OPTION 1D
VEHICLE MAINTENANCE PRACTICES

Description

This option examines the potential impact of increasing the fraction of consumers who properly maintain their light-duty vehicles and improve the fuel efficiency of existing vehicles. A consumer outreach and education campaign on vehicle maintenance practices would be conducted annually. Although the fuel savings per vehicle may be relatively small, the overall petroleum fuel reduction can be large if enough consumers are motivated to act. Improving the efficiency performance of California's vehicle population can achieve near-term savings. If the campaign can effect a change in behavior, the savings can multiply over the long term.

Background

During the 1970s when oil shocks caused consumers to more seriously consider fuel economy when acquiring a new vehicle, the federal government established the Fuel Economy Information Program. Since then, the level of interest and investment in public information campaigns have followed fuel price trends, increasing when prices spike only to wane when prices drop below some "public pain" threshold.[1] In a final report on the Green Vehicle Market Alliance Project contracted by Oak Ridge National Laboratory, John DeCicco of Environmental Defense pointed to the increasing government interest away from consensus-building and near-term strategies and toward long-term high technology approaches.[2]

Between 1999 and 2003, a series of workshops (Green Vehicle Market Alliance Project) were held nationwide, attended by state government representatives (including the Energy Commission), the automotive manufacturers, federal agencies, federal research laboratories, environmental groups, and universities.[3] One meeting in the sequence was hosted by the Institute of Transportation Studies, University of California at Davis. This meeting focused on market research issues with the inclusion of social marketing. Social marketing is defined as the use of marketing and social-science strategies to change individual behavior for the good of society.[4] Social marketing's premise is that the audience may not share the same social objectives when prioritizing their buying decisions. However, social marketing uses the same advertising and public relations strategies used for general product marketing. The automakers' view from the same series of workshops suggested that education related to the importance of fuel economy for the reasons of national security (rather than environmental ideologies) might be acceptable to them.

In response to escalating fuel prices in California, a 44 percent increase between December 2003 and May 2004, Governor Schwarzenegger enacted a Call to Action

and a “Flex Your Power at the Pump” campaign.[5] Leaders from both political parties reached consensus over the need to increase the state’s use of alternative power, along with a large dose of conservation.[6]

Status

The Car Care Council surveyed drivers on routine maintenance. Table 1 summarizes the survey results.[7] This is an decrease in good maintenance practices from their 2000 survey that found 10 percent of the vehicle population needed air filter replacement and 20 percent had exceeded their oil and filter change interval.[8]

Table 1. Percentages of Vehicles Not Following Suggested Maintenance Schedules

Driving on under-inflated tires.	54 percent[9]
Not following recommended oil maintenance.	38 percent[10]
Not replacing dirty air filters.	16 percent[11]

For this analysis, the staff assumed that vehicles that could improve fuel economy performance through a tune-up are accounted for in the base case demand forecast.[12]

Several conditions and trends regarding fuel economy make any action for vehicle fuel conservation more important now than in the past.

- Although they can perform the same function as cars, light-trucks – including sport utility vehicles (SUVs) – are not subject to the same penalties for poor fuel economy as are cars. Cars with combined fuel economy ratings of less than 22.5 miles per gallon are penalized with a tax of $1,000 to $7,700.[13] No such tax is applied to light-trucks. The fuel economy standard for light-trucks is also less than for cars. As the proportion of new vehicle sales has increased for light-trucks compared to cars, the overall fuel economy of light-duty vehicles has dropped.

- The average fuel economy of new cars and trucks has declined from about 26 miles per gallon in 1988 to 24 miles per gallon in 2000.[14] The staff’s transportation energy demand model, Calcars, reflects this same downward fuel economy trend in the estimates of California light duty vehicle gasoline consumption. Contrary to this actual result, a Roper poll[15] found that 62 percent of U.S. adults believed that auto fuel economy was improving

each year, 12 percent believed the fuel economy remained stable, and only 17 percent realized that average fuel economy had declined. In addition, two-thirds of Americans did not realize transportation was the largest user of petroleum.

- Gasoline consumption estimates made by the U.S. Environmental Protection Agency are based on data collected from vehicles being driven over a specific driving cycle. The driving cycle has not been updated to reflect increased traffic congestion, increased highway speeds, and more powerful vehicles.[16,17] Thus, vehicle fuel economy may be overestimated by as much as 34 percent.[18]

Although the resulting fuel economy improvement from the maintenance practices in this scenario can be small, their fuel consumption impact is magnified by California's existing population of vehicles and the relatively long life of these vehicles. Because vehicle fuel consumption is inversely related to fuel economy, a percentage change in fuel economy in a vehicle with low fuel economy will have a greater fuel consumption impact than the same percentage change in a more efficient vehicle. For example, a 1 percent change in the fuel economy of a vehicle that gets 16 miles per gallon will save 25 percent more gasoline per mile than the same 1 percent change in a vehicle that gets 20 miles per gallon. Thus, at a time when our vehicle population has a declining fuel economy and these vehicles will be operating for a decade or more, promoting fuel conservation measures for these vehicles is an important contributor to reduced petroleum fuel use.

Assumptions

Improving the efficiency performance of California's vehicle population can be achieved by focusing on fuel conservation-related measures that do not require technology advancements and can be initiated by individual actions with state or federal promotion. In general, these actions may include periodic engine tune-ups, engine lubrication, air and oil filter replacements, and proper tire inflation. However, the California Smog Check program is assumed to find engine operating problems that would be corrected by major engine tune-ups. Thus, tune-ups are not included in this evaluation because the staff's base case fuel demand forecast includes these tune-ups as normal practice.

This option would involve a state campaign to educate motorist on the benefits of improved maintenance practices. The options would include following manufacturers guidelines for oil and oil filter changes, air filter cleaning and replacement, and maintaining recommended tire inflation pressure. From California media campaign programs to encourage more efficient electricity use, the value of savings has been about double the cost to produce the savings.[19]

The U.S. Department of Energy estimates that replacing air filters can increase vehicle fuel economy by up to 10 percent, replacing dirty oil by up 1 to 2 percent,

and maintaining proper tire inflation by up to 3 percent.[20] Increased participation by vehicle owners and sustained gasoline savings over the life of the vehicle will only be achieved through a sustained media campaigns. It is assumed that each $1 million spent on advertising will increase participation by 3 percent.[21]

Without a campaign, staff assumed a maximum of two percent of the owners of the state's vehicles will change their behavior and increase the frequency of air filter changes with the current level of website information, publications, limited media coverage, and rising fuel prices. A major campaign effort, similar to recycling and electricity conservation campaigns, is assumed to change the behavior of up to 30 percent of the vehicle owners who are not performing maintenance practices.

Air Filters

Dirty air filters reduce the flow of air required for efficient combustion of fuel. It takes air to completely oxidize the fuel in the combustion process. If an engine is starved for air, fuel is not fully combusted and is wasted.

Based on the most recent surveys, 16 percent of the vehicle population was not getting air filters changed regularly (every 10,000 miles if the vehicle is not being driven regularly in dirty conditions). Replacing a dirty air filter will increase the individual vehicle efficiency by 10 percent.[22]

Tables 2 and 3 summarize average petroleum displacement and direct benefits for air filter maintenance at 2 percent and 30 percent participation, respectively.

Table 2: Air Filters, 2 Percent Participation, Average Petroleum Displacement and Direct Benefit

	Average Conventional Fuel Displaced (billions gallons)	Average Consumer Savings(million $)		Average Change in Government Revenue(million $)	
		Discount Rate		Discount Rate	
		12%	5%	12%	5%
2005 to 2010					
With GHG Standards					
• Low Fuel Price	0.0099	$46.56	$75.86	($6.94)	($11.30)
• Very High Fuel Price	0.0097	$45.73	$78.80	($6.81)	($11.09)
Without GHG Standards	0.01	$46.94	$74.44	($6.99)	($11.17)
• Low Fuel Price	0.0097	$46.04	$75.00	($6.86)	($18.75)
• Very High Fuel Price					
2005 to 2020					
With GHG Standards					
• Low Fuel Price	0.0094	$27.04	$106.29	($4.03)	($15.84)
• Very High Fuel Price	0.0091	$26.42	$103.68	($3.94)	($15.45)
Without GHG Standards	0.01	$28.26	$112.61	($4.21)	($16.78)
• Low Fuel Price	0.0090	$27.38	$108.65	($4.08)	($16.19)
• Very High Fuel Price					
2005 to 2025					
With GHG Standards					
• Low Fuel Price	0.0093	$16.70	$98.92	($2.49)	($14.74)
• Very High Fuel Price	0.0092	$16.31	$96.36	($2.43)	($14.36)
Without GHG Standards	0.0102	$17.65	$106.85	($2.63)	($15.92)
• Low Fuel Price	0.0097	$17.05	$102.54	($2.54)	($15.28)
• Very High Fuel Price					

Table 3: Air Filters, 30 Percent Participation, Average Petroleum Displacement and Direct Benefit

	Average Conventional Fuel Displaced (billions gallons)	Average Consumer Savings(million $)		Average Change in Government Revenue(million $)	
		Discount Rate		Discount Rate	
		12%	5%	12%	5%
2005 to 2010					
With GHG Standards					
• Low Fuel Price	0.148	$697.15	$1135.83	($103.86)	($169.21)
• Very High Fuel Price	0.148	$684.68	$1114.61	($102.00)	($166.05)
Without GHG Standards	0.149	$702.88	$1146.18	($104.71)	($170.75)
• Low Fuel Price	0.145	$684.68	$1114.61	($102.00)	($166.05)
• Very High Fuel Price					
2005 to 2020					
With GHG Standards					
• Low Fuel Price	0.140	$404.78	$1591.28	($60.31)	($237.06)
• Very High Fuel Price	0.137	$395.56	$1552.21	($58.93)	($231.25)
Without GHG Standards	0.150	$423.07	$1685.85	($63.03)	($251.15)
• Low Fuel Price	0.137	$395.56	$1552.21	($58.93)	($231.25)
• Very High Fuel Price					
2005 to 2025					
With GHG Standards					
• Low Fuel Price	0.139	$250.04	$1480.87	($37.25)	($220.62)
• Very High Fuel Price	0.135	$244.14	$1442.62	($36.37)	($214.92)
Without GHG Standards	0.152	$264.29	$1599.69	($39.38)	($238.32)
• Low Fuel Price	0.135	$244.14	$1442.62	($36.37)	($214.92)
• Very High Fuel Price					

Tires

Low tire pressure increases rolling resistance, or friction with the road, as the vehicle moves. This increases heat generated in the tires – energy from the engine that is not going towards moving the vehicle.[23] The more time spent driving at higher speeds, such as freeway driving, the more fuel is wasted from low tire pressure. Tire pressure will also fluctuate with changes in weather and air temperature.

An average of 54 percent of the population is assumed to be driving on four tires not maintained at the correct pressure. Maintaining proper tire pressure is assumed to decrease fuel consumption by 3 percent per vehicle (each tire is about 5 pounds per square inch or more below recommended pressure) from the baseline gasoline consumption.

Tables 4 and 5 summarize average petroleum displacement and direct benefits for tire maintenance at 2 percent and 30 percent participation, respectively.

Table 4: Tires, 2 Percent Participation, Average Petroleum Reduction and Direct Benefit

	Average Conventional Fuel Displaced (billions gallons)	Average Consumer Savings (million $)		Average Change in Gov't Revenue (million $)	
		Discount Rate		Discount Rate	
		12%	5%	12%	5%
2005 to 2010					
With GHG Standards					
• Low Fuel Price	0.0107	$50.35	$82.03	($7.50)	($12.22)
• Very High Fuel Price	0.0105	$49.45	$80.50	($7.37)	($11.99)
Without GHG Standards	0.0108	$50.76	$87.74	($7.56)	($12.33)
• Low Fuel Price	0.0105	$49.78	$81.10	($7.42)	($12.08)
• Very High Fuel Price					
2005 to 2020					
With GHG Standards					
• Low Fuel Price	0.0101	$29.24	$114.95	($4.36)	($17.12)
• Very High Fuel Price	0.0099	$28.57	$112.12	($4.26)	($16.70)
Without GHG Standards	0.0109	$30.56	$123.78	($4.55)	($18.14)
• Low Fuel Price	0.0099	$29.61	$117.49	($4.41)	($17.50)
• Very High Fuel Price					
2005 to 2025					
With GHG Standards					
• Low Fuel Price	0.0100	$18.06	$106.97	($2.69)	($15.93)
• Very High Fuel Price	0.0010	$17.64	$104.21	($2.63)	($15.52)
Without GHG Standards	0.0110	$19.09	$115.56	($2.84)	($17.21)
• Low Fuel Price	0.0100	$18.44	$110.89	($2.75)	($16.52)
• Very High Fuel Price					

Table 5: Tires, 30 Percent Participation, Average Petroleum Reduction and Direct Benefit

	Average Conventional Fuel Displaced (billions gallons)	Average Consumer Savings (million $)		Average Change in Gov't Revenue (million $)	
		Discount Rate		Discount Rate	
		12%	5%	12%	5%
2005 to 2010					
With GHG Standards					
• Low Fuel Price	0.160	$753.79	$1228.09	($112.29)	($182.94)
• Very High Fuel Price	0.157	$740.31	$1205.15	($110.28)	($179.52)
Without GHG Standards	0.161	$759.98	$1239.28	($113.21)	($184.60)
• Low Fuel Price	0.157	$740.31	$1205.15	($110.28)	($179.52)
• Very High Fuel Price					
2005 to 2020					
With GHG Standards					
• Low Fuel Price	0.152	$437.69	$1720.56	($112.29)	($182.94)
• Very High Fuel Price	0.148	$427.72	$1678.33	($63.71)	($250.01)
Without GHG Standards	0.163	$457.47	$1822.81	($68.15)	($271.53)
• Low Fuel Price	0.148	$427.72	$1678.33	($63.71)	($250.01)
• Very High Fuel Price					
2005 to 2025					
With GHG Standards					
• Low Fuel Price	0.150	$270.38	$1601.21	($40.28)	($238.52)
• Very High Fuel Price	0.146	$264.00	$1559.85	($39.33)	($232.36)
Without GHG Standards	0.165	$285.78	$1729.66	($42.57)	($257.65)
• Low Fuel Price	0.146	$264.00	$1559.85	($39.33)	($232.36)
• Very High Fuel Price					

Oil

As oil becomes dirty, its critical properties of lubrication and heat transfer deteriorate. This causes the engine to work harder and generate more heat – energy that is not being used to move the vehicle.

It was assumed 38 percent of the vehicle population was not changing oil according to vehicle manufacturer recommendations. Changing oil regularly is assumed to increase the individual vehicle efficiency by 2 percent.

Tables 6 and 7 summarize average petroleum displacement and direct benefits for oil maintenance at 2 percent and 30 percent participation, respectively.

Table 6: Oil, 2 Percent Participation, Average Petroleum Reduction and Direct Benefit

	Average Conventional Fuel Displaced (billions gallons)	Average Consumer Savings (million $)		Average Change in Gov't Revenue (million $)	
		Discount Rate		Discount Rate	
		12%	5%	12%	5%
2005 to 2010					
With GHG Standards					
• Low Fuel Price	0.0051	$23.83	$38.84	$3.55)	($5.79)
• Very High Fuel Price	0.0050	$23.41	$38.11	($3.49)	($5.68)
Without GHG Standards	0.0051	$24.03	$39.19	($3.58)	($5.84)
• Low Fuel Price	0.0050	$23.57	$38.40	($3.51)	($5.72)
• Very High Fuel Price					
2005 to 2020					
With GHG Standards					
• Low Fuel Price	0.0048	$13.83	$54.41	($2.06)	($8.11)
• Very High Fuel Price	0.0047	$13.52	$53.07	($2.02)	($7.91)
Without GHG Standards	0.0052	$14.46	$57.65	($2.16)	($8.59)
• Low Fuel Price	0.0050	$14.01	$55.62	($2.09)	($8.29)
• Very High Fuel Price					
2005 to 2025					
With GHG Standards					
• Low Fuel Price	0.0047	$8.54	$50.63	($1.27)	($7.55)
• Very High Fuel Price	0.0046	$8.34	$49.32	($1.24)	($7.35)
Without GHG Standards	0.0052	$9.03	$54.70	($1.35)	($8.16)
• Low Fuel Price	0.0050	$8.72	$52.49	($1.30)	($7.83)
• Very High Fuel Price					

Table 7: Oil, 30 Percent Participation, Average Petroleum Reduction and Direct Benefit

	Average Conventional Fuel Displaced (billions gallons)	Average Consumer Savings (million $)		Average Change in Gov't Revenue (million $)	
		Discount Rate		Discount Rate	
		12%	5%	12%	5%
2005 to 2010					
With GHG Standards					
• Low Fuel Price	0.076	$357.18	$582.01	($53.25)	($86.76)
• Very High Fuel Price	0.074	$350.79	$571.14	($52.30)	($85.14)
Without GHG Standards	0.076	$360.12	$587.32	($53.69)	($87.55)
• Low Fuel Price	0.074	$350.79	$571.14	($52.30)	($85.14)
• Very High Fuel Price					
2005 to 2020					
With GHG Standards					
• Low Fuel Price	0.072	$207.32	$815.34	($30.92)	($121.56)
• Very High Fuel Price	0.070	$202.59	$795.31	($30.22)	($118.58)
Without GHG Standards	0.077	$216.70	$863.84	($32.32)	($128.78)
• Low Fuel Price	0.070	$202.59	$795.31	($30.22)	($118.58)
• Very High Fuel Price					
2005 to 2025					
With GHG Standards					
• Low Fuel Price	0.071	$128.03	$758.72	($19.10)	($113.13)
• Very High Fuel Price	0.069	$125.01	$739.10	($18.65)	($110.21)
Without GHG Standards	0.078	$135.34	$819.64	($20.19)	($122.20)
• Low Fuel Price	0.069	$125.01	$739.10	($18.65)	($110.21)
• Very High Fuel Price					

Combination of Air Filter, Oil, and Tire Maintenance

Fuel savings from more diligent maintenance practices accrue by reducing the deterioration rate of the vehicle's fuel economy due to deteriorating vehicle performance. Thus, the savings from combined maintenance practices are not the additive of the individual savings, i.e., under "perfect" conditions, each vehicle has a maximum fuel economy it can obtain.

For the combination of maintenance practices, 14 percent fuel saving was calculated. It was estimated that 54 percent of the population had low tires, and dirty air filters and oil. This was based on the data regarding the population of low tires (54 percent) and the combination of the population for dirty air filters and oil (54 percent).

For the combined maintenance practices option, the table shows only the potential fuel savings with an ad campaign effecting a 30 percent participation. It was assumed behavior was changed for one cycle of maintenance or approximately 2 years for each participant.

Table 8 summarizes average petroleum displacement and direct benefits for air filter, oil, and tire maintenance at 30 percent participation.

Table 9 summarizes the cumulative petroleum displacement and benefits for air filter, oil, and tire maintenance at 30 percent participation.

Table 8: Combined Maintenance Practices, 30 Percent Participation, Average Petroleum Displaced and Direct Benefits

	Average Conventional Fuel Displaced (billions gallons)	Average Consumer Savings (million $)		Average Change in Gov't Revenue (million $)	
		Discount Rate		Discount Rate	
		12%	5%	12%	5%
2005 to 2010 With GHG Standards					
• Low Fuel Price	0.687	$3208.71	$5235.73	($483.26)	($787.22)
• Very High Fuel Price	0.673	$3150.67	$5137.00	($474.62)	($772.51)
2005 to 2020 With GHG Standards					
• Low Fuel Price	0.652	$1852.19	$5235.73	($483.26)	($787.22)
• Very High Fuel Price	0.636	$1809.29	$7137.82	($274.09)	($1075.31)
2005 to 2025 With GHG Standards					
• Low Fuel Price	0.644	$1140.17	$6803.33	($173.26)	($1025.84)
• Very High Fuel Price	0.626	$1112.74	$6625.45	($169.17)	($999.34)

Table 9: Petroleum Reduction and Benefits for Improved Maintenance Practices

Alternative Fuel Option or Scenario	+Displacement in 2025, Billion gal/yr gasoline equivalent	Reduction from Base Case Demand, percent	Highest Cumulative Benefit or Change, Present Value, 2005-2025, 5% discount rate, Billion $2005				
			A	B	C	D	A+B+C+D
			Direct Non-Environmental Benefits	Change in Government Revenue	Direct Environmental Net Benefit	External Cost of Petroleum Dependency	Direct Net Benefits
30% Participation With GHG • Highest Fuel Price	0.89	4.26	7.18	(1.00)	1.46	0.78	8.51

Uncertainties

- There is an uncertainty regarding the number of California consumers who do not perform regular maintenance since statistical data was drawn from nationwide surveys. The surveys also did not determine if maintenance practices were delayed versus not performed.

- The statistical data does not indicate what percentage of consumers continues with regular maintenance once they are induced to change behavior. This added knowledge would assist in establishing a baseline condition from which we could measure the effect of consumer change on gasoline consumption and savings.

- Consumer benefits and gasoline savings also depends on things beyond their control such as weather and the cost of gasoline.

- There is a pervasive view in the transportation sector that consumer information campaigns for fuel conservation measures will not produce large or long-term impacts on energy use. The electricity sector held an analogous view prior to campaigns for electricity conservation – individual conservation actions could not sufficiently impact California demand for energy.

Endnotes

[1] California Energy Commission staff experience with providing information to media and web sites during gasoline price spikes and electricity shortages.

[2] DeCicco, John M., *Final Report on the Green Vehicle Market Alliance Project*, prepared for Oak Ridge National Laboratory, March 2004.

[3] March 1999, June 2000, December 2000, March 2001, December 2001, and January 2003.

[4] Ogilvy Public Relations Worldwide, "Applying social Marketing Principles to Selling 'Green' Cars," presentation by C. Black to the Workshop on Marketing Clean and Efficient Vehicles, University of California – Davis, March 22-23, 2001.

[5] www.fypower.org/save_gasoline/

[6] "State makes progress in kicking oil habit," San Francisco Chronicle, October 24, 2004.

[7] [www.carcarecouncil.org/service_schedule.shtml], March 2005. The percentages are not mutually exclusive, i.e. some of the cars that had dirty engine oil also had low tire pressure.

[8] Ibid.

[9] National Care Council [www.carcarecouncil.org], (March 21, 2005)

[10] Ibid.

[11] Ibid.

[12] Calcars, modeling run conducted by the California Energy Commission in February/March 2005.

[13] Form 6197, "Gas Guzzler Tax," Department of the Treasury, Internal Revenue Service, January 2004.

[14] Department of Transportation's annual report to Congress for 2001 model year vehicles stated an average fuel economy of 24.4 miles per gallon. Environmental Protection Agency's annual report to Congress stated 23.9 to 20.4 miles per gallon for the 2001 model year.

[15] "American's Low Energy IQ: A Risk to Our Energy Future: Why America Needs a Refresher Course on Energy," *Tenth Annual National Report Card: Energy*

Knowledge, Attitudes, and Behavior, National Environmental Education & Training Foundation and Roper ASW, August 2003.

[16] www.fueleconomy.gov/feg/info.shtml: How are fuel economy estimates obtained?

[17] Davis, Stacy and Susan Diegel, Oak Ridge National Laboratory, Center for Transportation Analysis, *Transportation Energy Data Book: Edition 24*, ORNL-6973, December 2004.

[18] Bluewater Network, *Fuel Economy Falsehoods: How government misrepresentation of fuel economy hinders efforts to reduce global warming and US dependence on foreign oil*, October 2002 revision and re-issue.

[19] Steve Nadel and Marty Kushler, "Public Benefit Funds: A Key Strategy for Advancing Energy Efficiency," *The Electricity Journal*. October 2000. Pp. 74-84.

[20] www.fueleconomy.gov

[21] Cost assumes an initial expenditure to develop the media campaign and the cost of television air time. Estimate based on the Electric Vehicle Consumer Awareness Program, prepared by Edson + Modisette for the U.S. Department of Energy and the California Energy Commission and Summary of Dealer Fuel Efficiency Incentive Program Proposal by Ecos Consulting for the California Energy Commission.

[22] U.S. Department of Energy and Environmental Protection Agency, "Gas Mileage Tips," [www.fueleconomy.gov/feg/maintain.shtml], (March 21, 2005).

[23] Cummins, *Secrets of Better Fuel Economy: The Physics of MPG*, December 2003.