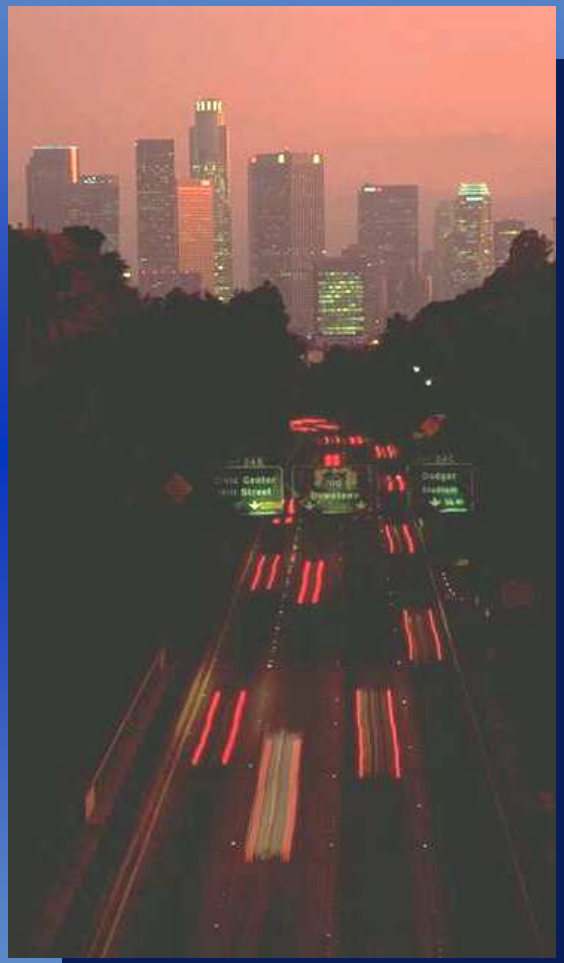
Update on California's Motor Vehicle Fuel Programs

February 22, 2007

California Environmental Protection Agency

Air Resources Board

Outline



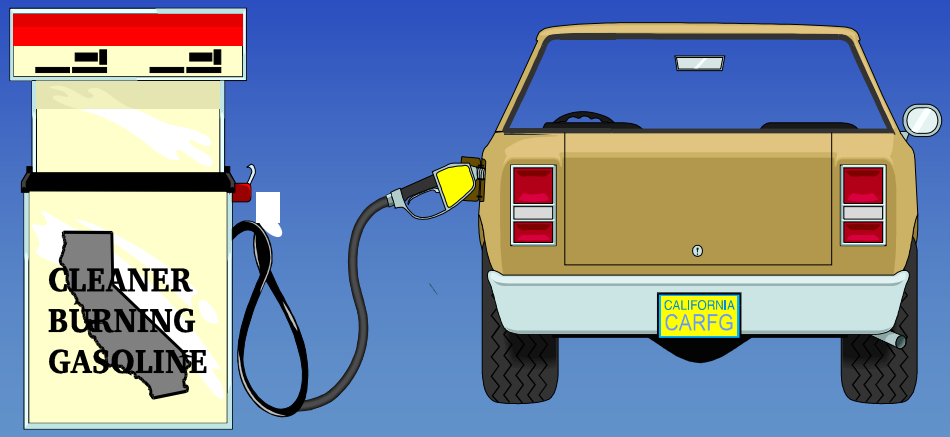
- Overview
- Reformulated Gasoline
- Reformulated Diesel Fuel
- Alternative Fuels
- Price and Consumption
- New Fuel Activities
- Summary

Why are Fuels Important?

- 24 million gasoline-powered vehicles
- 1.3 million diesel-fueled vehicles and engines
- 38 million people
- Population growing by about 500,000 people each year.

How California Approaches Motor Vehicle Emissions Control

- Treat vehicles and fuels as a system
  - Lowest emission standards - the LEV and ZEV programs
  - Cleanest fuel - California reformulated gasoline/diesel
- Flexibility allowed, so long as benefits are preserved



California's Vehicle Fuel Programs

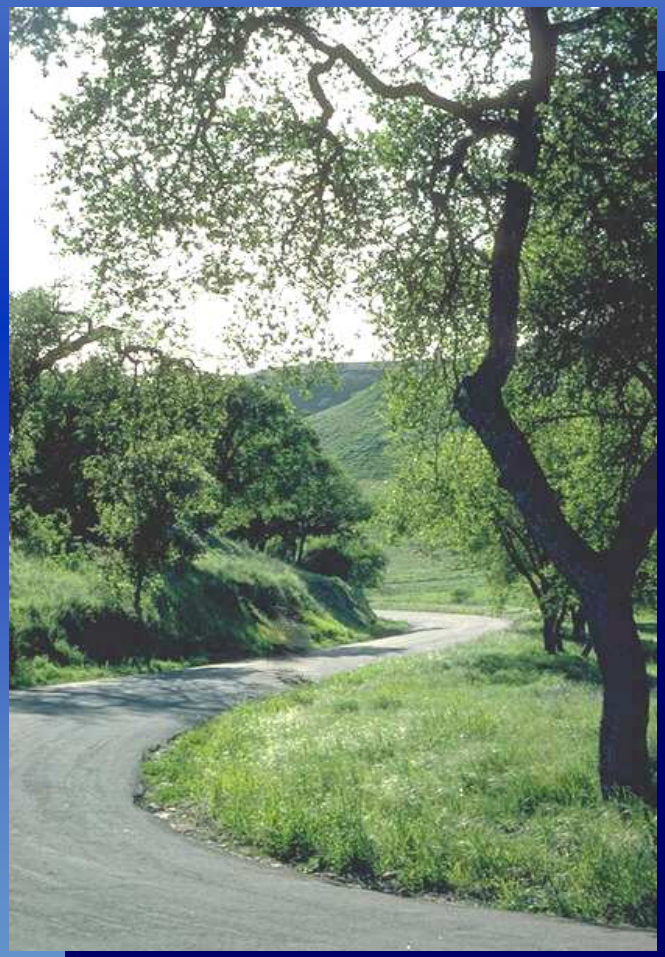
Year Adopted	Gasoline	Diesel	Alternative Fuels
1971	Reid Vapor Pressure	-------	-------
	Bromine Number	-------	-------
1975	Sulfur	-------	-------
	Manganese/Phosphorus	-------	-------
1976	Lead	-------	-------
1981	-------	Sulfur (SCAB)	-------
1982	Lead	-------	-------
1988	-------	Sulfur/Arom. HC	-------
1990	Phase 1 RFG	-------	-------
	-------	-------	Clean Fuels/LEV
1991	Phase 2 RFG	-------	-------
	Wintertime Oxygenates	-------	-------
1992	-------	-------	Commercial and Certification Specs
1994	Phase 2 RFG Predictive Model	-------	-------
	-------	-------	LPG (amended)
1998	Combustion Chamber Deposits (amended)	-------	-------
	Wintertime Oxygenates (amended)	-------	-------
	-------	-------	LPG (amended)
1999	Wintertime Oxygenates (amended)	-------	-------
	-------	-------	Clean Fuels (amended)
2000	Phase 3 RFG (eliminates MTBE)		
2003	---------	Sulfur 15 ppm	--------

Summary of Fuels Program Benefits

	Emissions Reductions (tpd)					
Program	HC	NOx	PM	SOx	CO	Toxics
Diesel	--	70	21	86	--	25%
CaRFG	400	129	--	34	1300	47%
Total (tpd)	400	199	21	120	1300	na
% Reduction	15%	10%	25%	90%	6%	na

California Reformulated Gasoline Program

California Phase 1 Reformulated Gasoline Program



- Approved in 1990
- Implemented in 1992
- Required Lowered RVP limit
- Deposit control additives
- Eliminated lead
- Benefits: 210 tpd or 10% VOC reductions

California Phase 2 Reformulated Gasoline Program

- Adopted in 1991
- Implemented March 1996

- Limits on:

Sulfur	RVP (Summertime)
T50	Benzene
T90	Aromatic Hydrocarbons
Olefins	Oxygen Content

Benefits of CaRFG2

- Reductions equivalent to removing 3.5 million vehicles
- Reduced emissions from motor vehicles by 15%
- Reduced cancer risk from vehicle emissions by 40%

Predictive Model

- Allows refiners to use alternative formulations of CaRFG
- Used for virtually all California gasoline
- Uses mathematics model to show that emissions from an alternative formulation meets required reductions
- Producers must meet standards for NOx, ozone forming potential, and air toxics
- Model is periodically updated

MTBE

- As reformulated gasoline was phased in, MTBE in groundwater was discovered
- An investigation led to Executive Order D-5-99 which directed the phase-out of MTBE
- ARB asked to implement the ban

California Phase 3 Reformulated Gasoline Program

- Approved on December 9, 1999
- Implemented the MTBE ban
- Provided flexibility to produce MTBE-free gas
- Enhanced emission benefits slightly
- Updated Predictive Model with latest emissions data
- Led to increased ethanol use

The California Reformulated Gasoline Revised Standards

Property	Flat Limits	
	CaRFG2	CaRFG3
RVP	7.00	6.90
Sulfur	40	20
Benzene	1.00	0.80
Aromatics	25.0	25.0
Olefins	6.0	6.0
T50	210	213
T90	300	305
Oxygen	1.8 – 2.2	1.8 – 2.2

Average Properties[1] of CaRFG3

	Actual	Flat Limit
RVP, psi	6.8	6.9
Sulfur, ppmw	10	20
Aromatic HC, vol	22	25
Benzene, vol%	0.5	0.8
Olefins, vol%	4.9	6.0
T90, deg F	307	305
T50, deg F	212	213
Oxygen, wt%	2.0	2.0

[1] **Based on 2003-2006 ARB Enforcement Division Sampling of California refiner's summertime fuel**

Effects of Ethanol on CaRFG

- During the 1999 rulemaking, ethanol use was suspected of increase evaporative emissions (permeation)
- Insufficient data available to quantify impact
- CRC study initiated
- CRC concluded ethanol use increases permeation emissions by about 65 percent; total evaporative emissions by about 6 percent

Ethanol Effects on Off-road Sources

- Ethanol also increases permeation emissions from off-road engines and storage containers
- Insufficient data available to quantify the increased emissions
- Testing program under development

Current Rulemaking Activity

- State law requires ARB to ensure that switching from MTBE to ethanol does not increase emissions
- Rulemaking underway to:
  - Achieve additional emission reductions from the use of reformulated gasoline
  - Update the Predictive Model
- Scheduled for Board consideration this spring

Proposed Updates to the Predictive Model

- Include new data on LEVS, ULEVS and SULEVS
- Improve handling of CO as ozone precursor
- Require permeation increase from on-road motor vehicles to be mitigated

Two Proposed Limit Modifications

- Adjust RVP flat limit
- Reduce the sulfur cap limit from 30 ppmw to 20 ppmw

Other Proposed Amendments

- Allow alternative emissions reductions to provide flexibility in offsetting permeation emissions
- Provide compliance flexibility to meet lower sulfur limits

National Energy Policy Act of 2005

- Removed federal “oxygen mandate” that required ethanol in CaRFG
- Replaced oxygen content requirement with a renewable fuels standard
- Beginning in 2006, requires 4 billion gallons nationwide of renewable fuel be consumed

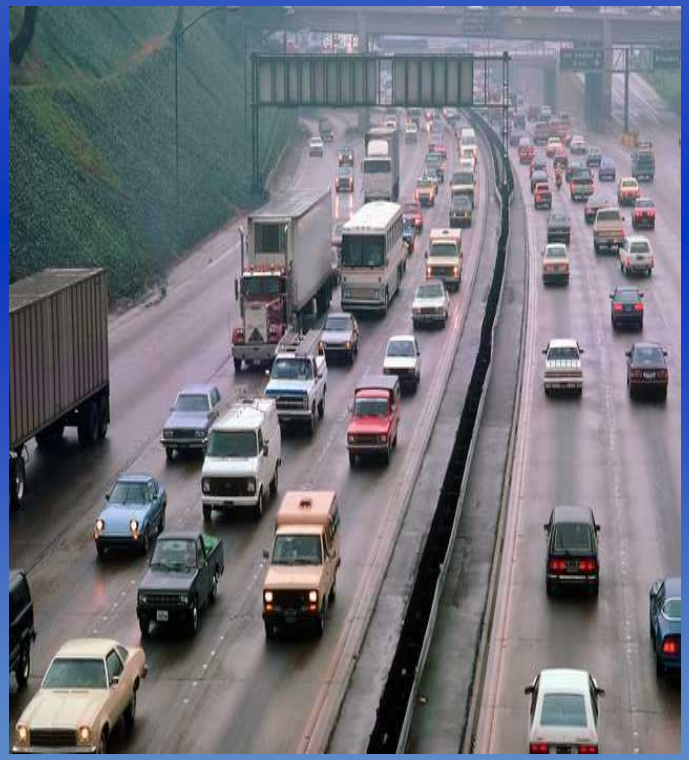
National Renewable Fuels Standard

Year	Renewable Fuels (billions of gallons)
2006	4.0
2007	4.7
2008	5.4
2009	6.1
2010	6.8
2011	7.4
2012	7.5

California Diesel Fuel Regulations

Diesel Vehicle Emissions

- Disproportionate contribution to statewide emissions
  - –Represent about 4 percent of California motor vehicles
  - –Produce about 40 percent of the NOx and about 60 percent of directly emitted PM_{10} from vehicles
  - –Account for approximately 70 percent of the air toxics cancer risk



ARB Diesel Emission Controls

- Cleaner Fuels
- Clean New Engines
- In-use Inspection and on board diagnostics
- Retrofit Programs

CARB Clean Diesel Regulations

- Adopted in November 1988
- Implemented October 1993
- Applicable to diesel fuel sold for on-road and off-road motor vehicle use

- Provides flexibility by allowing certification of equivalent alternative formulations

California Low Sulfur Diesel Regulation

- In July 2003, the Board approved a 15 part per million (ppm) sulfur limit
  - Aligns with U.S. EPA on-road sulfur rules
- Enables new engines to meet new standards
- Applies to on-road and off-road vehicles in September 2006
- Applies to all harbor craft and intrastate locomotives starting on January 1, 2007
- Retains aromatic hydrocarbon standard to control NOx emissions

Federal Low Sulfur Diesel Fuel Program

- The 15 ppmw low sulfur standards will be phased-in:
  - June 2006 for on-road vehicles
  - 2010 for Non-road equipment and vehicles
  - 2012 for locomotives and marine vessels

Alternative Fuels

Alternative Fuels Program

- Alternative fuel use expected to grow
- ARB rules provide engine manufacturers with a known fuel quality for designing engines
- Help prevent fuel related engine performance problems and excess emissions

Standards Adopted

- In 1992, specifications adopted for seven fuels:
  - M-100 Fuel Methanol
  - M-85 Fuel Methanol
  - E-100 Fuel Ethanol
  - E-85 Fuel Ethanol
  - Compressed Natural Gas
  - Liquefied Petroleum Gas
  - Hydrogen

Liquefied Petroleum Gas (LPG)

- LPG consists primarily of propane and butane, and is obtained from petroleum refining or by oil and gas extraction

- ARB specs are:
  - –85% propane (min)
  - –10% propene (max)
  - –5% butane (max)

LPG Activities

- Declining use of LPG as a transportation fuel
  - Decrease in OEM engines
  - Decrease in certified conversions
- Use declined from 44 million gallons in 1999 to 26 million gallons in 2004
- Fuel quality survey underway supporting ARB's 2007 exhaust standards for forklifts

Compressed Natural Gas (CNG)

- CNG consists primarily of methane, and is obtained by oil and gas extraction
- ARB specs are:
  - 88% methane (min)
  - 6% ethane (max)
  - 3% propane and higher hydrocarbons (max)

CNG Activities

- The CPUC established a Wobbe Index of 1385
  - Current average is 1330
  - Possibility of increased NOx emissions at higher Wobbe Index values
  - Little impact on motor vehicles
- SCAQMD sued CPUC over adequacy of new Wobbe Index
- ARB not proposing to adjust the CNG specifications

Ethanol

- 4.8 billion gallons ethanol produced in the U.S. (estimated)
- 33 million gallons ethanol produced in California
- 900 million gallons ethanol per year consumed in California, mostly as a gasoline blending component (5.7% of fuel)

E85 Fuel Activities

- E85 is 85 percent ethanol and 15 percent gasoline
- Over 240,000 E-85 vehicles in CA; limited retail availability
- Need to revise E85 specifications
  - Update to match ASTM D 5798
  - Update test methods

E85 Demonstration Program

- Joint venture between ARB, Caltrans, Chevron, General Motors, Pacific Ethanol, CEC, and other state agencies
- Agreement signed in December 2005
- One year program using up to 100,000 gallons E85
- E85 meets ASTM D 5798-99 specifications

E85 Demonstration Program

- Installed 5,000 gallon above ground storage tanks and dispensers at Caltrans maintenance stations in Oakland and Marysville
- Added 50 new flexible fuel vehicles to the Caltrans fleet
- First fuel deliveries made in October 2006
- ARB to produce a final report in early 2008

Biodiesel

- Renewable fuel derived from vegetable oils and animal fats
- Common feedstocks: Soy based and recycled yellow grease
- Future feedstocks: Trap grease, algae derived biodiesel, and other vegetable seed oil biodiesels

Biodiesel Benefits and Issues

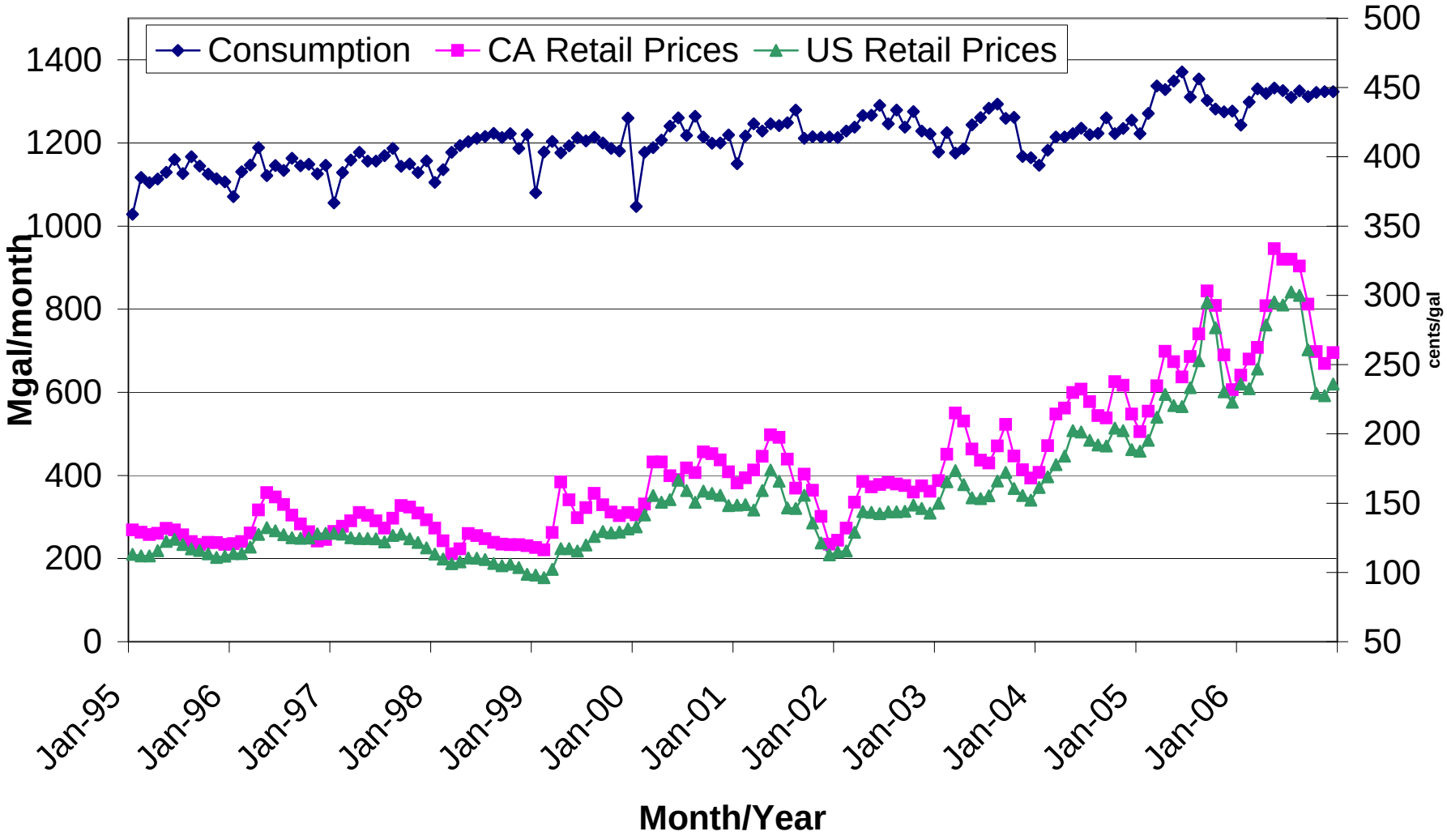
- Generally reduces greenhouse gases, PM, and toxic emissions; however could cause higher NOx emissions
- Less toxic, biodegradable, low sulfur, no aromatics, and can be generally used with no engine modification
- Fuel stability issues--tendency to degrade
- Engine warranty issues with higher level blends
- Need specifications for biodiesel blends and B100

Biodiesel Activities

- Biodiesel emissions study
- Biodiesel NOx mitigation study
- Multimedia Evaluation

Price and Consumption

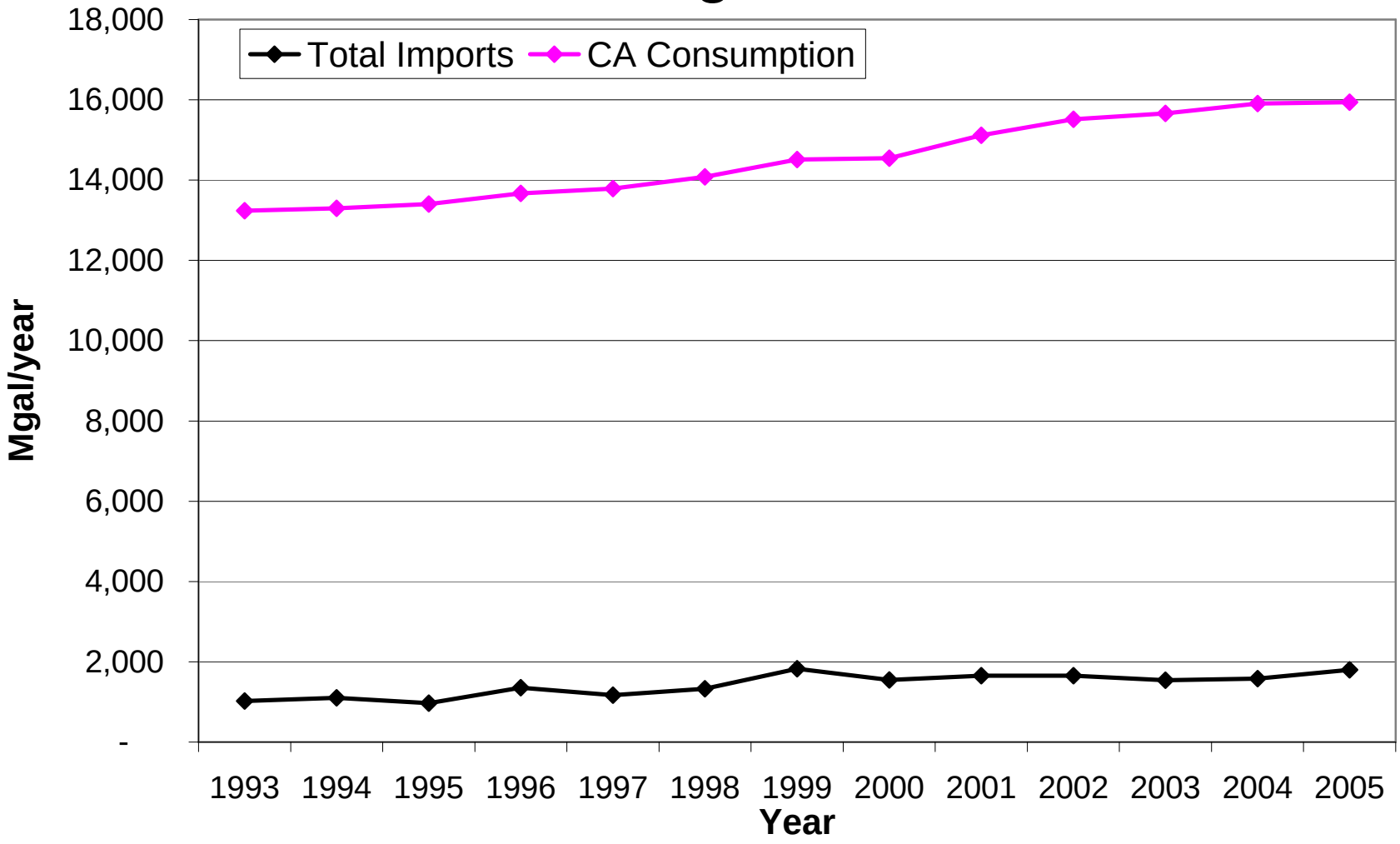
Gasoline Consumption vs Retail Prices



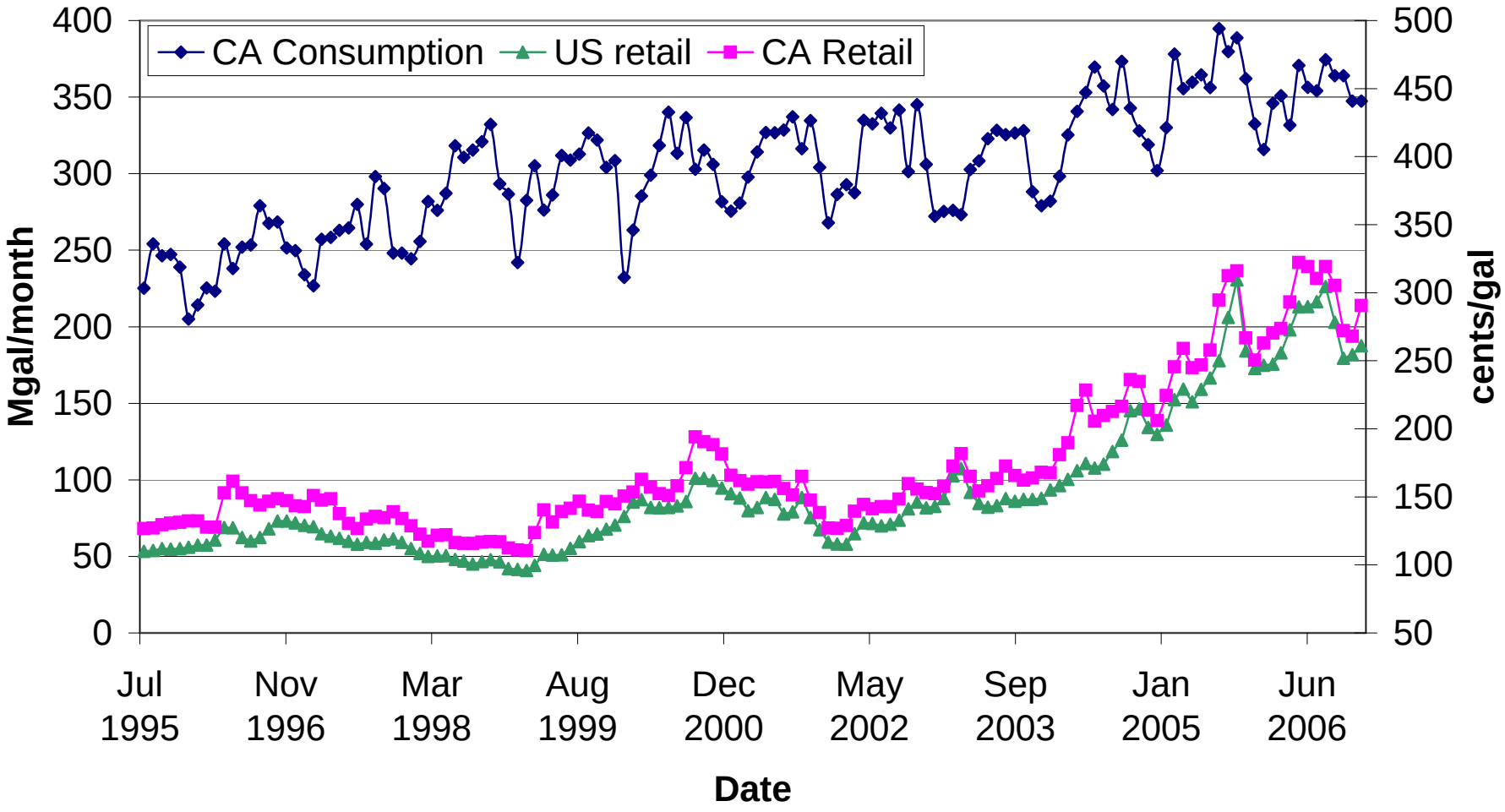
2005 Gasoline Imports into Pacific Region

Source	Mgal
PADD 3 (Gulf Coast)	1,000
Canada	113
South Korea	60
Virgin Islands (US)	52
Taiwan	41
Singapore	24
Saudi Arabia	22
United Kingdom	14
Romania	11
Japan	9
Other Countries	18
Total	**1,360**
% of Consumption	**9%**

Total Imported Gasoline into Pacific Region



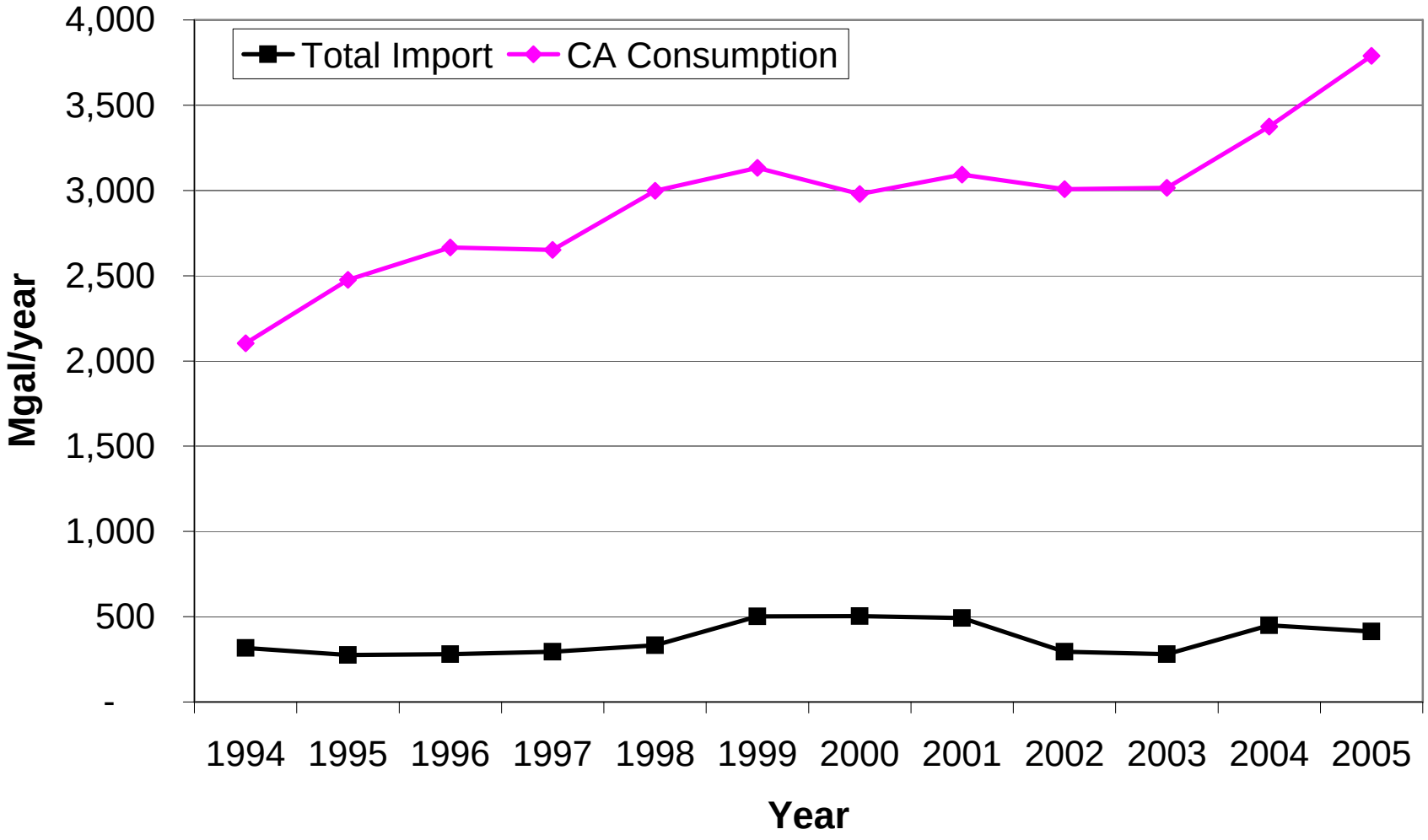
Diesel Consumption vs Retail Prices



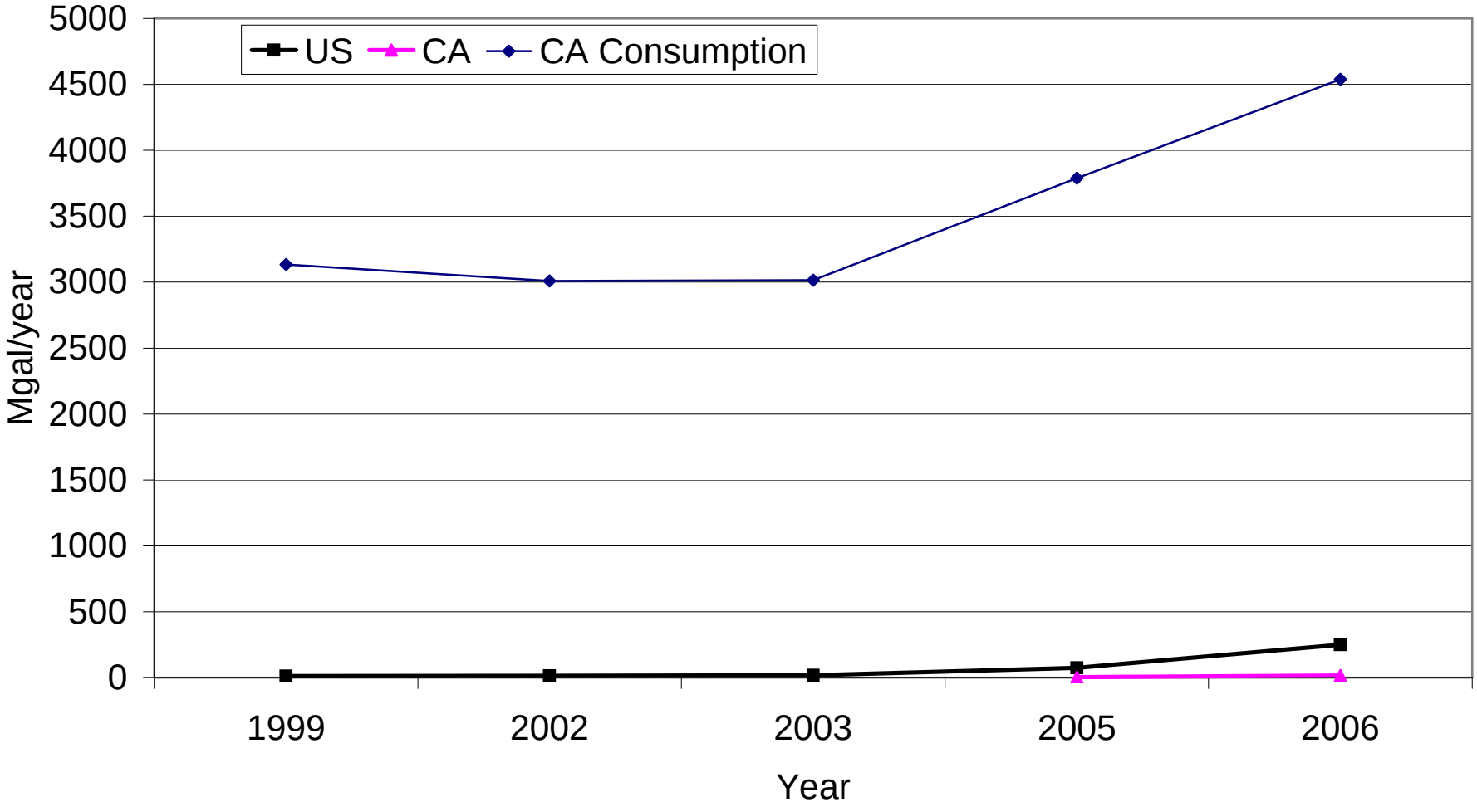
2005 Diesel Imports into Pacific Region

Source	Mgal
PADD 3 (Gulf Coast)	75
Canada	52
Russia	48
Japan	43
South Korea	39
Virgin Islands (US)	28
Aruba	21
Taiwan	9
Singapore	6
Philippines	3
Total Gallons Imported	**324**
% of Consumption	**8%**

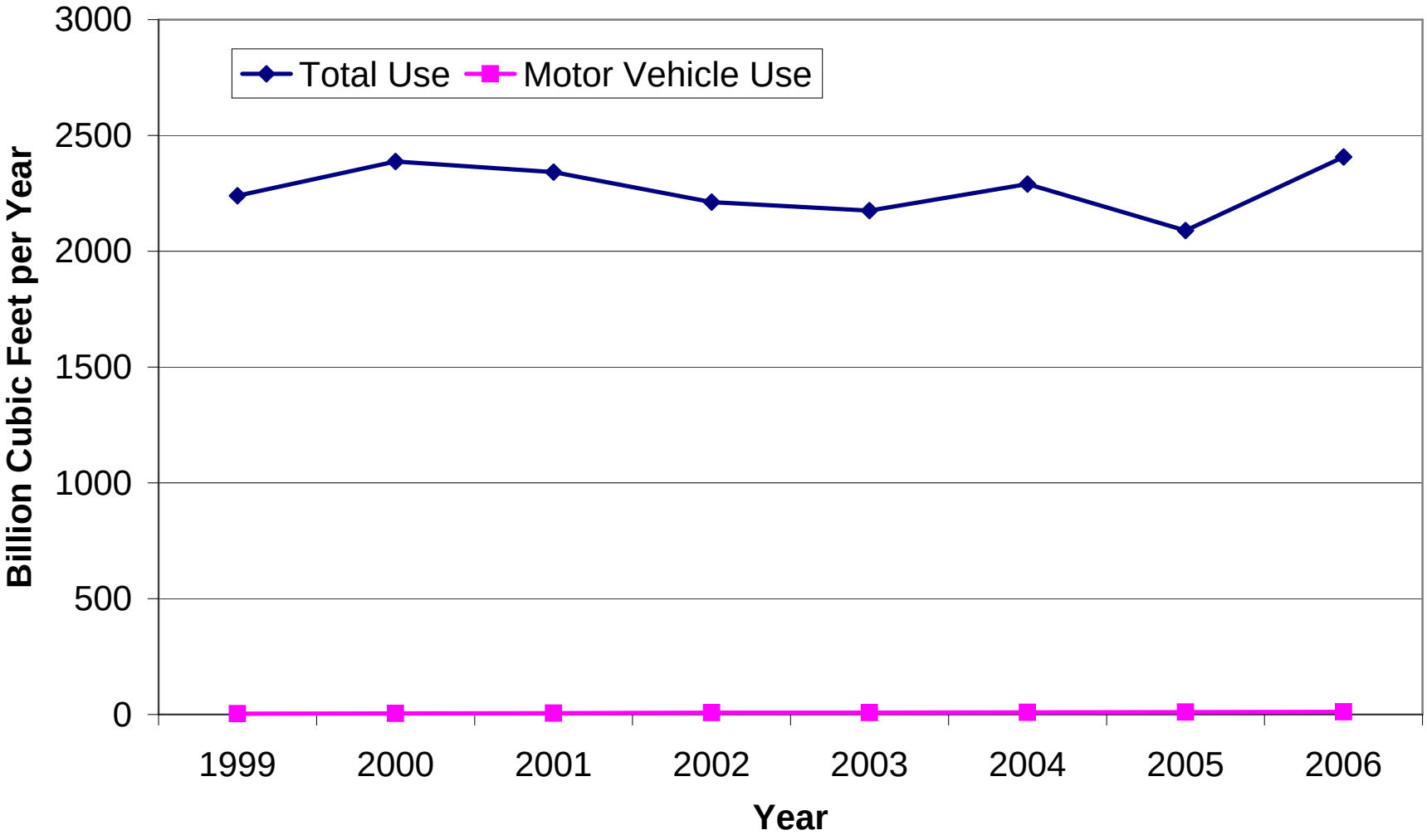
Total Imported Diesel into Pacific Region



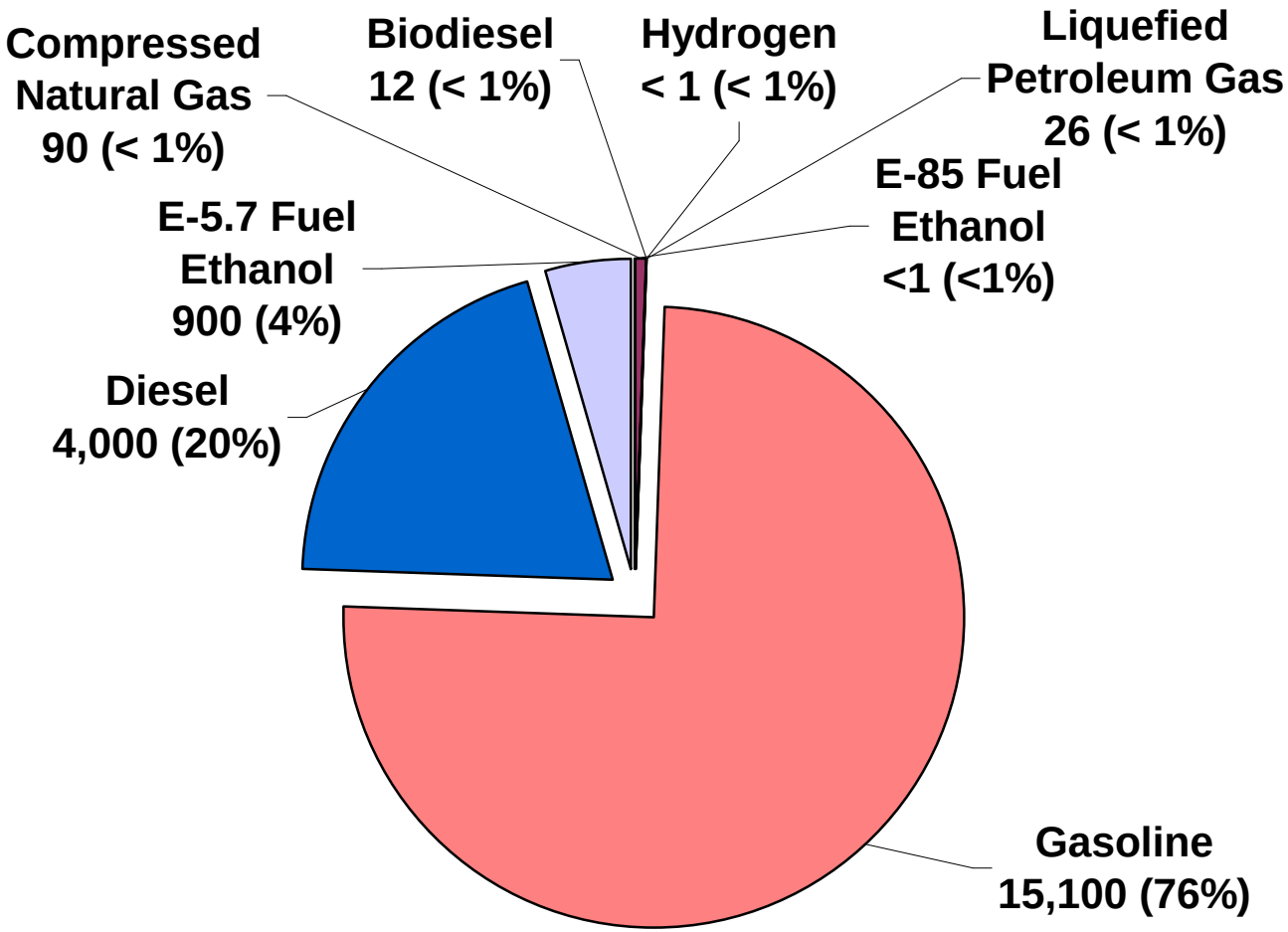
US and CA Biodiesel Production

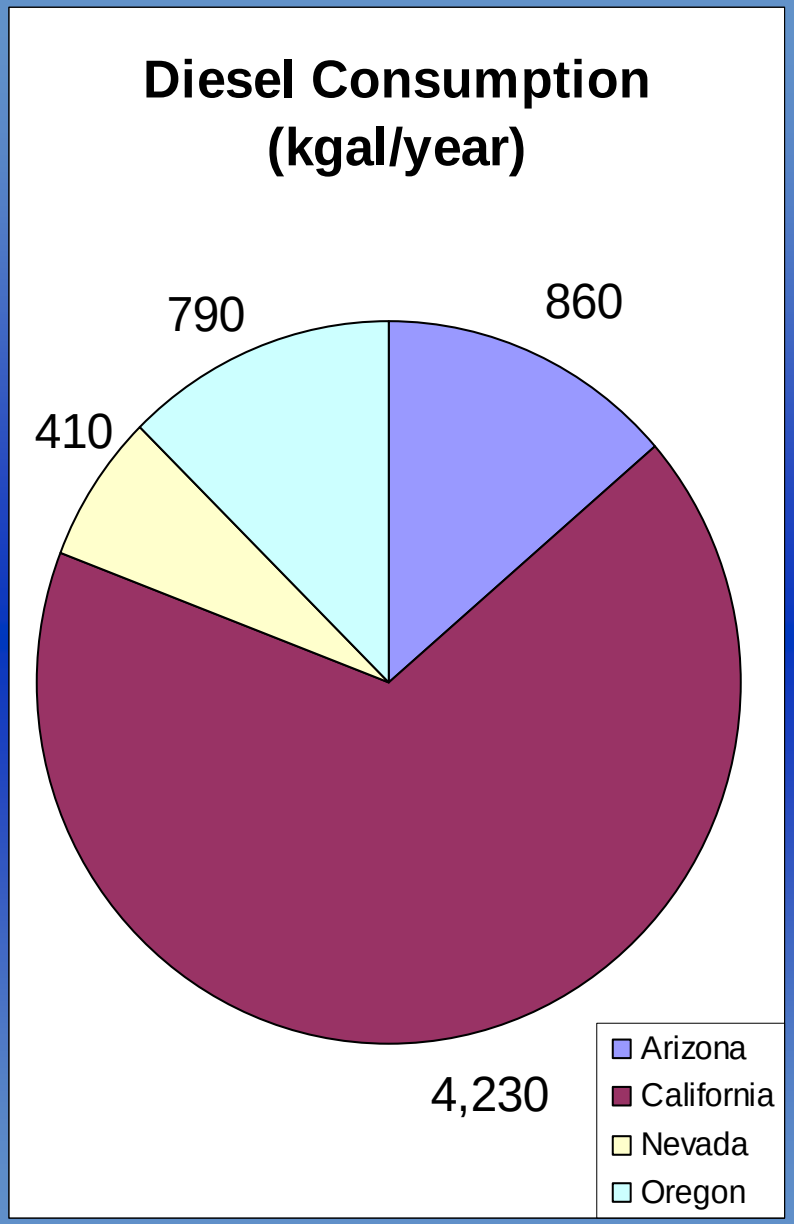


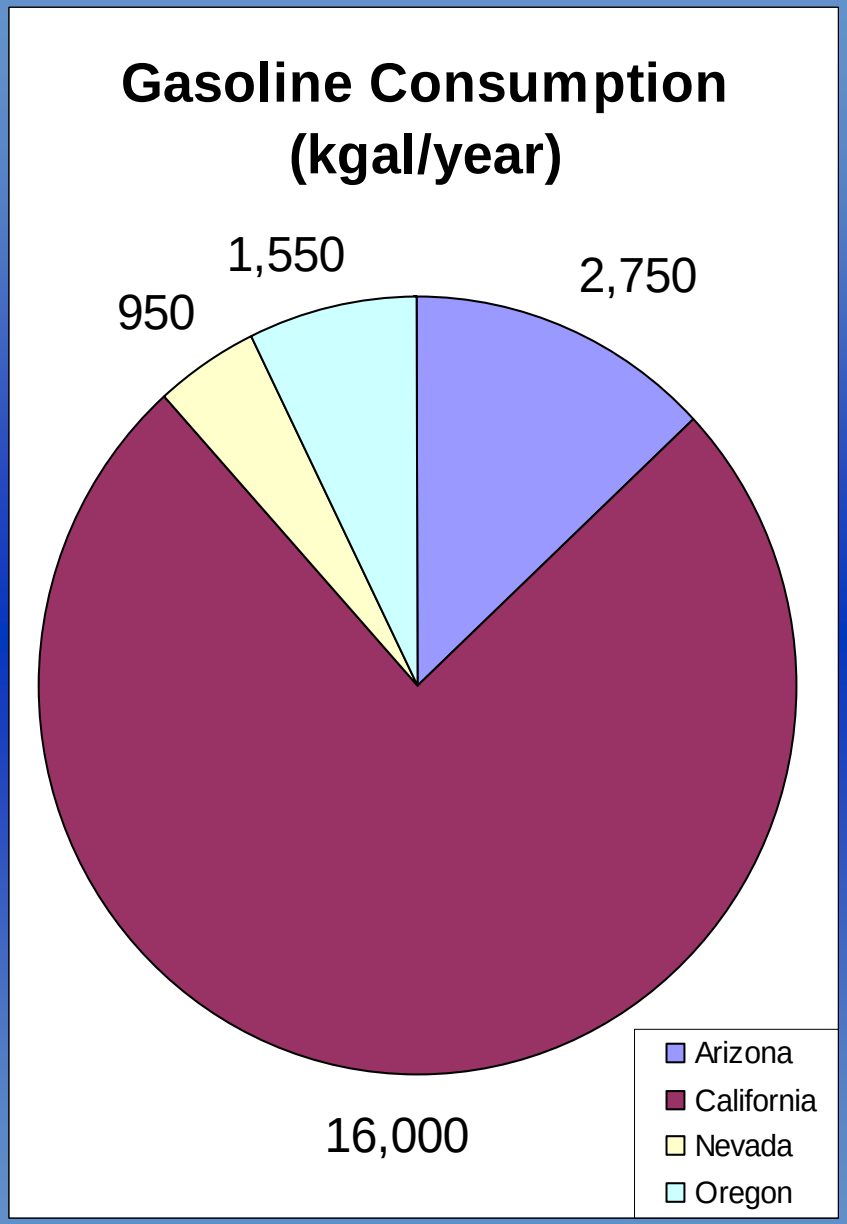
Natural Gas Consumption



Current Annual Fuel Use in California (million gallons)




Diesel Consumption
(kgal/year)
860
790
410
4,230
Arizona
California
Nevada
Oregon

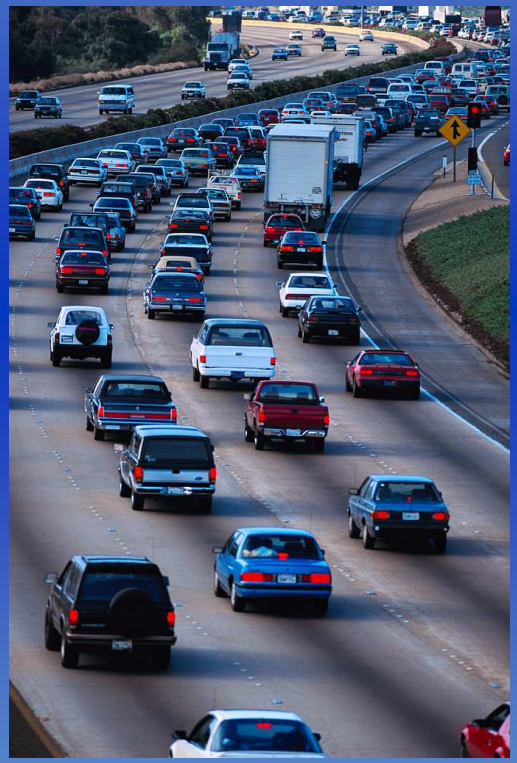

Gasoline Consumption
(kgal/year)
1,550
2,750
950
16,000
Arizona
California
Nevada
Oregon

New Fuel Activities

Alternative Fuels Incentives Program ($25 million)

- Joint effort with the California Energy Commission
- Public and private alternative fuel vehicles and fueling stations, including E-85 stations
- Alternative fuel production incentives
- Grants for research and development
- No funds for fuels derived from petroleum, coke, or coal
- Reduce air pollution and greenhouse gases

Alternative Fuels Incentives Program Status



- Workshop September 2006
- Board meeting October 2006
- Solicitations out February 2007
- Proposals due March 2007
- Recommendations to the Board in April 2007
- Funds encumbered by July 2007

Executive Order S-06-06 for Biofuels

- Encourages use of biofuels
- Establishes targets for in-state production of biofuels used
  - 20% by 2010
  - 40% by 2020
  - 75% by 2050

Bioenergy Action Plan

- Provide maximum flexibility for using biofuels
- Evaluate the emissions and performance of biofuels
- Develop fuel specifications for biofuels

Assembly Bill 1007 Requirements

- Requires the CEC and ARB to prepare State plan to increase use of alternative fuels in California
- Sets goals for 2012, 2017, and 2022
- Optimizes environmental and public health benefits
- Requires a full fuel-cycle assessment

Low Carbon Fuel Standard (LCFS)

- Governor issued Executive Order S-01-07 in January 2007
- Establishes goal to reduce carbon intensity of transportation fuels 10% by 2020
- Specifies implementation process
- Requests ARB to consider LCFS as early action measure under AB 32

Examples of Lower Carbon Fuels

- E10: increase ethanol blend from current E6
- E85: high blend ethanol for flex fuel vehicles
- Low carbon ethanol: “cellulosic” materials have 4-5 times lower GHGs than today’s corn
- Hydrogen
- Electricity,
- CNG, LPG
- Biogas
- Biodiesel

Benefits of LCFS Reductions of 10%

- 13.4 million metric tons of CO_2-equivalent reductions in direct emissions from vehicles
- Equivalent to removing 3 million cars from the road
- Less petroleum consumption: displace 20% of on-road gasoline consumption
- Expand renewable fuels market by 3 to 5 times
- Increase the number of alternative fuel and hybrid vehicles to 7 million (20 times current number)

LCFS Implementation Process

- Study by University of California, in cooperation with CEC and ARB, to be completed Spring 2007
- Study will be incorporated into AB 1007 Report
- CEC will propose draft compliance schedule as part of AB 1007 Report
- ARB to initiate regulatory proceedings to establish and implement the LCFS
- Anticipated adoption late 2008

Summary

- California has the cleanest motor vehicle fuels in the world
- LCFS will result in:
  - New technologies
  - Greater market stability
  - Supply diversity
- Future Challenges:
  - Competition for clean fuels and components
  - Maintain adequate fuel supply