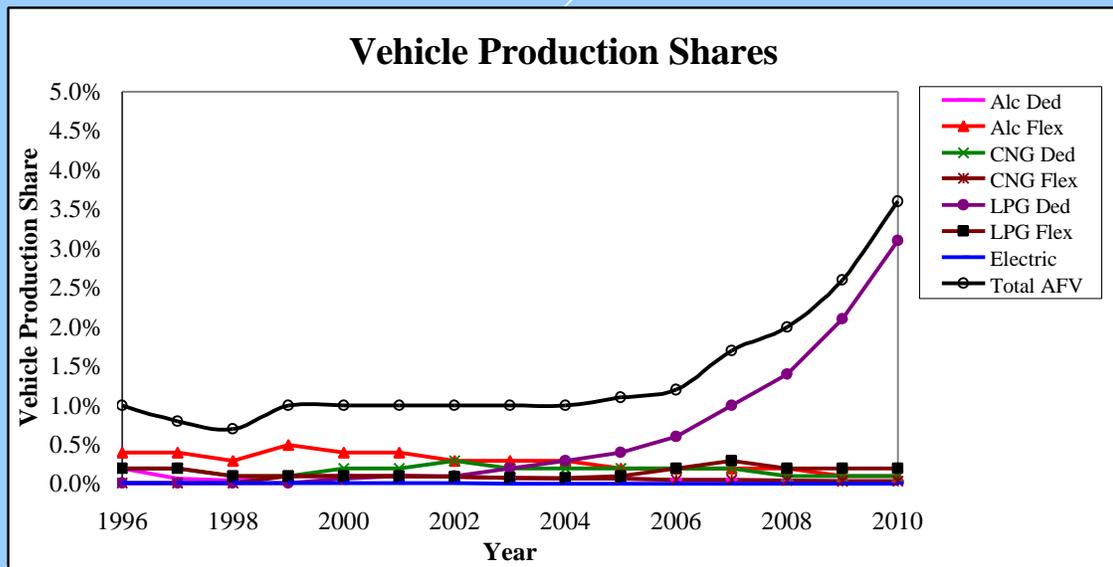
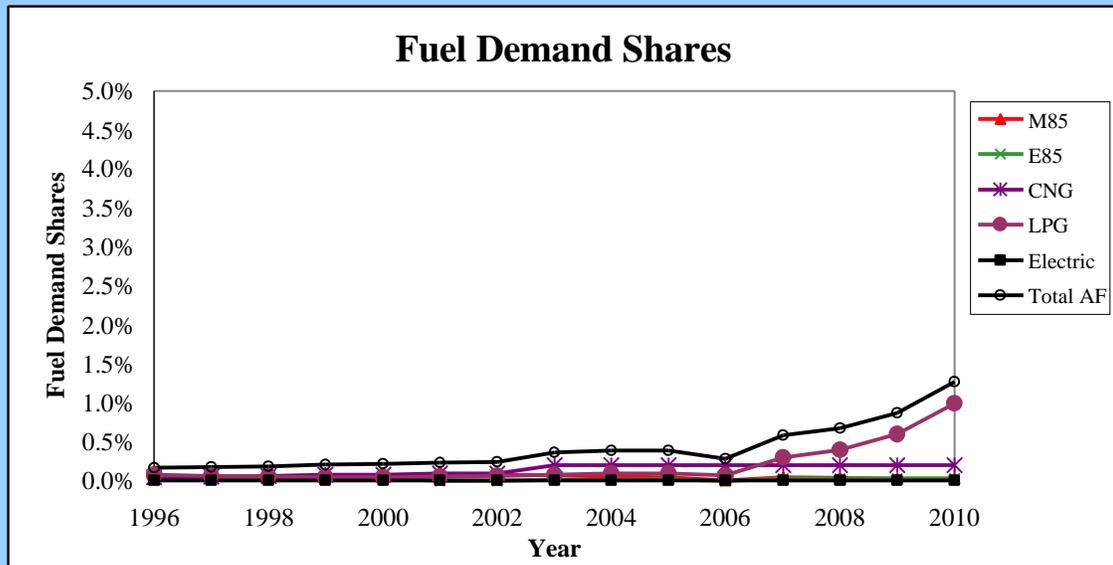
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Higher LPG Costs

# Base - Lower LPG Costs



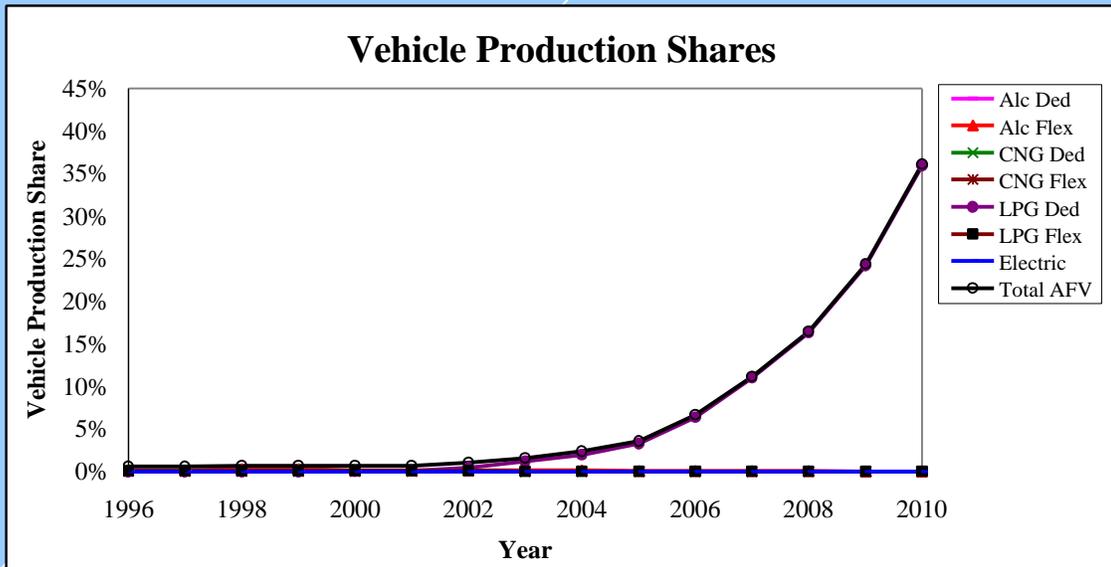
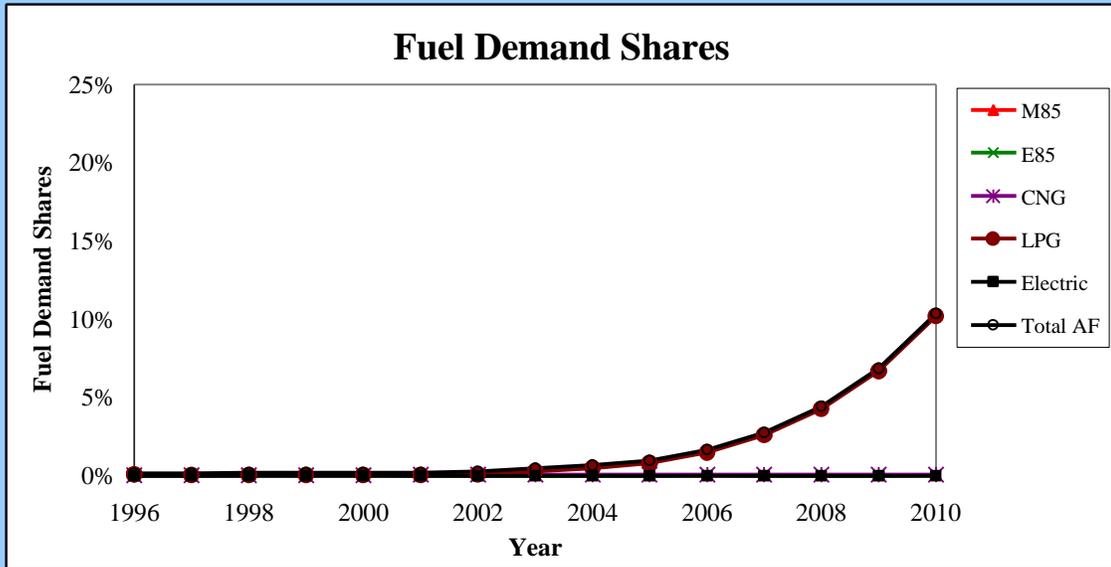
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Lower LPG Costs

# Base - Lower LPG Costs Costs (Enlarged)



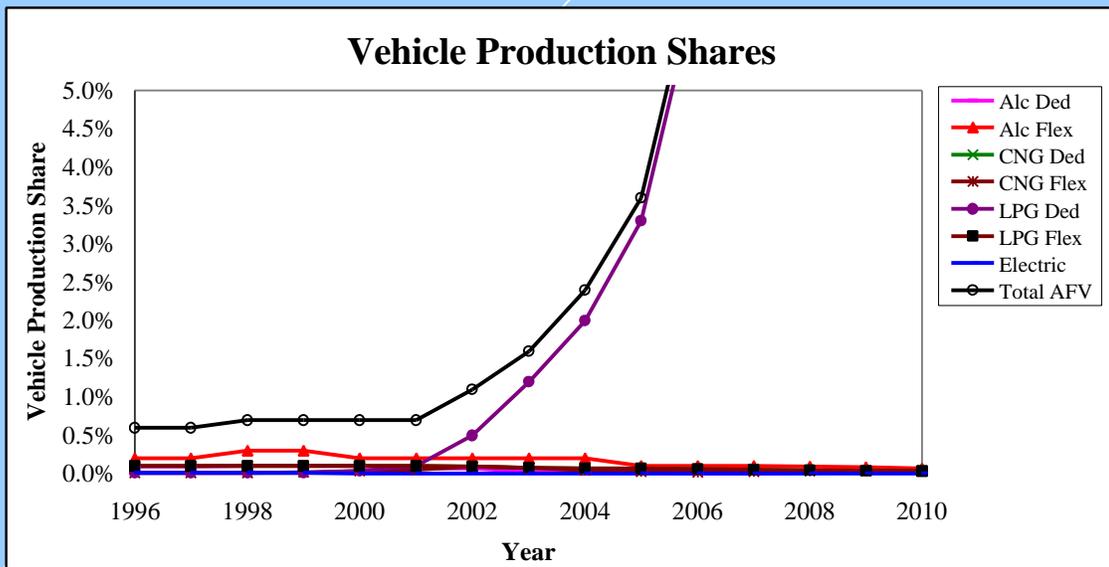
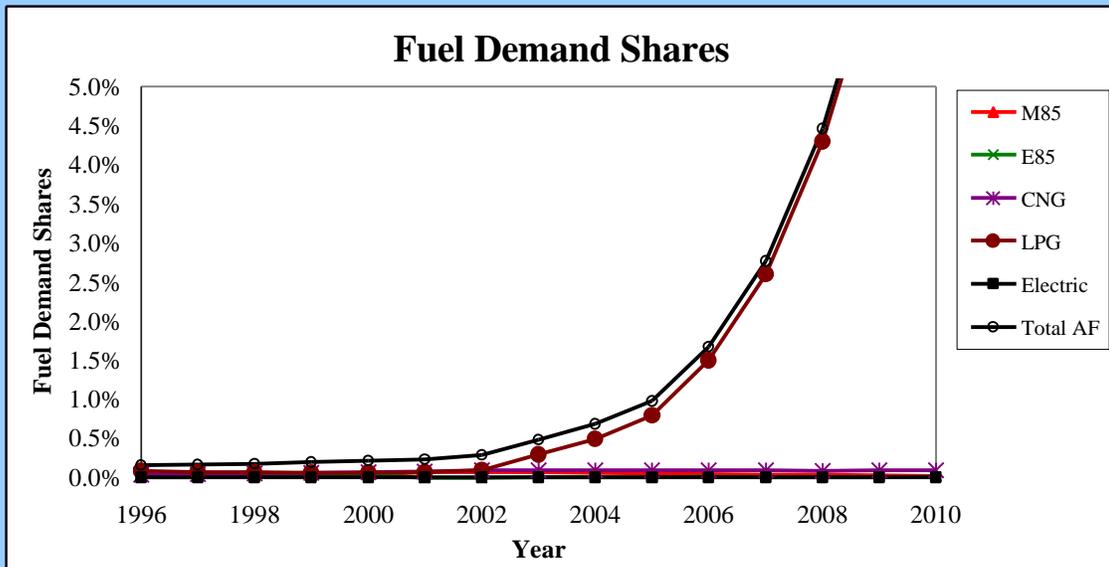
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Lower LPG Costs

# EPACT Late Rule Making Plus 50% Use - Lower LPG Cost



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Lower LPG Costs

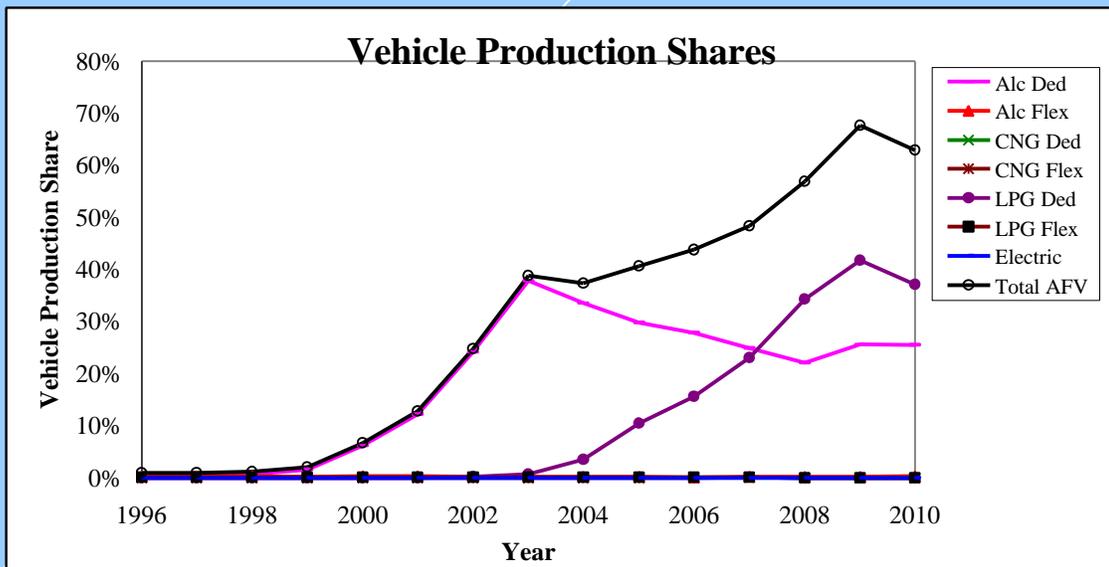
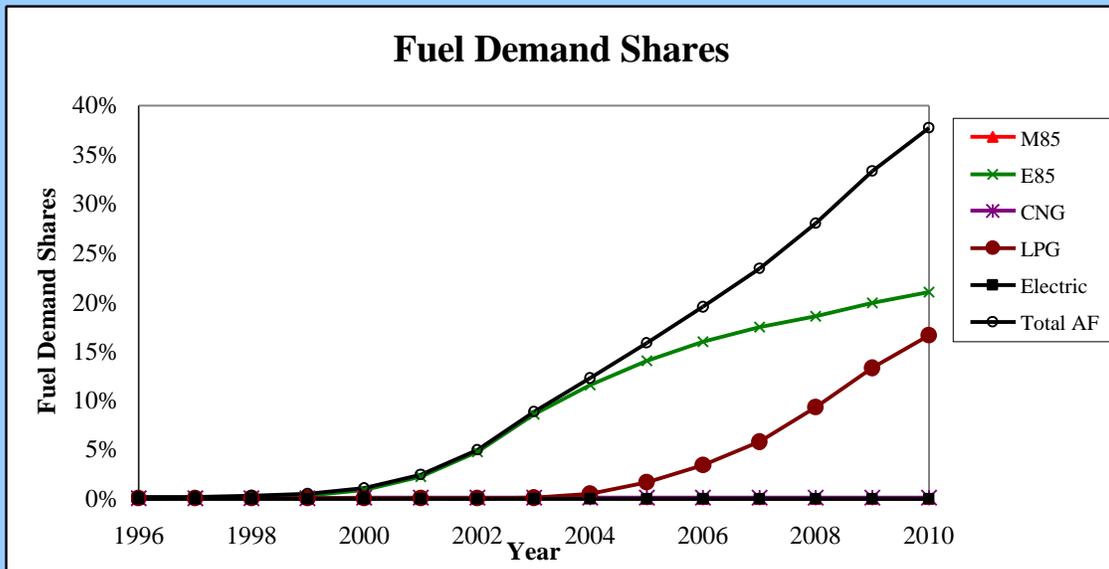
# EPACT Late Rule Making Plus 50% Use - Lower LPG Cost



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Lower LPG Costs

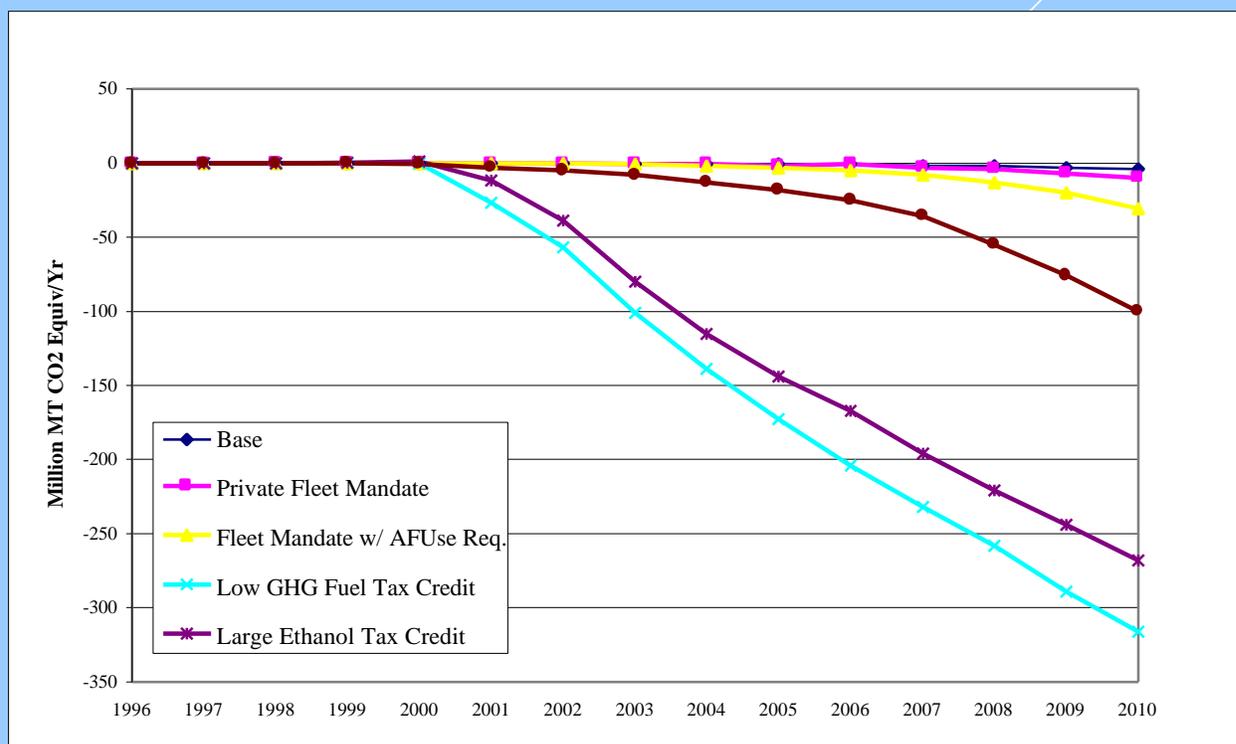
# Tax Credits for Low GHG Fuels

## - Lower LPG Cost

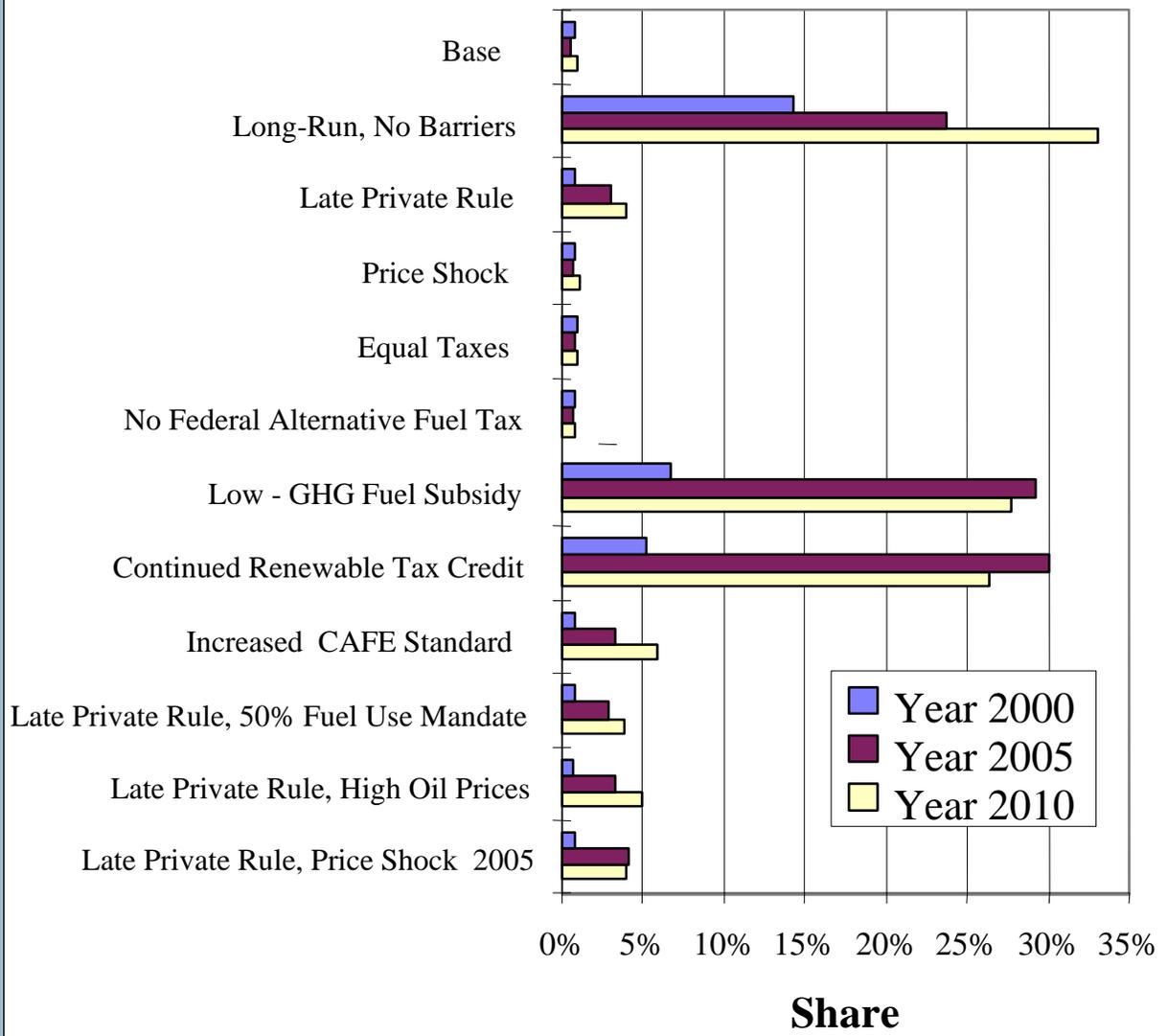


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Lower LPG Costs

# Reduction in GHG Emissions Due to Light Duty AFVs - Lower LPG Costs

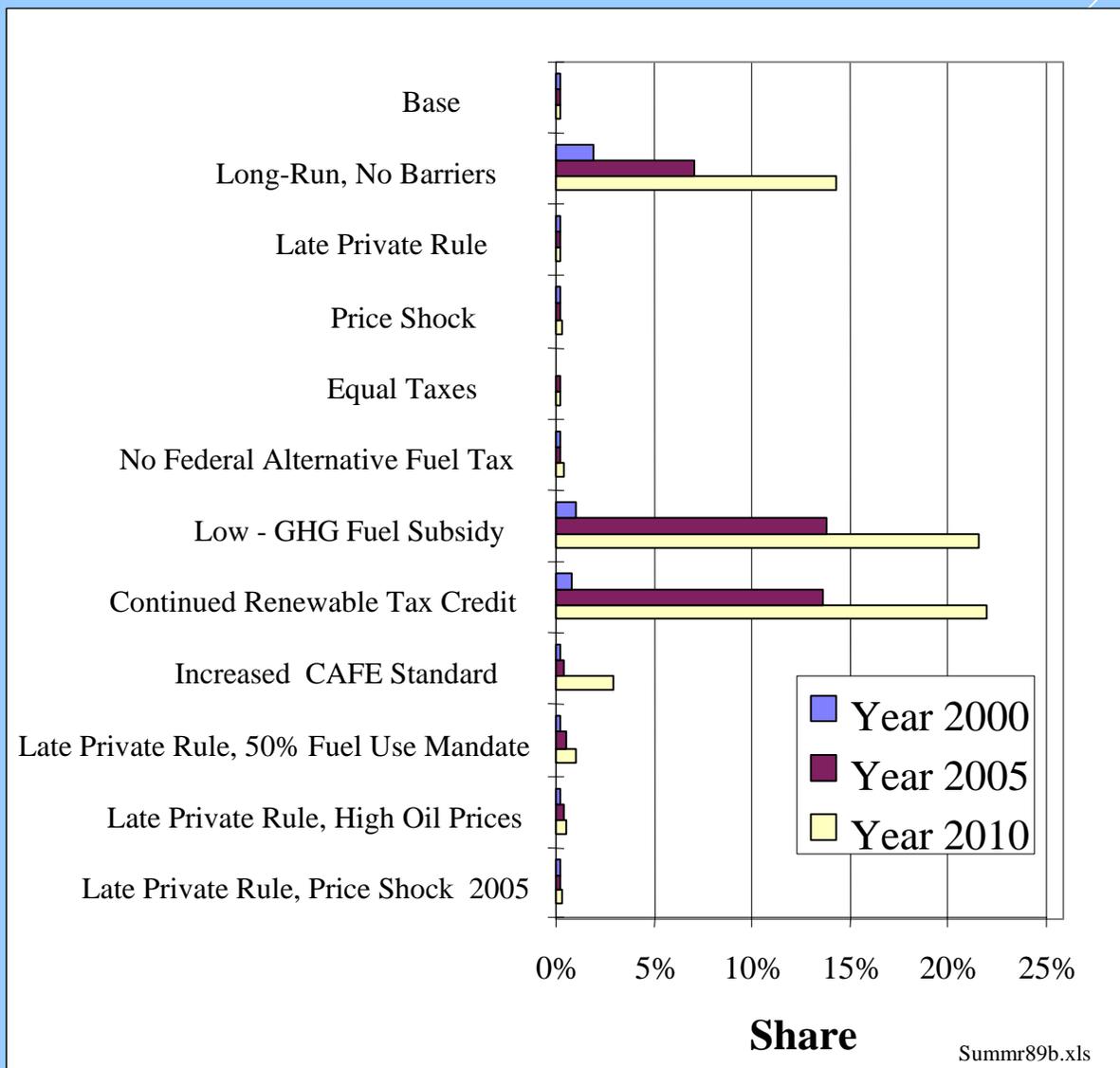


# New Vehicle Share Results



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# Fuel Share Results



# Results and Insights

- Transitional impediments matter
- Limited retail fuel availability and vehicle production scale-economies important
- May be hard for the vehicle/fuel market to get started
- Non-fleet AFV purchases respond to fleet policies
- Fleet policies mandating fuel use can jump start fuel retailing and fuel demand

# Results and Insights II

- Consumers prefer diversity, but “Feedbacks” encourage specialization
- In market, lower costs of specialization balance against consumer utility from fuel and vehicle diversity
- Can evaluate relative importance of policy levers
- Observe interactive policy effects

# Additional Information

## Sources

- See TAFV Website:  
<http://pz11.ed.ornl.gov/altfuels.htm>
- “The Alternative Fuel Transition: Draft Final Results from the TAFV Model of Alternative Fuel Use in Light-Duty Vehicles 1996-2010,” February 27, 1998, Paul Leiby and Jonathan Rubin.
- “The Transitional Alternative Fuels and Vehicles Model,” 1997, (*Transportation Research Record* 1587) Paul Leiby and Jonathan Rubin.